

# INTEGRATING ISRU PROJECTS TO CREATE A SUSTAINABLE IN-SPACE ECONOMY

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## Introduction/Outcome Thinking

Funding for space exploration is limited. Expanding our space capabilities, knowledge and actual presence to the Moon, Mars and elsewhere, is dependent on the concurrent formation and growth of a supporting in-space economy. Without this in-space economy, space exploration will continue to be severely constrained by NASA's budget and the taxpayers' willingness to pay for it. As such, lunar ISRU research projects and other lunar activities need to be modified away from the traditional government-focused approach and transformed to co-create an in-space economy.

This outcome...our future in space...will be enabled by the economic activity that it generates. Lunar ISRU projects can be integrated, right from the start, in a way that co-creates an in-space economy.

## Definitions

Creating a sustainable in-space economy will be easier if we agree on what exactly it is that we're trying to create.

**In-Space Economy:** *products and services in space, that are created, sold, bought, and used in space, that are sourced entirely from the raw materials and other resources found in space.*

Basically, "in space" all around. Note: just because a product or service is *physically* in space doesn't necessarily mean its part of the in-space economy, as defined here.

This definition is important because its also a fundamental definition of a space civilization. Grow an in-space economy to self-sufficiency, and you've just created a sustainable space civilization. They are essentially one and the same.

This definition now becomes a powerful guideline for developing NASA projects, business ideas, efforts, investments, education, legislation and policies that produce *direct* progress towards this goal. Also, we can *objectively* track our progress, via the economic activity that fits within this definition. (FYI the in-space economy is currently \$0!)

**Space Civilization:** *see "In-Space Economy" above.*

**Sustainable:** *self-supporting, maintains its own viability regardless of NASA's budget or lack thereof.*

## Current Value of the In-Space Economy: \$0

### **Products: \$0**

- **There are currently no products made in space from lunar or any other space resource. Everything that's been manufactured in space has been made from material launched from Earth, using hardware that was manufactured and launched from Earth.**

### **Services: \$0?**

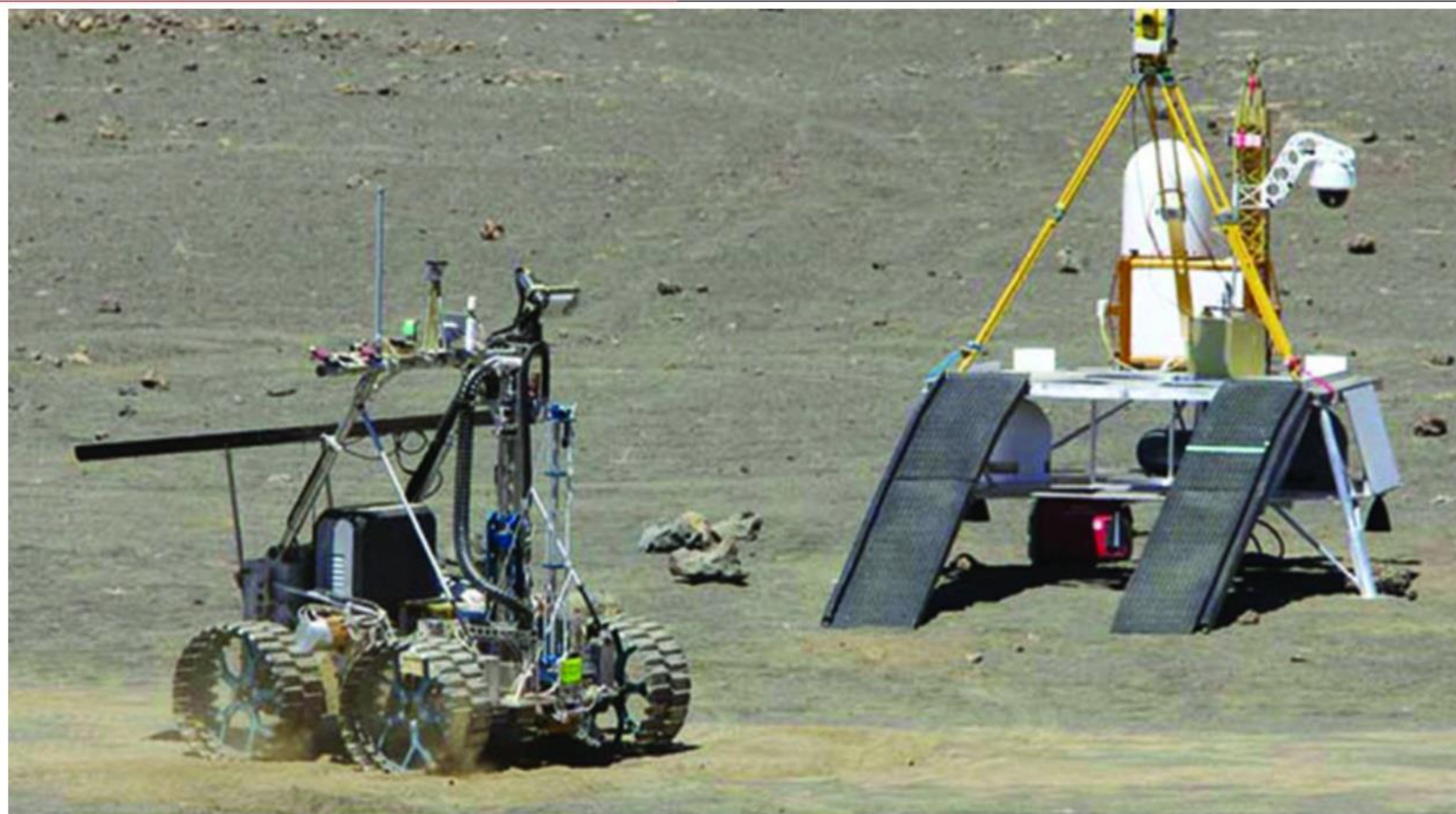
- **It's somewhat subjective whether any of the services currently taking place in space fully fit this definition of "in-space economy". The hardware that's used to provide services in space came from Earth so, technically, these services don't qualify. In addition, almost all of these services (like communications, GPS, imagery, satellite tv, etc.) are for use on Earth...not in space. Commercial cargo services to/from the ISS don't qualify either because that's economic activity between Earth and space.**

