

AES Modular Power Systems Project

Advanced Exploration Systems Program | Human Exploration And Operations Mission Directorate (HEOMD)



ABSTRACT

The AES Modular Power Systems (AMPS) project will demonstrate and infuse modular power electronics, batteries, fuel cells, and autonomous control for exploration ground system demonstrations; assess and provide recommendations for improvements of proposed power systems for other Advanced Exploration Systems (AES) projects/HEOMD demonstration systems; and develop modular power design concepts that will guide the ground system demonstrations and modular component and assembly development for the duration of this project.

ANTICIPATED BENEFITS

To NASA funded missions:

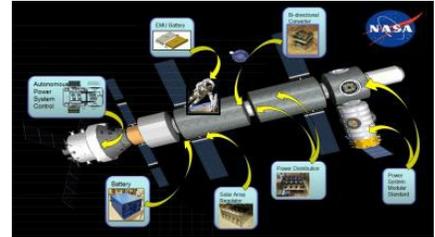
By optimizing across multiple platforms, AMPs power systems designs will differ from those that would be developed by considering one application in isolation. It is this multivehicle commonality that will provide the cost savings for NASA's planned fleet of flight hardware and reduce the number and mass of spare parts/components required.

To NASA unfunded & planned missions:

By optimizing across multiple platforms, AMPs power systems designs will differ from those that would be developed by considering one application in isolation. It is this multivehicle commonality that will provide the cost savings for NASA's planned fleet of flight hardware and reduce the number and mass of spare parts/components required.

To other government agencies:

Modular power system technology improvements and cost savings realized from this project would also be applicable to other government space projects that use similar power systems..



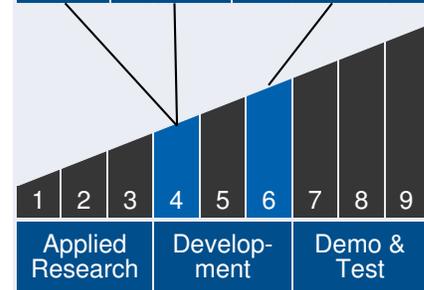
Modular Power Approach for Future Systems

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Technology Maturity

Start: 4 | Current: 4 | Estimated End: 6



Management Team

Program Director:

- Jason Crusan

Program Executive:

- John Warren

Continued on following page.

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To the commercial space industry:

The commercial space industry would also benefit from the technology improvements and cost savings realized from this project.

To the nation:

Because of the potential commonality across multiple space exploration vehicles and spacecraft for NASA, other government agencies, and commercial space industry, the technology improvements and cost savings realized from this project would also benefit the nation.

DETAILED DESCRIPTION

The goals of this project are to 1) develop modular power design concepts for human exploration flight vehicles (longer-term) and assess, develop, and/or improve power system designs for AES/HEOMD ground/flight demonstrations (nearer-term); 2) demonstrate the modular power design concepts, by participating in annual ground demonstrations, infusing power technologies developed by the Space Technology Program Game Changing Development (GCD) Space Power Systems (SPS) project, Small Business Innovative Research (SBIR), and other government agencies as practicable; and 3) demonstrate and verify the operation of the modular power systems in a relevant, end-to-end, ground test environment. Specifically, the AMPS project will:

- 1) Continue to develop and demonstrate improved performance of high-capacity batteries for the Advanced Extra-Vehicular Mobility Unit (AEMU) Power and Life Support System (PLSS) space suit system for the AES Extravehicular Activity (EVA) project;
- 2) Continue to develop and demonstrate performance and operation of modular power electronics hardware in a relevant, virtual, end-to-end ground based testbed environment for the AES Integrated project;

Management Team (cont.)

Project Manager:

- Patrick George

Technology Areas

Primary Technology Area:

Space Power and Energy Storage (TA 3)

Secondary Technology Area:

Space Power and Energy Storage (TA 3)
└ Energy Storage (TA 3.2)

Additional Technology Areas:

Space Power and Energy Storage (TA 3)
└ Energy Storage (TA 3.2)
 └ Batteries (TA 3.2.1)
└ Power Management and Distribution (TA 3.3)
 └ Fault Detection, Isolation, and Recovery (TA 3.3.1)
 └ Management and Control (TA 3.3.2)
 └ Hierarchical Control of a Power System (TA 3.3.2.1)
└ Distribution and Transmission (TA 3.3.3)
 └ Modular High- and Low-Power Switchgear (TA 3.3.3.3)
└ Conversion and Regulation (TA 3.3.5)
 └ Modular Power Converters (TA 3.3.5.3)

Robotics and Autonomous Systems (TA 4)

