THE LUNAR SURFACE INNOVATION CONSORTIUM IN-SITU RESOURCE UTILIZATION GROUP: STATUS UPDATE AND PATH FORWARD. J. Berdis, A. Coburger, C. Hibbitts, P. Burke, R. Miller, M. Nord, Johns Hopkins Applied Physics Laboratory, 11100 Johns Hopkins Rd., Laurel, MD, 20723 (Jodi.Berdis@jhuapl.edu).

Introduction: The Lunar Surface Innovation Consortium (LSIC) was established by NASA's Space Technology Mission Directorate and is managed by the Johns Hopkins Applied Physics Laboratory. The primary goal of the LSIC is to bring together universities, non-profit institutions, commercial companies, NASA, and other government agencies to advance technologies and overcome challenges involved in establishing a sustained presence on the Moon. LSIC consists of four Capability Areas, and the goal of the In-Situ Resource Utilization (ISRU) Capability Area is to facilitate the development of ISRU-related technology to enable a sustained presence on the surface of the Moon, including fostering communication within and between members of the community.

Past Achievements: Achieving the above goal requires the ISRU Capability Area to be active on multiple fronts. We identify gaps in the technologies that are needed for a sustained presence in order to enable industry's development of ISRU technologies. We have hosted approximately one workshop per year since inception, which has included, but is not limited to, the "Supply and Demand Workshop" in 2020, which led to the determination that the approximate amount of O_2 usage will be on the order of 10s to 100 metric tons/year.

Building off of interest from the community to further investigate O_2 extraction from regolith in lunar gravity, we have conducted research on preliminary computational Fluid Dynamic models of electrolytically-produced O_2 bubbles growing and detaching from an electrode. We have modeled water electrolysis (as a control), molten regolith electrolysis, and molten salt electrolysis in Earth's gravity, lunar gravity, and martian gravity. Different electrode orientations with respect to the g-vector have also been tested. Results were used to develop more detailed models and techniques to mitigate decreased electrolytic efficiency in lunar gravity [1].

Furthermore, we are working torward understanding and defining the needs for a Lunar Proving Grounds (LPG), at which technology developers could achieve system-of-systems testing to prepare for system-level and system-of-systems operations on the lunar surface. We led the organization of an LSIC-wide workshop on LPG Definition, and started the conversation for defining the needs of the users. Several needs identified include a focus on integration, validation, lifecycle testing, humans-in-the-loop, digital engineering tools, and international and small business accessibility.

In September 2024, the LSIC ISRU Capability Area hosted the virtual Oxygen from Regolith (O_2fR) Collaborative Systems Interface Workshop. The objective of this workshop was to provide a framework to help the ISRU community identify quantitative mismatches between upstream and downstream system parameters. The O_2fR Collaborative Systems Interface Study and Workshop mark a significant step forward in coordinating subsystem interactions for lunar ISRU. Takeaways from the event include:

- The need for standardization to ensure interoperability between different organizations' hardware;
- Requirements as well as a better understanding of end-users would help the community improve current design processes; and
- Modularity will be key to scaling up demonstration ISRU systems.

Moving forward, maintaining and building the database of O_2fR System Interface information will make it easier for ISRU stakeholders to collaborate, share data, and build on each other's work. So far, we have created an Integrated Data Worksheet that takes all the ISRU interface data collected and allows the user to filter on upstream and downstream interface, interface parameter, organization, and more. We look forward to meeting with more organizations in the coming year to discuss ISRU-system level design considerations and incorporating participants' interface parameters into the database.

This Next Year: Over this next year, the ISRU Capability Area will direct its efforts into three specific areas. These include (1) a focus on systems engineering and integration, (2) identifying gaps and paths forward for resource reconnaissance water, O_2, and metals extraction, and production of propellant, consumables, and feedstock, and (3) integrating our efforts with those of the other LSIC Capability Areas: Surface Power, Excavation & Construction, and Crosscutting Capabilities.

Conclusion: We continue to invite participation in these activities through active involvement with the Capability Area, and are excited to continue engaging with the lunar ISRU community in 2025.

References: [1] Paul A. Burke, et al., 2024. "Modeling Electrolysis in Reduced Gravity: Producing Oxygen from In-Situ Resources at the Moon and

Beyond." *Front. Space Technol. Sec. Space Exploration*, Volume 5. doi: 10.3389/frspt.2024.1304579