

# Can We Achieve Economic Sustainability in the Space Economy?

*Framework, Process, System*

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# What We'll Cover

- What Exactly is the Space Economy?
  - Defining “Sustainability”
    - Economic Sustainability Framework  
*Opportunities and Challenges*
      - Framework → Process → System
  - Wrap up



# What Exactly is the **Space Economy**?

## • **Scope**

- Manufacturing and operations of spacecraft and satellites, launch services, satellite communications, navigation, Earth observation, and all other related government and commercial activity (BEA)
- Lunar/cislunar infrastructure development
- Propellant manufacturing, storage, delivery

## • **Size**

- Global: \$613 billion (2024, Space Foundation)
- Global: \$630 billion (2023, WEF/McKinsey)
- U.S.: \$241 billion (2023, BEA)

## • **Trajectory**

**Global** (2015-2024, Space Foundation data)

- Nominal CAGR:  $\approx 8.7\%$
- Real CAGR:  $\approx 5.6\%$

**U.S.** (2012-2023, BEA data)

- Nominal CAGR:  $\approx 2.1\%$
- Real CAGR:  $\approx -0.8\%$

**Projecting forward to 2030 (nominal):**

- Global: \$1.01 trillion
- U.S.: \$280 billion

# Defining “Sustainability”

Source	Definition	Year
<b><i>Our Common Future</i></b> (Brundtland Report/WECD; Oxford University Press)	“Development that meets the needs of the present without compromising the ability of <b>future generations</b> to meet their own needs.”	1987
<b><i>What is sustainable development?</i></b> (Kates, Parris, Leiserowitz; <i>Environment: Science and Policy for Sustainable Development</i> )	“...To make development sustainable—to ensure that it meets the needs of the present without compromising the ability of <b>future generations</b> to meet their own needs.”	2005
<b><i>A safe operating space for humanity</i></b> (Rockström et al.; <i>Nature</i> )	“Identifying and quantifying <b>planetary boundaries</b> that must not be transgressed could help prevent human activities from <b>causing unacceptable environmental change</b> ...”	2009
<b><i>The Limits to Growth</i></b> (Meadows, Meadows, Randers, Behrens; <i>Universe Books</i> )	“Use of systems-dynamics modeling indicates exponential economic/ industrial growth will hit <b>ecological limits</b> .”	1972
<b><i>Our Ecological Footprint: Reducing Human Impact on the Earth</i></b> (Wackernagle & Rees; <i>New Society Publishers</i> )	“Sustainability means living within the regenerative <b>capacity of ecosystems</b> .”	1998
<b><i>An almost practical step toward sustainability</i></b> (Solow; <i>Resources Policy</i> )	“ <b>Future generations</b> should inherit at least the same <b>capacity</b> to be well off as we had. Sustainability = <b>non-declining intergenerational opportunities</b> , but not necessarily the same specific resources.”	1993
<b><i>A natural-resource-based view of the firm</i></b> (Hart; <i>Academy of Management Review</i> )	“Achieving long-term competitive advantage will require firms to <b>internalize environmental stewardship</b> . Sustainability is strategic, not just ethical.”	1995
<b><i>Three pillars of sustainability: in search of conceptual origins</i></b> (Purvis & Robinson; <i>Sustainability Science</i> )	“Defines three pillars as <b>environmental, economics, and social</b> .”	2019



# Notable Characteristics

“...future generations...”

“...planetary boundaries...”

“...[preventing] unacceptable environmental change...”

“...capacity of ecosystems...”

“...non-declining intergenerational opportunities...”

“...internalize environmental stewardship...”

“...environmental, economic, and social pillars...”



# Space Economy **Sustainability** Framework

**Opportunities**



**Challenges**



# Facet #1



## Opportunities

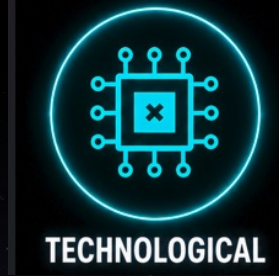
- Continued access to capital
  - ~\$8 billion in private investment in space industry (2024)
  - Can **SPACs** make a comeback?
- Infrastructure development
- Dual-purpose products (Honeybee, Redwire)
- Long way off from significant market consolidation

## Challenges

- Space agency funding (symptom) → National deficit spending, debt levels (actual problem)
- L-O-N-G investment timelines and profitability timelines
- Transition from reliance on Govt funding to commercial market growth



# Facet #2



## Opportunities

- Vertical dis-integration
- Infrastructure development
- Technical solutions designed with sustainability in mind

## Challenges

- Getting stuck in the TRL trough
- MUST stick the landing!



