AMERICAN FOREIGN POLICY COUNCIL
Space Policy Initiative

Space Policy Review

Ten Years Later: How the ELA Predicted America's Lunar Future

By: Peter Garretson

The Big Picture

- **The SLS detour cost America a decade and $50 billion -** While the U.S. spent massively on 1970s shuttle-derived technology, SpaceX developed reusable rockets for a fraction of the cost, proving commercial innovation outpaces government-led programs
- **China is racing to dominate Lunar space -** With plans for a nuclear-powered moon base, industrial lunar facilities, and a $10 trillion Moon-Earth economic zone, China shifted from copying SLS to mimicking SpaceX's reusable Starship design
- **The commercial lunar ecosystem has exploded -** Over 95 companies now have lunar business plans, with billions in private investment creating a robust industry ready for large-scale lunar development across landers, mining, construction, and logistics
- **The ELA provides a proven roadmap -** The 2015 study's public-private partnership model, which inspired CLPS and other programs, estimated establishing lunar propellant production for $49 billion (inflation-adjusted) using commercial providers as NASA's anchor customers
- **America can lead through commercial partnerships -** By canceling Gateway, retiring SLS after Artemis 3, and funding 6-10 commercial providers for lunar infrastructure, the U.S. can establish permanent lunar industrial facilities and enable thousands of Americans to live and work in space

Economic Assessment and Systems Analysis of an Evolvable Lunar Architecture that Leverages Commercial Space Capabilities and Public-Private-Partnerships

Forward

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NexGen Space LLC **Page 1** **Evolvable Lunar Architecture**

On the tenth anniversary of the Evolvable Lunar Architecture (ELA) study,[1] its historical significance has come into sharp focus as a visionary roadmap that helped reframe U.S. Lunar ambitions around sustainability, affordability, and commercial partnership.

Released in 2015, the ELA study catalyzed a shift from

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traditional government-led Moon missions toward a modular, commercially driven architecture—laying intellectual groundwork for programs like Artemis, Commercial Lunar Payload Services (CLPS), and public-private In-Situ Resource Utilization (ISRU) development. Its core principles—such as leveraging reusable systems, tapping Lunar resources, and anchoring federal demand to unlock private investment—have not only shaped NASA policy but now find renewed momentum under the current administration.

The national goal to "Extend human economic activity into deep space by establishing a permanent human presence on the Moon, and, in cooperation with private industry and international partners, develop infrastructure and services that will enable science driven exploration, space resource utilization, and human missions to Mars"[2] inherently requires both scale and high launch rates. For decades it has been understood that expendable architectures cannot achieve the necessary scale and affordable cost.

The Expensive Lesson: Why Commercial Beats Government-Led

Unfortunately, rather than trusting U.S. industry and American ingenuity to succeed in developing reusable rockets, the nation took a decade-long detour attempting to repurpose 1970's shuttle technology to create a shuttle-derived, government-designed and operated expendable heavy lift vehicle, the Space Launch System (SLS). The SLS developed far more slowly and cost way more than what NASA evaluated as 'paper rockets.' As early as 2009, the Augustine commission recognized the mistake, noting the architecture was unaffordable.[3]

Nevertheless, the Congress generously poured in over $49.9 billion on SLS-Orion between 2006 and their first test launch in 2022 ($23.8 billion on SLS and $20.4 billion on the Orion deep space capsule).[4] That's an average of about $3B a year for 16 years against an annual NASA's total budget of about $25 billion. Today, it is estimated that each SLS launch may cost about $4.1 billion,[5] has a very limited stock of engines,[6] and can only support an extremely anemic launch cadence of just once or twice a year.[7] In the interim, SpaceX developed the first-stage reusable Falcon Heavy for about $500 million[8] with a per launch cost of $90 million, and began development of the fully reusable Starship.

The Strategic Imperative: Competing with China

China's economic and strategic goal in space is establishing a commanding position in Cislunar space—the space within the Moon's orbit of Earth.[9] China has ambitious plans to build an International Lunar Research Station (ILRS), a 1.5 megawatt nuclear power plant to power their Moon base,[10] in order to industrialize the Moon,[11] build Lunar Catapults,[12] and build at $10 Trillion Moon-Earth Economic Zone,[13] and eclipse the United States as the dominant spacepower. China's interest in the Moon has changed the strategic environment and the importance of the Moon.[14]

Observing SpaceX's progress, China shifted its strategy from an SLS-like replica to pursuing a fully reusable design similar to Starship for its Long March 9 Super Heavy lift vehicle. There is a reason China chose to pattern the Starship instead of SLS: China realizes that a fully reusable architecture can better support its high cadence goals.