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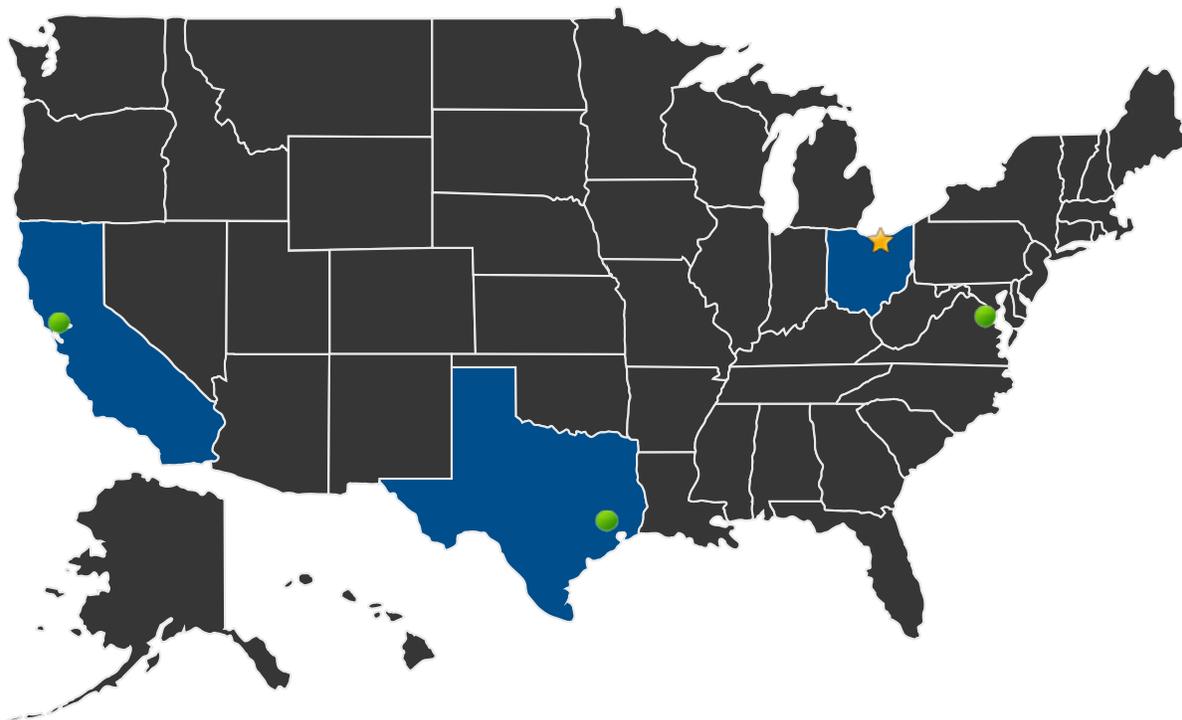
- 3) Procure a 1kW fuel cell stack for vibration testing and conduct further development for the Space Launch System (SLS) Exploration Upper Stage (EUS) application;
- 4) Design and build two AMPs modular Power Distribution Units (PDUs) with controllers and provide design concepts for modular converter and battery for infusion into the Space Technology Mission Directorate's (STMD) Solar Electric Propulsion (SEP) project;
- 5) Continue to develop an autonomous control power system utilizing features which will allow the power system to operate in certain nominal or failure situations without ground or crew intervention;
- 6) Develop a modular standard which may be used by NASA and other national and international space government agencies and industry to improve power availability and reliability; and
- 7) Conduct a Mars power system technology demonstration study to determine the most appropriate technology to provide power to a demonstration sized In-Situ Resource Utilization (ISRU) plant.

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U.S. WORK LOCATIONS AND KEY PARTNERS



■ U.S. States With Work

★ **Lead Center:**
Glenn Research Center

● **Supporting Centers:**

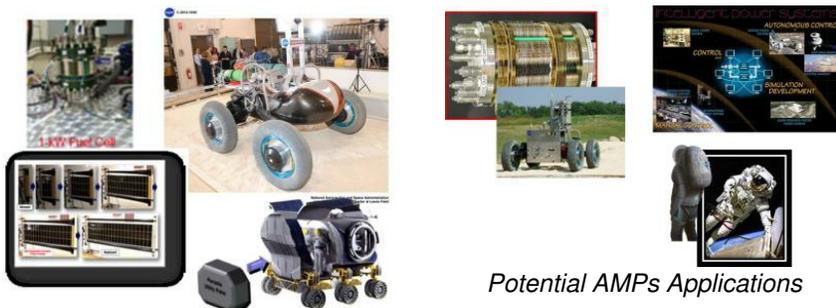
- Ames Research Center
- Johnson Space Center
- NASA Headquarters

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IMAGE GALLERY



AES Modular Power Systems (AMPs)

Potential AMPs Applications

DETAILS FOR TECHNOLOGY 1

Technology Title

AES Modular Power Systems

Technology Description

This technology is categorized as a hardware system for manned spaceflight

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- 1) Continue to develop and demonstrate improved performance of high-capacity batteries for the Advanced Extra-Vehicular Mobility Unit (AEMU) Power and Life Support System (PLSS) space suit system for the AES Extravehicular Activity (EVA) project;
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- 7) Conduct a Mars power system technology demonstration study to determine the most appropriate technology to provide power to a demonstration sized In-Situ Resource Utilization (ISRU) plant.

Capabilities Provided

The AMPs project will develop modular power elements with standard power, mechanical, and thermal interfaces to provide commonality across different space exploration vehicles and spacecraft, including launch vehicles, habitats, landers, rovers, and other transport vehicles that the Agency expects to build. Common modular power system modules will reduce development, testing and flight system costs and improve the affordability and reliability of future space exploration power systems.

Potential Applications

AMPs modular power units with standard interfaces could be combined to provide modular commonality across a variety of space exploration vehicles and spacecraft, including deep space and planetary surface habitats, landers and rovers, electric propulsion systems, launch vehicles, and other spacecraft and vehicles. Specifically, the AMPS project is developing batteries for the Extravehicular Activity (EVA) Portable Life Support System (PLSS) within the EVA Suit Development project, a Non-Flow-Through (NFT) fuel cell as a possible replacement energy storage source for the Space Launch System (SLS) Extended Upper Stage (EUS), modular power system hardware and software for a virtual spacecraft testbed for the Exploration Integrated project, modular Power Distribution Units (PDUs) with controllers and modular converter and battery design concepts for the Space Technology Mission Directorate's (STMD) Solar Electric Propulsion (SEP) project.