National Aeronautics and
Space Administration

NASA GLENN RESEARCH CENTER

ELECTRIC PROPULSION

NASA is developing vital electric propulsion technologies to help government and commercial customers extend the length and enhance the capabilities of ambitious new exploration and science missions. These advanced propulsion technologies deliver the right mix of cost savings, safety and superior fuel economy to support a variety of next-generation journeys to deep space destinations.

NASA GLENN LEADS ELECTRIC PROPULSION

NASA's Glenn Research Center is the lead center for the agency's electric propulsion efforts. Its researchers and engineers are developing and demonstrating high-power electric propulsion systems as well as supporting technologies, including high-voltage power management and distribution and spaceflight diagnostics for measuring system performance. NASA Glenn performs in-house technology development, oversees contracted efforts and collaborates with other NASA centers and commercial partners on electric propulsion efforts.

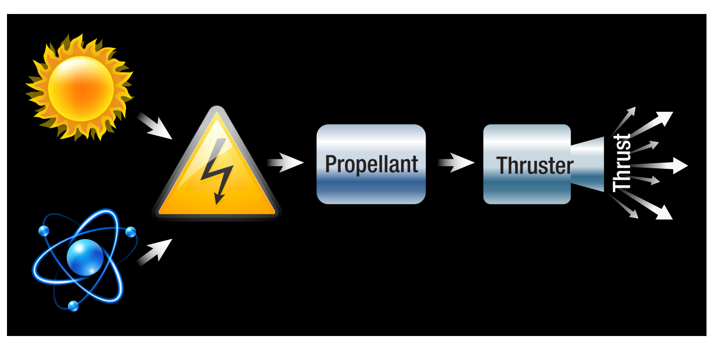
HOW ELECTRIC PROPULSION WORKS

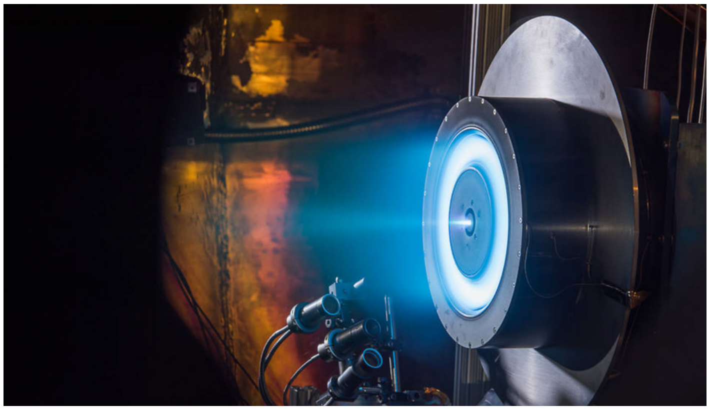
Electric propulsion systems are capable of using electric power from various power sources, but solar and nuclear are the primary options. The systems then use that power to ionize and accelerate inert gases to produce highly-efficient, long-duration thrust, ultimately reducing the amount of fuel needed by up to 90 percent compared to the current chemical in-space propulsion systems.

A solar electric propulsion (SEP) system uses sunlight collected by solar arrays for electric power generation, while a nuclear electric propulsion (NEP) system uses a nuclear heat source coupled to an electric generator. As a result, both SEP and NEP are cost-effective methods to reach the deepest destinations in space.

Electric propulsion systems consist of four main parts:

- The power source (solar or nuclear)
- The power processing unit (PPU) converts the source electrical power into the power required for each component of the electric propulsion thruster
- The propellant management system (PMS) controls the propellant flow from the respective tank to the thruster
- The thruster processes the power and propellant to produce thrust