**Our efforts have not yet created an in-space economy.**

## Traditional/Unintegrated Lunar ISRU Project (Example)

### **Water Extraction Demonstration:**

Rover navigates to a suitable location on the Moon, drills down into the lunar regolith, analyzes the material, and then processes it to demonstrate water extraction.



RESOLVE, shown during testing on Canada's Artemis Jr. rover, is intended to pave the way toward incorporating the use of space resources into mission architectures. Credit: NASA photo

Photo and caption above from a January 28, 2014 article in SpaceNews.<sup>1</sup> This project didn't go to the Moon, but it serves as a good example of a traditional science mission that might go to the Moon in the future.

- Design lifespan essentially one lunar day.
- Valuable data and knowledge gained.
- No enduring capabilities on the Moon.

## Integrated Version of the Same Project

An integrated version of this same mission might be to break it up into four separate projects/companies that work together in a commercial manner. Each is a separate business that specializes in one area and purchases the service or raw material of the other. Each asset is designed to be very robust with a lifespan of several years.

**Project/Company 1:** Drill.

**Project/Company 2:** Material Analyzer.

**Project/Company 3:** Material processor...water extraction.

**Project/Company 4:** Rover capable of moving payloads (drill rig, regolith, analyzer, processor).

Just as before, water extraction is demonstrated, and the science objectives are met. However, the commercially integrated version also creates:

- A lunar marketplace.
- Economic activity on the Moon.
- Enduring commercial science capabilities/assets on the Moon.

Building this commercial framework on the Moon, right from the start, is an important step in creating an in-space economy. This transformation in the way we do science missions maximizes the benefits of our investments/efforts and improves their financial and political sustainability.

## Other Benefits of an Integrated Approach

- Robust lunar assets are now useable for future projects, resulting in increased affordability...expensive launch cost gets spread out over multiple science and/or commercial missions.
- Each asset/capability on its own is less complex and easier to master than combining all of them in one unit.
- More opportunities for a larger number of people and businesses.
- Increased versatility and flexibility for creating new missions/future business.
- Easier for each company to raise funds/attract investors.
- Congress and the general public perceives growth/benefit/return.

## Conclusion

We don't have to wait for science mission results to transform into commercial capabilities, such as a full-scale commercial lunar water/fuel depot, before we start a lunar/in-space economy. This in-space economy can, and should, start now, with integrated science missions geared specifically to co-create a lunar economy.

## Reference

1. <https://spacenews.com/39307nasa-planning-for-mission-to-mine-water-on-the-moon/>