RADIOISOTOPE POWER SOURCES TO SURVIVE THE LUNAR NIGHT BY 2025. A. Q. Gilbert[1], Zeno Power (alex@zenopower.com).

Introduction: Zeno Power is developing a lightweight, high-reliability radioisotope power system (RPS) that enables lunar landers and rovers to survive the lunar night by providing heat and electrical power for 2-5 years.

By using available isotopes and our technological innovations, we can deliver systems that provide hundreds of watts-thermal and tens of watts-electric by 2025. Using thermoelectric conversion systems, we reduce technological complexity and mission risk. Our technology is scalable to support larger missions in the kilowatt range using dynamic conversion and multiple units.

Radioisotope power: Radioisotopes produce heat through radioactive decay on a predictable basis. When coupled with thermoelectric conversion, radioisotopes are high-reliability energy sources. Given the inherent energy density of nuclear power sources, RPSs are lightweight, therefore able to work within the tight mass constraints of interplanetary missions. RPSs powered some of the most important government missions to the Moon, including Apollo experiments, Lunokhod rovers, and Chang'e missions.

However, the extremely limited availability of the government's preferred isotope, plutonium-238 (Pu-238), makes legacy systems unavailable for commercial efforts, as well as other NASA missions. [1] Further, most alternative isotopes face similar supply chain and availability limitations for timely and high volume of deployments.

Zeno Power: Commercial radioisotope innovation can unlock new radioisotope sources for space applications. Drawing on innovations in fuel design and shielding, Zeno Power is building radioisotope systems. With Zeno Power's access to multiple sources of radioisotope supply, we can enable near-term missions and can scale up along with broader lunar commerce.

Zeno Power is developing two types of RPSs: radioisotope heater units (RHUs) and radioisotope thermoelectric generators (RTGs). Our RHUs can provide scalable heat, with systems sized from sub-watt-thermal up to hundreds of watts-thermal. By adding commercial-off-the-shelf high reliability thermoelectric conversion, our RTGs can provide tens of watts-electric. With a long-term half-life, our RHUs and RTGs can provide heat and electrical power for at least 2-5 years.

Zeno Power can deliver either type of RPS for lunar applications by 2025. Our prototype system will be fabricated and evaluated in 2023, with demonstration missions in 2024 and 2025. Underlying our technology is a world-leading team with expertise in nuclear engineering, heat source design, supply chain, radioisotope missions, and regulatory approvals. Recent policy changes have streamlined space nuclear launch approval, reducing regulatory risk by introducing commercial regulatory pathways for the first time.

Commercial Potential: Ultimately, radioisotope innovation can catalyze lunar development by enabling robotic landers, rovers, and more complex systems to not only survive the lunar night, but to thrive. RHUs can be scaled up to ensure that payloads survive for years. RTGs can enable operations during the lunar night or for extended periods in permanently shadowed regions, avoiding hibernation scenarios and increasing mission duration and value.

References:

[1] National Research Council. 2009. Radioisotope Power Systems: An Imperative for Maintaining U.S. Leadership in Space Exploration. Washington, DC: The National Academies Press. https://doi.org/10.17226/12653.