JOHNS HOPKINS
APPLIED PHYSICS LABORATORY

Lunar Technical Mining Value-Chain Architecture Study

LOGIC ISRU Working Group Overview and Update

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LOGIC Website: logic.jhuapl.edu

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LUNAR OPERATING GUIDELINES *for* INFRASTRUCTURE CONSORTIUM

LOGIC

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Introductions

Paul Burke

LOGIC ISRU Working Group

- Computational physicist and expert in multiphase fluid dynamics with experience in studying ocean worlds, astrobiology, human space exploration, and in situ resource utilization (ISRU).
- Has developed computational models of molten lunar regolith electrolysis, leading investigations into extraction of oxygen and metals from lunar regolith; has also modeled planetary defense systems, astrodynamics, chaotic systems, spacecraft instruments, laser ablation, and human systems.
- Teaches and develops computational fluid dynamics curriculum for Johns Hopkins University's Department of Mechanical Engineering.

Mallory Kinczyk

LOGIC ISRU Working Group Lead

- Planetary geologist with expertise in lunar geology, terrain analysis, and remote-sensing investigations focused on understanding the surface evolution of terrestrial planets.
- Science Co-Investigator on ShadowCam on board the Korea Pathfinder Lunar Orbiter; science team affiliate of active missions Lunar Vertex and Lunar Reconnaissance Orbiter Camera, and previously MESSENGER and New Horizons.
- Experience in optical instrument calibration, landing site selection and surface hazard assessment, rover traverse planning, and science-driven surface operations planning.

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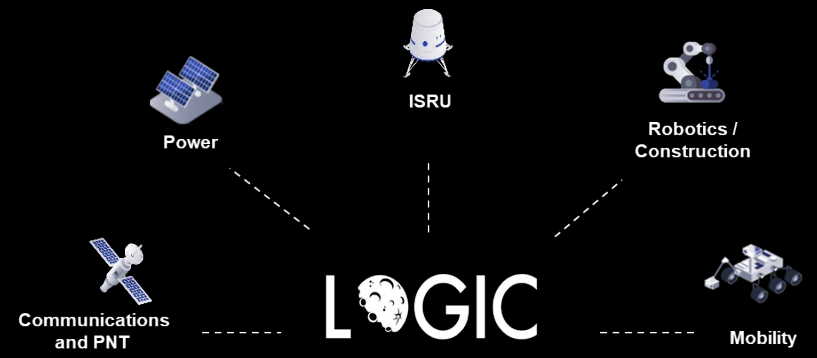
Lunar Guidelines for Infrastructure Consortium (LOGIC) Vision

Vision: LOGIC is the trusted, independent focal point for shaping **interoperability** and sharing information that fuels a global lunar economy. By promoting international and commercial partnerships, LOGIC enables lunar infrastructure systems and products that operate within a cohesive ecosystem.

2026 Focus:

- Advocating for interoperability standards
- Addressing interoperability challenges and opportunities through strong partnerships
- Supporting member-led working groups



Ensuring lunar infrastructure systems that function within a cohesive ecosystem

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LOGIC ISRU Objectives and Past Progress

LOGIC's Goals for ISRU:

- Identify critical interoperability gaps with the lunar mining value chain and lunar resource prospecting data
- Develop community-recommended pathways to close these gaps that enable space sustainability

Work in the Past Year:

- Use case development
  - Gathered community input to develop the following use cases: I1 – Oxygen Production; I2 – Material Storage; I3 – Prospecting; I4 – Metals Production
- Cross-cutting prospecting efforts
  - Conducted two cross-functional meetings on Lunar Resource prospecting