The FY2026 "skinny budget" of the current administration refocuses NASA on "beating China back to the Moon," allocating over $7 billion for Lunar exploration, cancelling Gateway, and phasing out the overbudget SLS "to replace it with more cost-effective commercial systems that would support more ambitious subsequent Lunar missions."[16] With these significant policy shifts, now is the time to freshly consider an even greater embrace of the ELA's recommendations.

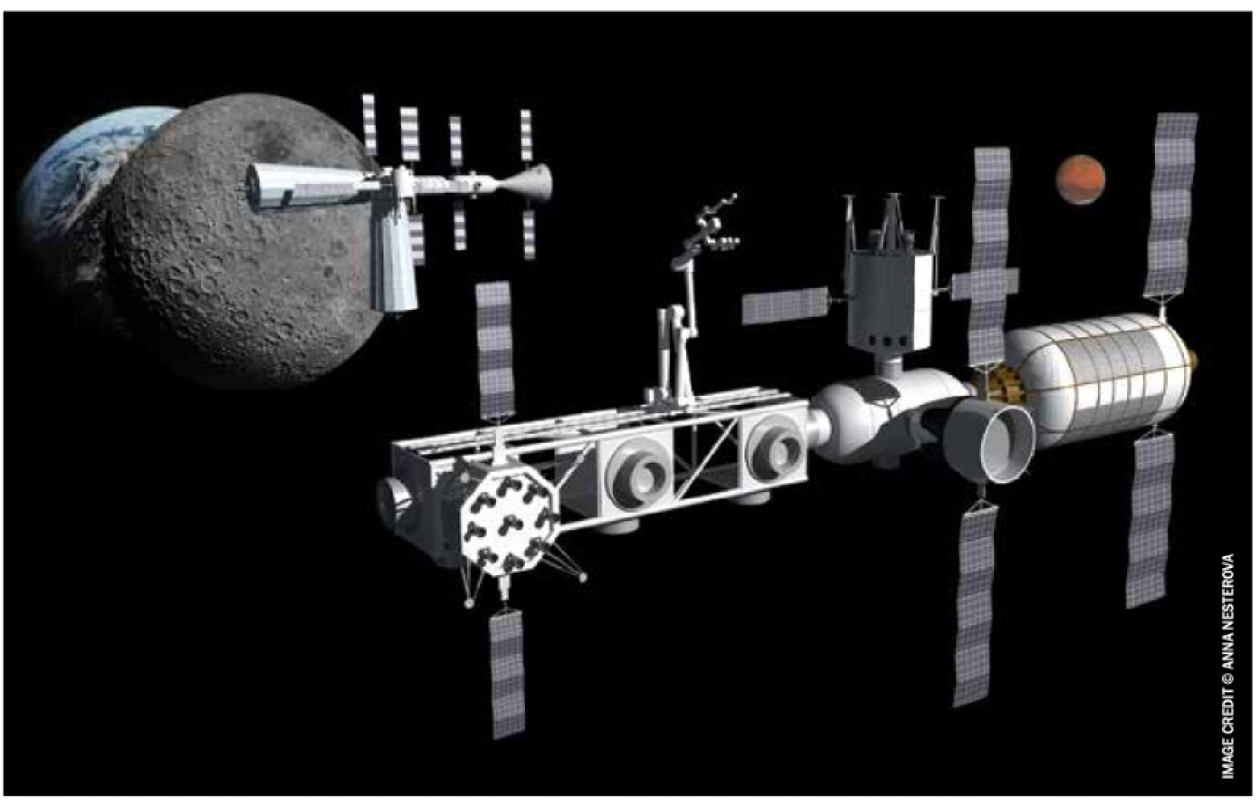
The ELA Framework and Today's Commercial Reality

The Evolvable Lunar Architecture (ELA) study **proposed a transformative public-private partnership (PPP) model** in which **NASA would serve as an anchor customer rather than builder or operator, with private companies owning and operating all Lunar infrastructure.** The study called for **funding at least 6 to 10 commercial providers to develop reusable landers, fuel depots, ISRU systems, and Lunar logistics,** enabling a competitive and resilient industrial base.

Based upon known working successful models as the Commercial Orbital Transportation Service (COTS)[17] which resulted in an **8-to-1 cost savings**, the ELA estimated the total cost of establishing Lunar propellant production and delivery at $38 billion in 2015 dollars—approximately $49.1 billion in 2025—with **an annual spending cap** of $3 billion (**$3.88 billion adjusted**). A single commercial round-trip to the Moon was projected at $475 million, or about $614 million today.