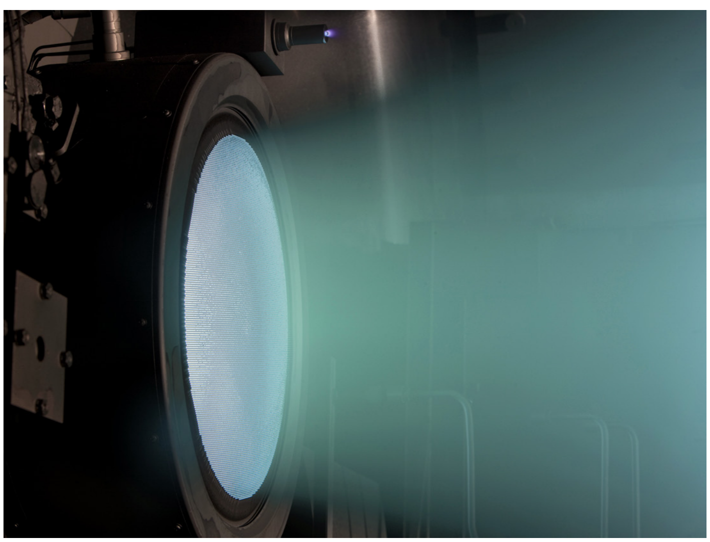


Hall Thrusters

The high-power SEP systems under development use Hall thrusters which generate and trap electrons in an intense magnetic field, using them to ionize the propellant into a plasma plume. The plume is then accelerated by an electric field and expelled to create thrust capable of more than 65,000 mph—enough force to move cargo and perform orbital transfers. Several Hall thrusters can be combined to increase overall system power. In 2015, NASA Glenn successfully tested a 12.5-kilowatt (kW) Hall thruster that employs magnetic shielding, enabling it to operate continuously for years—a capacity important to deep-space exploration missions.

Gridded Ion

Gridded ion thrusters, similar to Hall thrusters, use electrical energy to create positively-charged particles, or ions. However, these thrusters accelerate the ions using an electric field applied across a pair of plates called grids. This electric field attracts the positively-charged particles to the negatively-charged plate, called the accelerator grid, and are then focused and expelled at high speed through thousands of tiny holes within the grids.



NASA's Evolutionary Xenon Thruster (NEXT) is a 7-kW, state-of-the-art gridded ion thruster capable of exhaust speeds over 90,000 mph and can be operated continuously for several years, making it an attractive, enabling propulsion system for NASA deep-space science missions.

THE FUTURE

Proving Technology for Missions to the Moon and Mars

NASA is developing and demonstrating electric propulsion technologies needed to affordably enable future human missions to the Moon, and eventually Mars, by dramatically reducing the mass of these systems through a reduction in the amount of propellant. A high-power electric power and propulsion spacecraft can be used to transport cargo, payloads and other spacecraft elements required for future robotic and crewed exploration beyond low Earth orbit. These technologies will also enable a range of other commercial and government missions.

The Power and Propulsion Element for Gateway

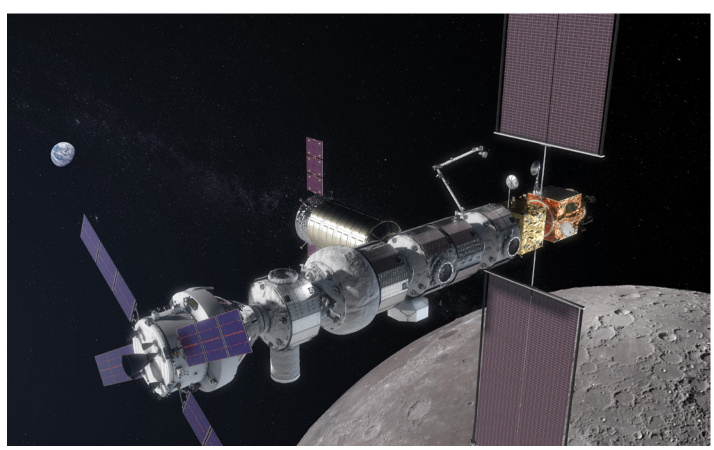
As part of the agency's Exploration Campaign, NASA's Gateway will become the orbital outpost for robotic and human exploration operations in deep space. Built with commercial and international partners, the Gateway will support exploration on and near the Moon and beyond, including Mars.

In support of the Gateway, NASA is developing a high-power, 50-kW SEP spacecraft, known as the power and propulsion element, to maintain and move between lunar orbits. The 50 kW-class SEP system is an important advancement toward future technologies needed to validate the higher power SEP systems required for missions into deep space.

The power and propulsion element will also provide power, controls and high-data rate communications between Earth and deep space. It could also provide other capabilities, such as the ability to carry scientific payloads as well as other types of technology demonstrations.

NASA Glenn is leading this effort, and will work with industry to develop, build and perform a flight demonstration of the spacecraft. Following this in-space flight test, which could last up to one-year after launch, NASA will have the option to acquire the spacecraft as the first element of the Gateway.

To meet current Gateway development planning, NASA is targeting launch of the power and propulsion element on a partner-provided rocket in 2022.



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