

The background of the slide is a space-themed image. It features a large, detailed view of the Moon on the left, with the reddish planet Mars visible in the upper left. A rocket is shown in the center, firing a bright blue plume of exhaust. The sky is a deep blue with many stars. In the bottom right, there is a silhouette of a person's head and shoulders, looking towards the left. The bottom of the image shows a dark, silhouetted horizon line.

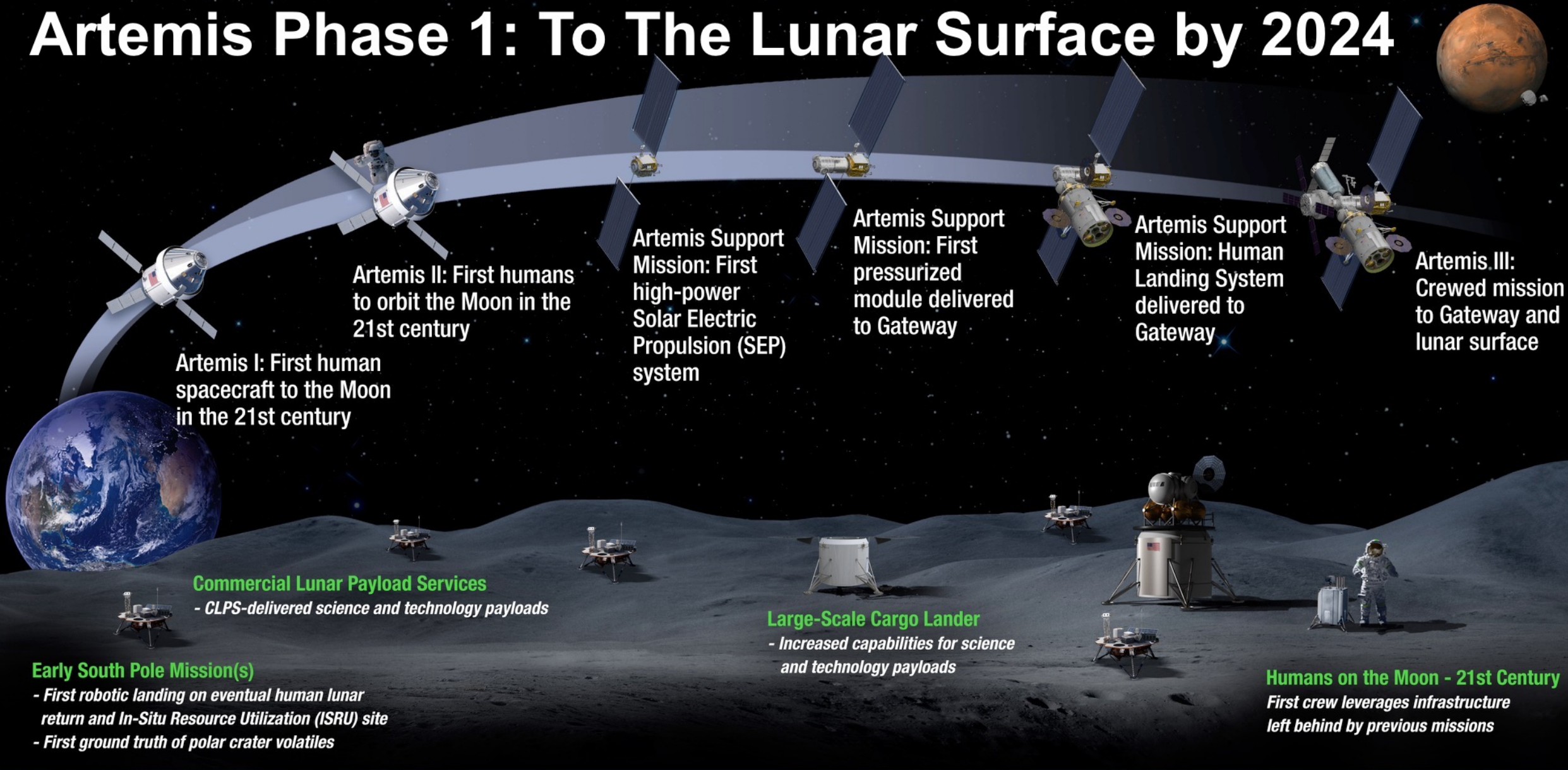
**EXPLORESpace TECH**  
TECHNOLOGY DRIVES EXPLORATION