This architecture anticipated and helped shape modern efforts like CLPS and tipping point contracts, and its core logic is now echoed in the current administration's FY2026 budget proposal, built on the same belief: that U.S. leadership on the Moon is best secured by empowering American industry to build and operate the infrastructure.

Since the 2015 Evolvable Lunar Architecture study, **launch costs have dropped dramatically**—SpaceX's Falcon 9 now averages under $3,000/kg to LEO (~20x less expensive than the Space Shuttle), and Starship promises even steeper reductions. The **range of launch options has expanded** with operational heavy-lift vehicles (Falcon Heavy, New Glenn, Vulcan), upcoming com-



Alliance for Space Development (ASD): Propellant depot fueling a Mars transit vechicle (background) & crewed waystation at Earth-Moon LaGrange Point.

mercial super-heavies (Starship), and small launch providers targeting Lunar rideshares. Moreover, there are now five companies pursuing reusable systems: SpaceX (**Starship**), Blue Origin (**New Glenn**), Relativity Space (**Terran-R**), Rocket Lab (**Neutron**), Stoke (**Nova**).

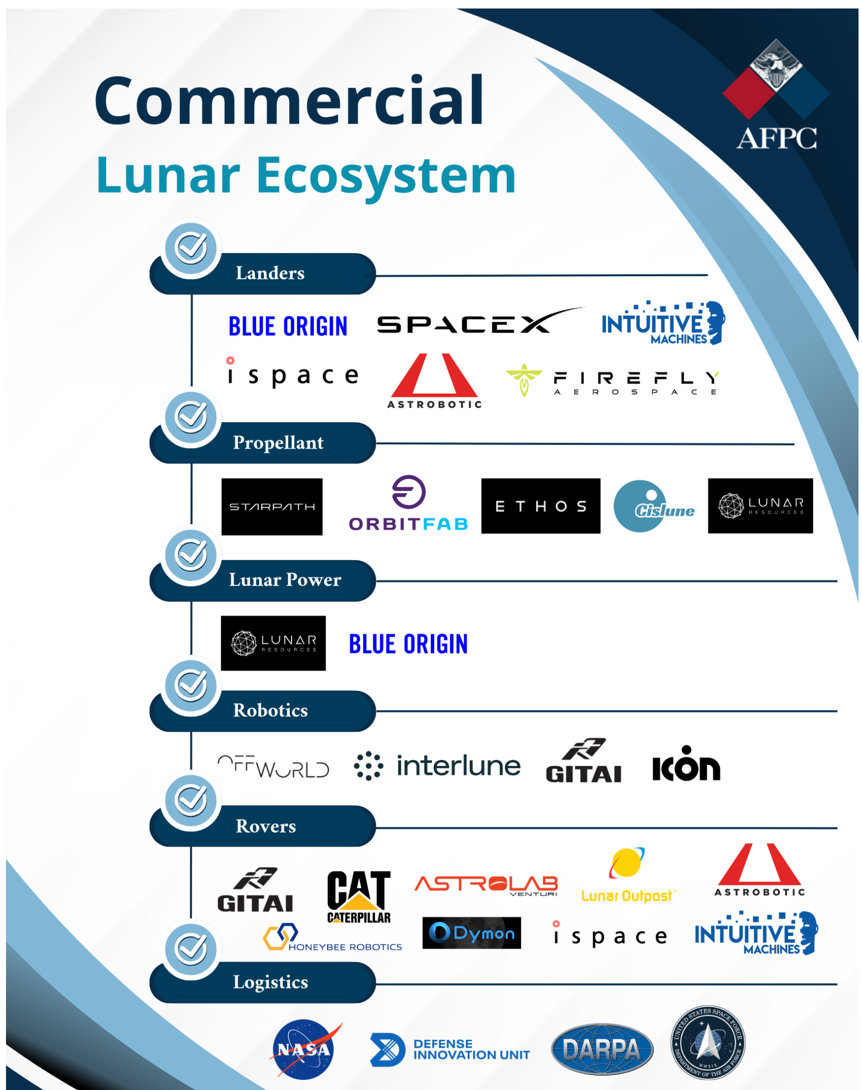
This expanding launch capability has coincided with explosive growth in the broader Lunar ecosystem. In 2021, the Space Force, Defense Innovation Unit (DIU) and Air Force Research Laboratory (AFRL) reported that at least 95 companies already had business plans involving Lunar or Cislunar operations.

