RELIABLE POWER FOR DECADES



The Tyranny of Power in the Dark

Surviving and operating through the lunar night is a priority for NASA and industry

Integrated Rank	Average Integrated Score	Shortfall ID
1	8.1035	1618: Survive and operate through the lunar night
2	7.6118	1596: High Power Energy Generation on Moon and Mars Surfaces
3	7.4345	1554: High Performance Onboard Computing to Enable Increasingly Complex Operations
4	7.3831	1557: Position, Navigation, and Timing (PNT) for In Orbit and Surface Applications
5	7.2473	1545: Robotic Actuation, Subsystem Components, and System Architectures for Long-Duration and Extreme Environment Operation
6	7.2076	1552: Extreme Environment Avionics
7	7.1961	1519: Environmental Monitoring for Habitation
8	7.1679	709: Nuclear Electric Propulsion for Human Exploration
9	7.1145	1304: Robust, High-Progress-Rate, and Long-Dista Autonomous Surface Mobility

Civil Space Shortfalls Source: NASA



Surveyor 7 Source: Wikipedia



Apollo 12 Source: Wikipedia

Globally, R adioisotope Power Systems are being deployed or developed for lunar surface operations



Chang'e 3 Source: Wikipedia



Chandrayaan-3 Source: Wikipedia

Argonaut Source: ESA

WE'RE BUILDING RADIOISOTOPE POWER SYSTEMS

On track to deliver initial RPSs by 2026 and scale production by 2028



zeno

Zeno Power is a leading commercial entity in isotope power, developing next-generation radioisotope power systems for space, maritime, and other frontier environments Founded: 2018 Locations: Washington D.C. and Seattle Team Size: 56 Contracts: > \$65M



Developing Full Suite of RPSs for All Classes of NASA Missions from the Moon to Deep Space

RHUs



Size: $1 \text{ s W}_{t} - 10 \text{ s W}_{t}$ Efficiency: N/A Ready for Launch : 2026





Size: $10s W_e - 100s W_e$ Efficiency: ~5% Ready for Launch : 2027 RSGs



Size: $10s W_e - 100s W_e$ Efficiency: ~25% Ready for Launch : 2028

Executing on Three Contracts for Space and Maritime RPS Deployments









"DISTRIBUTED ENERGY PROVIDED THROUGHOUT THE SEAS" (DEPTHS)

- **Deliverable:** Seabed RPS with energy distribution
- Customer: US Navy
- Radioisotope: Sr-90



- NUCLEAR SATELLITE (LENS)
- **Deliverable:** Small satellite with RPS and electric propulsion
- Customer: US Space Force
- Radioisotope: Sr-90



"PROJECT HARMONIA"

- **Deliverable:** ESG for landers and rovers on the lunar surface
- Customer: NASA
- Radioisotope: Am-241

Enabling Flagship Science at a Fraction of the Cost

Supporting science and commercial activities in cislunar and deep space



NASA

- Enduring lunar night survivability and operation for science missions
- Capabilities historically reserved for flagship missions are now available to SIMPLEx and Discovery class missions
- Available to missions requiring a range of power from W kW



Commercial

- Enduring lunar night survivability and operation for CLPS providers
- Available for integration with commercial payloads
- Available to commercial operations requiring a range of power from W-kW

Key Takeaways from Stakeholder Feedback Survey

1. Strong Engagement Across Sectors

zeno

 Survey effectively captured feedback from NASA, universities, and industry, showing diverse input from relevant stakeholders.

2. Prioritizing Sustainable Lunar Technologies

 Results highlight the need to prioritize investment in technologies that will support sustained and sustainable lunar presence.

3. Clarify NASA's Investment Alignment

• It's important to bridge the gap between survey outcomes and NASA's future investment and procurement decisions for greater impact and clarity.

QUESTIONS

Jacob Matthews Co-Founder and CTO jake@zenopower.com



Zeno Power and the Moon to Mars Objectives

While current RPSs are generally limited to NASA Flagship or New Frontiers missions, Commercial RPSs enable RPS use for CLPS, Artemis, SIMPLEx, and Discovery Class missions

LI-1^L: Develop an incremental lunar power generation and distribution system...

MI-1^M: Develop Mars surface power sufficient for an initial human Mars exploration campaign

SE-6^{LM} – Enable long-term, planet-wide research by delivering science instruments to multiple science-relevant orbits and surface locations at the Moon and Mars.

Relevant STMD Shortfalls Announcement: Advanced Manufacturing, Advanced Materials and Structures, Autonomous Systems & Robotics, Communications & Navigation, Power, and ISRU

WE'VE SECURED OUR INITIAL NUCLEAR FUEL SUPPLY AND FACILITIES

Positioning us to bring our RPSs to market by 2026.

FUEL

zeno

- Zeno has acquired a legacy source of Sr -90 from the Department of Energy – providing fuel for 10+ RPSs
- Zeno is engaged with stakeholders to extract large-scale quantities of Am -241

FACILITIES

• Zeno is under contract with Westinghouse to utilize their radiological facility to build and assemble the initial RPSs



Zeno's Approach to Safety

Lifecycle Mission Safety Framework guides approach for novel space nuclear technologies



See: Gilbert. "Lifecycle Mission Safety for Space Nuclear Power Systems." *Journal of Space Safety Engineering* 2023. Zeno developed novel nuclear safety defense-in-depth principles for RPS

Level 1. Operations

Level 2. Containment

Level 3. Radioisotope

Level 4. Contingency

See: Gilbert and Matthews. "Defense in Depth for Radioisotope Power Systems for Space Applications." *ANS NETS* 2024.