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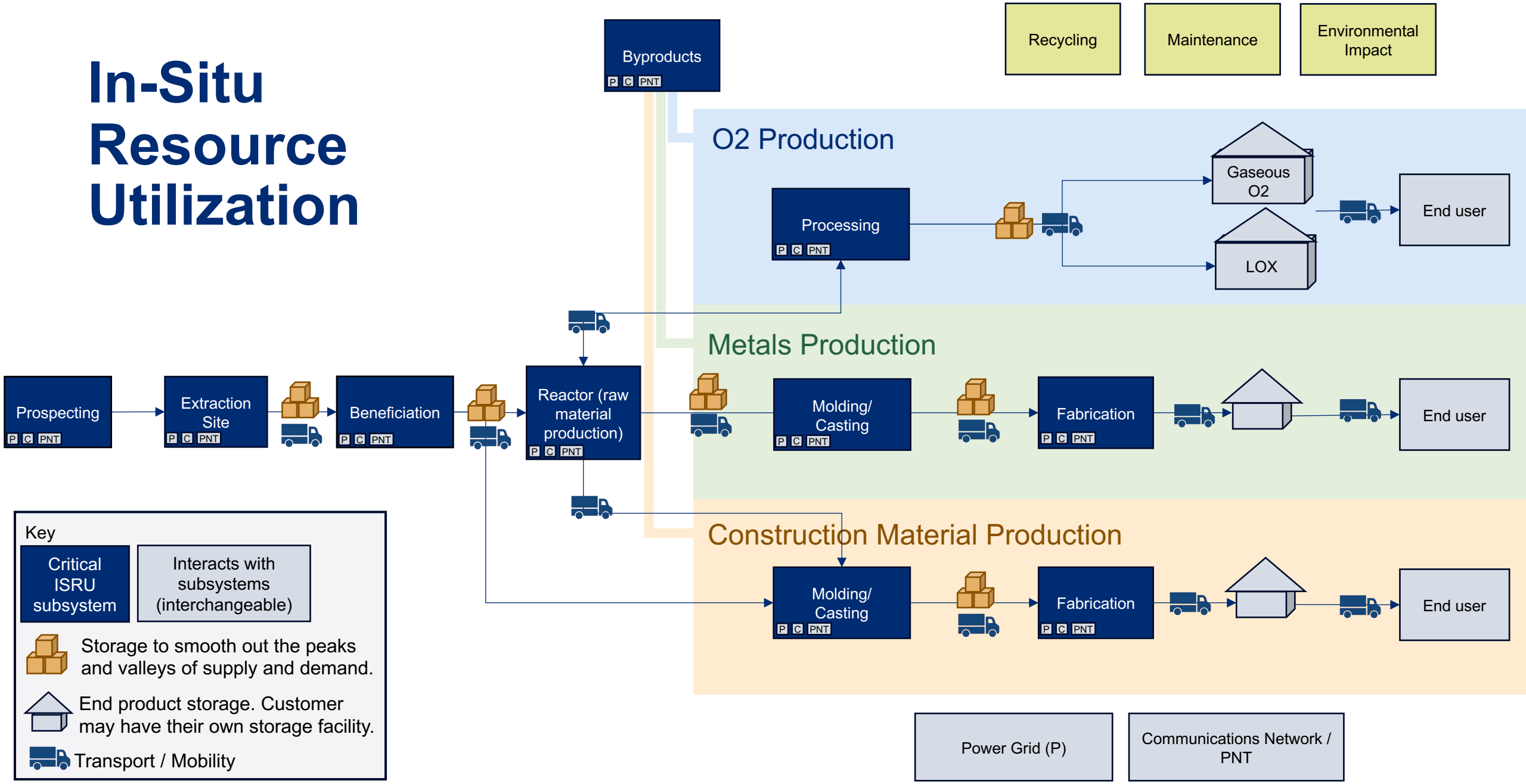
In-Situ Resource Utilization



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LOGIC ISRU – Path Forward

Change in LOGIC ISRU Approach:

- Before standards can be adopted or before designing any system architecture, DATA is needed
  - Where are the resources?
  - How accessible are the resources?
  - What is the state of the resources?
  - Resource distribution and concentration
  - What makes the resource economically viable (i.e., reserve)?