This growth stems from two key factors. First, significant private investment has flowed into the sector, with about $10-15 billion invested in Lunar-focused commercial space companies over the past decade. A dedicated Space Resources program now exists at the Colorado school of mines.[18]

Second, substantial government support has helped nurture this commercial ecosystem. The Defense Advanced Research Project Agency's **(DARPA) LunA-10**[19] initiative has engaged 14 companies—such as **SpaceX, Blue Origin**, and **CisLunar Industries**[20]—to develop integrated Lunar infrastructure encompassing power, communications, mobility, and ISRU. NASA has also funded a number of Lunar focused companies: two companies for Human Landing Systems (SpaceX and Blue Origin); three companies for uncrewed cargo landers (Intuitive Machines, Astrobotic, iSpace); NASA Tipping Point Programs with six companies (Astrobotic, Blue Origin, Big Metal Additive, Protoinnovations, Psionic, Zeno Power), as well as four other companies (ICON, Lunar Resources, Nokia, Varda).

As a result, very different than a decade ago, there is now a healthy stable of commercial companies[21] (far beyond just 6-10 providers) ready for an ELA or "Lunar COTS"[22] initiative such as:

- <u>Medium and Large Lunar Landers</u>: U.S. firms like **Blue Origin, SpaceX** are developing medium and large landers.
- <u>Small Commercial Landers</u>: NASA's CLPS program has matured, funding over a dozen missions on smaller private landers with companies like **Intuitive Machines, Astrobotic, Firefly, and iSpace**.
- <u>Propellant Manufacture</u>: At least two companies are pursuing Starship-class propellant manufacture, **Ethos Space Resources**, **Starpath Robotics**, with a broader ecosystem including **Cislune**, **Lunar Resources** and **OrbitFab**.
- <u>Lunar Power Manufacture</u>: At least two compa-



Source: American Foreign Policy Council nies are pursuing large-scale manufacture of solar cells from Lunar regolith for megawatts of power, **Lunar Resources** and **Blue Origin Blue Alchemist**.

- Lunar Mining & Construction Robotics: Many companies are focused on supporting Lunar robotics for mining and construction including Offworld, ICON, GITAI, and Interlune.
- Commercial Rovers: Commercial rover companies developing Lunar mobility systems include Astrobotic, Intuitive Machines, Venturi Astrolab, iSpace, Dymon, Lunar Outpost, GITAI, Honeybee Robotics, and Caterpillar, each contributing specialized vehicles or technologies for science, logistics, ISRU, or astronaut support on the Moon.
- Cislunar In-Space Logistics: Beyond the companies listed above which provide launch and lander services, NASA, DARPA, USSF and DIU have been funding multiple companies to develop in-space tugs for Cislunar logistics.

By 2025, a diverse ecosystem of commercial companies stands ready to participate in Lunar Development.

NASA's Commercial Lunar Payload Services (CLPS)[23] program has already contracted with multiple firms, including **Intuitive Machines, Firefly Aerospace,** and **Astrobotic**, to deliver payloads to the Moon, further expanding the commercial Lunar ecosystem. Over 20 companies are actively pursuing Lunar propellant production and infrastructure development, with key players like iSpace, Orbit Fab focusing on in-situ resource utilization (ISRU) technologies to extract and process Lunar materials for fuel and construction. Collectively, these efforts signify a robust and growing commitment across the aerospace industry to establish a sustainable and economically viable presence on and around the Moon.

Beyond the Moon: Mars and International Leadership

The ELA's vision extends beyond the Moon itself, positioning a Lunar base as critical infrastructure for affordable Mars exploration. With renewed interest in Mars missions, the ELA framework provides the logical foundation for this broader exploration strategy.

The ELA also included an international partnership element. It offers a useful way forward to replace international cooperation at the International Space Station (ISS) and on Gateway with better options on a Lunar base. An ELA approach gives our international partners a compelling alternative: making history by walking on the Moon, rather than just watching it from Lunar orbit.

In today's context, adjusted for inflation, the ELA provides a viable program to fund **6 to 10 commercial providers** to develop **reusable landers, fuel depots, ISRU systems, and Lunar logistics—providing a much more significant Lunar program at a substantially lower cost.**

Given these advantages, Congress and the administration should seriously consider adopting the ELA-recommended approach as the primary thrust of America's Lunar efforts.

To maintain U.S. competitiveness against China's ambitious Lunar colonization and resource extraction plans, Congress should support the Administration's strategic pivot: canceling Gateway, retiring SLS-Orion after Artemis 3, and pursuing an ELA-inspired approach. This would fund multiple commercial providers to establish a high-cadence, permanent Lunar industrial facility—ultimately enabling thousands of Americans to live and work permanently in space.

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Space Policy Review

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