# NASA Power Development for Artemis

Randall Furnas, NASA Glenn Research Center  
EnergyTech 2019



# Artemis Phase 1: To The Lunar Surface by 2024



## LUNAR SOUTH POLE TARGET SITE

2020

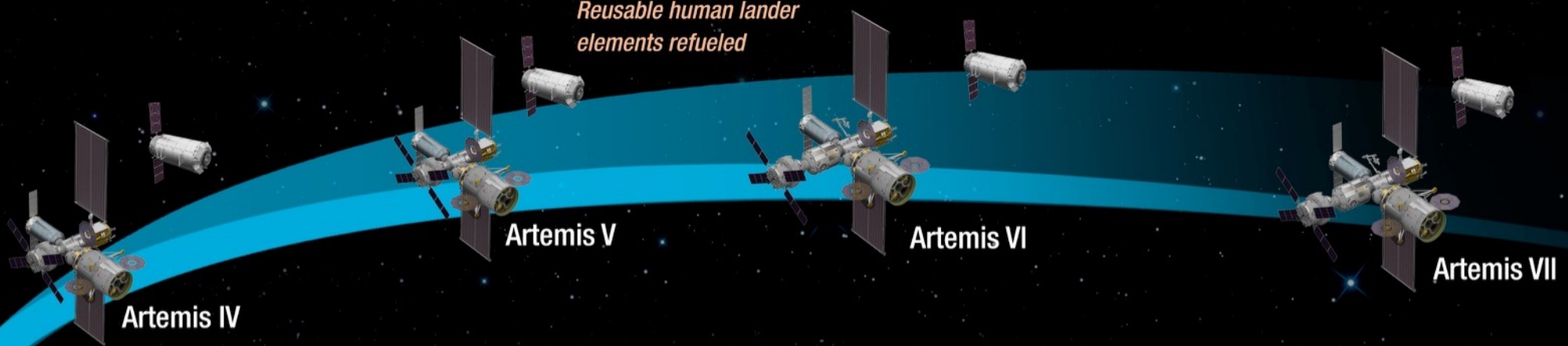
2024



# Artemis Phase 2: Building Capabilities For Mars Missions



*Reusable human lander elements refueled*



Artemis IV

Artemis V

Artemis VI

Artemis VII

**Artemis Support Mission**  
*Lunar surface asset deployment for longer surface expeditions*

CLPS opportunities



## **SUSTAINABLE LUNAR ORBIT STAGING CAPABILITY AND SURFACE EXPLORATION**

MULTIPLE SCIENCE AND CARGO PAYLOADS

INTERNATIONAL PARTNERSHIP OPPORTUNITIES

TECHNOLOGY AND OPERATIONS DEMONSTRATIONS FOR MARS

2025

2029

# Lunar Surface Power

*STMD is developing technologies which can provide the capability for continuous power throughout day and night for lunar and Mars Surface missions.*

## Technology Developments Underway:

- Power Generation
  - Fission Surface Power: Flight reactor demonstration (2027)
  - Adaptable Lunar Lander Solar Array Systems: Requirements definition and concept evaluation leading to a 10kW-class solar array
  - Chemical Heat Integrated Power Source: Develop 100 W-class, 350 hour lunar night power source
- Energy Storage: Develop a sub-kW class, integrated Regenerative Fuel Cell (RFC) and conduct lunar relevant ground testing to demonstrate long-duration energy storage & night power generation (~350 hr)

## Additional Investments:

- Conducting a phased, system level assessment of power architecture for lunar surface missions
- Primary Fuel Cell Technology Tipping Point (September 2019): Demonstrate fuel cell element on early lander using propellant-grade hydrogen and oxygen reactants to extend the lander surface mission duration
- Technology development efforts initiated for surface-to-surface power beaming, advanced rover energy storage technology and power distribution architectures.