New Guiding Objectives:

- Lunar Mining Value Chain Architecture Study
  - Review existing lunar ISRU and relevant terrestrial mining architectures to determine ISRU interoperability gaps and opportunities
- Lunar Resource Data
  - Leverage interoperability standards such that LOGIC members can benefit from the collection and dissemination of lunar resource data that enables ISRU

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LOGIC ISRU – Path Forward

Lunar Mining Value Chain Architecture Study:

- Goal: Identify interoperability gaps and opportunities for development (gaps to existing architectures, different architecture viewpoints highlighting these gaps, and recommended set of initiatives that could close these gaps)
- Phase 1 – Gather Data – use a broad approach to gain an understanding and catalog all current, relevant architecture studies.
  - Where do standards exist and what gaps remain?
- Phase 2 – Analysis – create a framework and tool to study and identify gaps, iteratively gaining input from the community
- April LOGIC Ad-Hoc meeting solicited community feedback for Phase 1

Lunar Resource Data Study:

- Leverage interoperability standards such that LOGIC members can benefit from the collection and dissemination of lunar resource data that enables ISRU
  - e.g., Adapt terrestrial resource modeling techniques to define how lunar data is analyzed and presented for determining lunar resource potential
- Identify interoperability information gaps (with regard to Lunar Resource Prospecting) and ways to fill those needs

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Lunar Mining Value Chain Architecture Study

- Why this study now?
  - Resource uncertainty remains a first-order architecture driver: concentration, form, accessibility, and reserve confidence.
  - Architecture choices couple across mass, power, losses, timing, storage, logistics, and interfaces.
  - Community alignment is needed on a reference value chain, boundaries, vocabulary, and metrics.
- Scope:
  - Near-term focus: lunar polar water ice to useful water-derived products.
  - Value chain includes prospecting, reserve definition, site access, extraction, capture, processing, storage, transport, delivery, and recycling.
- Interoperability Gaps:
  - What data or product definition crosses these interfaces?
  - Who owns mass, energy, thermal, timing, and safety margins and their corresponding interfaces?
  - Which standards exist, need adaptation, or are missing?
  - Which experiment, model, or demonstration would close the gap fastest?

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Lunar Mining Value Chain Architecture Study

Study Approach

1 Phase 1 - gather and catalog

Lunar ISRU studies, terrestrial mining analogs, assumptions, boundaries, metrics, and existing standards.

2 Phase 2 - analyze and iterate

Create a framework/tool, compare architecture viewpoints, identify gaps, and review with the community.

3 Recommended initiatives

Prioritize standards opportunities, follow-on modeling, experiments, and demonstrations that close interoperability gaps. Create general framework and tool to be used in future Lunar tech value chain studies, to identify interoperability gaps.

Expected Outputs

- Interoperability gap report highlighting identified gaps and opportunities as markets and relevant technologies mature
- Common vocabulary and value-chain decomposition.
- Reference case boundaries and key assumptions.
- Architecture-study catalog and dataset format
- Standards recommendations where appropriate
- Generalizable framework to apply this study to other Lunar value chains

Community Input Needed

- Product definition (current and future market drivers)
- System boundaries
- Dominant variables: resource model, prospecting data resolution and uncertainty, instrument performance and calibration, power, mobility/logistics, processing location, demand?
- Relevant studies, terrestrial analogs, interfaces, or metrics to be considered

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Lunar Resource Data Study

- July LOGIC meeting will concentrate on Prospecting and Lunar Resource Data collection/analysis
- Tuesday July 21 at 1 pm Eastern
- Industry and Governmental Agencies will be presenting their perspectives on Lunar Prospecting

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Looking Foward

- Upcoming LOGIC meetings:
  - **LOGIC Semi-Annual Meeting**
    - *June 16, 2026, 1-2:30PM EST*
  - **Lunar Water Ice Resource Data and Prospecting Panel**
    - *July 21, 2026, 1-2:30PM EST*
- Sign up and become a member of LOGIC!
- Website: https://LOGIC.jhuapl.edu

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