National Aeronautics and
Space Administration

# Solar Electric Propulsion

## *Developing solar electric power and propulsion systems for efficient travel beyond low-Earth orbit*

NASA facts

### Expanding Our Reach

Once they are placed into orbit and separated from their launch vehicle, spacecraft must rely on their onboard propulsion systems for any further maneuvering. For certain deep-space missions, the onboard propulsion systems and their required propellant may make up more than half of the overall spacecraft mass. By utilizing solar electric propulsion (SEP), the mass of the propulsion system and propellant can be reduced by up to 90 percent by augmenting the propellant with energy from the Sun. As a result, SEP is a cost-efficient method to transport cargo to the deepest reaches of space.

### Lighter and Longer Mission Solutions

SEP will be demonstrated on Gateway's Power and Propulsion Element (PPE). This demonstration will

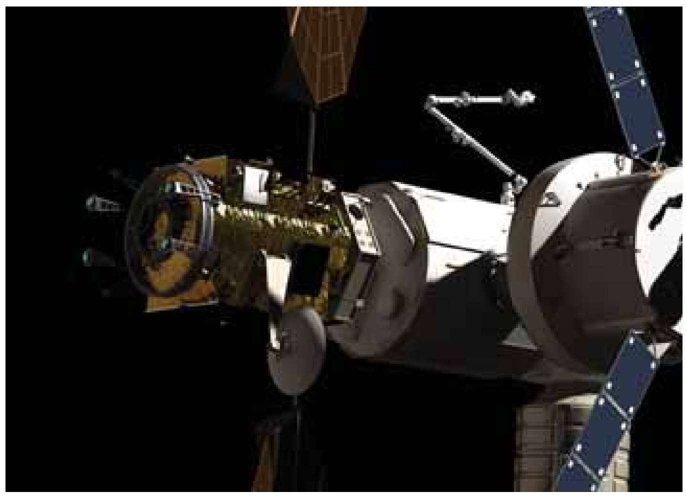
- Demonstrate technology applicable to other Government and commercial uses
- Reduce costs for interplanetary missions, including robotic and cargo missions to Moon and Mars
- Enable future long-duration, deep-space robotic exploration
- Lead to very high power systems for human interplanetary exploration

### Technological Advantages

Mission needs for high-power SEP are driving the development of advanced technologies including magnetically shielded ion propulsion thrusters and high-voltage power processing units. Utilizing electric power from solar arrays to ionize and accelerate xenon gas, highly efficient thrust is produced using one-tenth of the propellant required by conventional chemical propulsion systems. SEP enables spacecraft weight reduction, increases flexibility of mission design and provides higher delta-V systems.

### Hall Thrusters

The high-power SEP systems under development use electrostatic Hall thrusters instead of chemical rocket engines. A Hall thruster uses electricity and xenon gas to create a plasma that comprises electrons and ions. The thruster electric field accelerates xenon ions to extremely high velocities and expels them to produce the thrust that propels the spacecraft.



*Power and Propulsion Element (PPE) with Hall thruster electric propulsion systems.*

### Power Processing Units

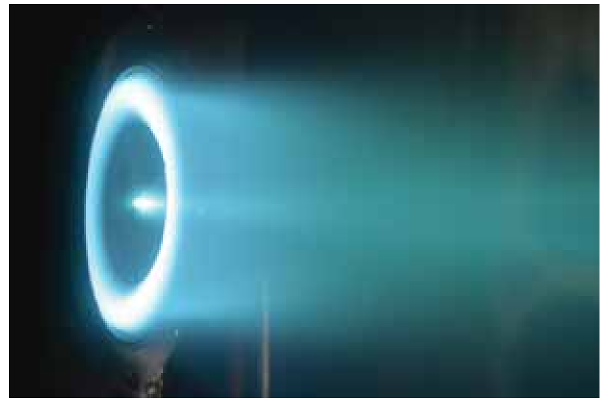
High-voltage power processing units condition electricity generated by solar arrays into voltages and currents needed to operate Hall thrusters.

Combining SEP technologies enables high-fuel-efficiency spaceflight missions beyond low-Earth orbit at much lower mass and cost than is achievable with conventional chemical propulsion systems.

## Plasma Diagnostics Package

The Plasma Diagnostics Package (PDP) will collect plasma plume data in orbit from the PPE ion propulsion system. PDP in-orbit data is necessary to eliminate the conservatism in plume modeling based on ground testing.

- PDP data will improve model fidelity and assist in reducing SEP operational risks.
- PDP data will assist in extensibility models for future SEP spacecraft.
- More accurate plume models will assist in mitigating the risks of plasma plume interaction for PPE and Gateway.



*Hall Effect Rocket with Magnetic Shielding (HERMeS) Technology Development Unit shown during testing in Vacuum Facility-5 at NASA Glenn Research Center.*

## The Future: NASA Explore Moon to Mars

NASA is developing and demonstrating SEP technologies needed to affordably enable human missions to the Moon and Mars. A high-power SEP spacecraft can be used to transport cargo, payloads, and other spacecraft elements required for crewed exploration beyond low-Earth orbit. The SEP technology enables a range of other commercial and Government missions.

## Glenn Leads SEP for the Agency

NASA Glenn Research Center in Cleveland, Ohio, is the Agency's lead center for research development. NASA Glenn performs in-house SEP technology development activities and oversees SEP contracted efforts as well as teamed efforts supported by contractors at the NASA Jet Propulsion Laboratory. NASA Glenn also recently awarded a contract to Aerojet Rocketdyne for development of a high-power Hall thruster, power processing unit, and xenon flow controller to be used on SEP missions.

## SEP Key Facts

- Allows deep-space missions to carry more cargo and use smaller launch vehicles while reducing mission costs
- Provides such high fuel economy that it reduces the amount of propellant required onboard vehicles for deep-space missions by as much as 90 percent
- Enables affordable human-crewed missions beyond low-Earth orbit

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## MORE INFORMATION

For more Information visit www.nasa.gov/mission_pages/tdm/sep/index.html.

FS-2019-04-056-GRC

PS-02859–0419