# Lunar Landing Outcomes 2015 – 2025

12 launches with the goal of landing  
on the Moon



10 made it into lunar orbit

10 reached the lunar  
surface (including crashes)

7 successful,  
operational  
landings

58% success rate

**Global launch success  
rate 2000-2025: ~96%**

- **JAXA SLIM**
- **Intuitive Machines' IM-1**

*NOTE: Operational success includes missions that landed and conducted meaningful operations, even if spacecraft attitude was compromised.*



# Facet #3



“...ability of **future generations** to meet their own needs.”

“Sustainability = non-declining **intergenerational** opportunities...”



# Facet #4



## Opportunities

- Honoring carrying capacity scarcity
- Pre-activity remediation planning (and regulations)

## Challenges

- Orbital debris: The Tragedy of the Commons
- Free Riders
- Quantifying carrying capacity
- Auction/allocation rights?



## Facet #5



### Opportunities

- “We must.”

### Challenges

- “How dare we.”

*“Just because we can, doesn’t mean we should.”*



# Facet #6



## Opportunities

- U.S.:
  - U.S. Space Competitiveness Act (2015)
  - Artemis Accords (2020)
  - Executive Orders 13914 (2020), 14369 (2025)
  - Special Policy Directives 1-7 (2017-2021)
- International:
  - Combined Space Ops Initiative (CSpO; 2014)
  - Luxembourg Space Resources Law (2017)
  - Japan Space Resources Act (2021)
  - UAE Federal Space Law (2019-2020)
  - Italy Unified Space Law (2025)
  - The EU Space Act Draft (2024–2026)

## Challenges

- Cold War-era treaties
- Polarized global factions competing for hegemony
- Multiple direct-action conflicts
- Distrust
- Bad behavior



# Facet #7



CONSTITUENT

**Outer Space Treaty**, Article 1: “Exploration and use of outer space... shall be the province of **all mankind**.”

Commercial customers →  
end users

Employees

Government customers  
→ end users

Environmentalists

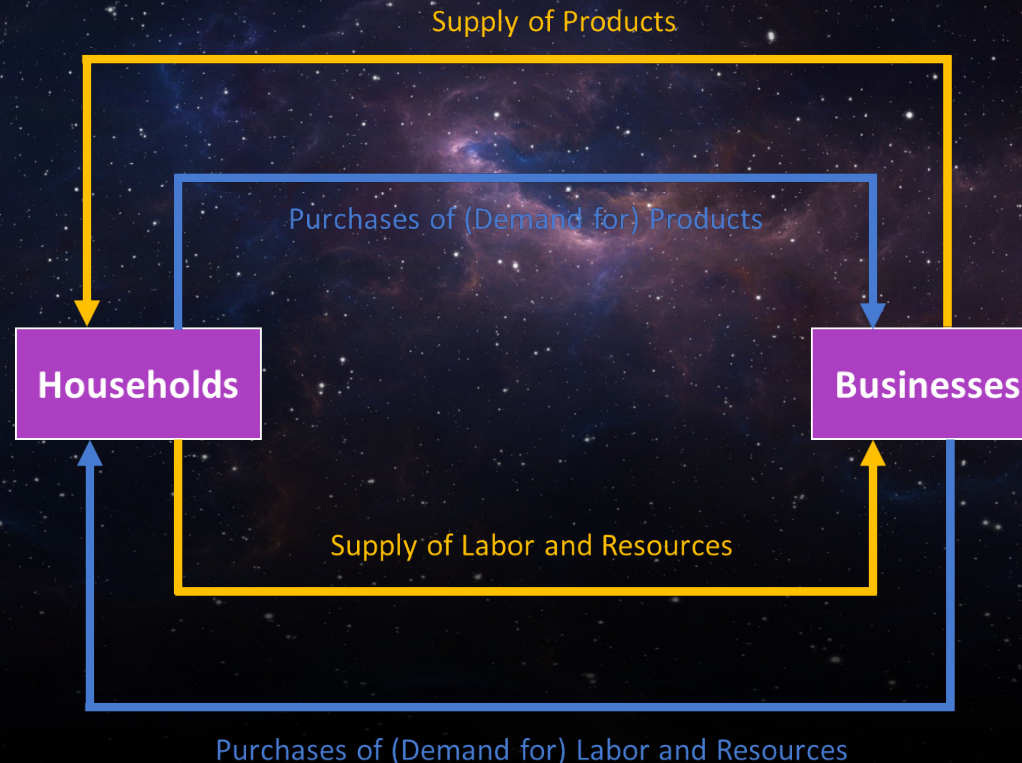
Investors

National Space  
Agencies

Regulatory bodies

Other nation-states

- *Allies*
- *Antagonists*









400+ aerospace  
companies and  
major space-  
adjacent military  
installations



# Colorado Aero/Space Ecosystem





# Framework





# Framework → Process → System: Situational Awareness



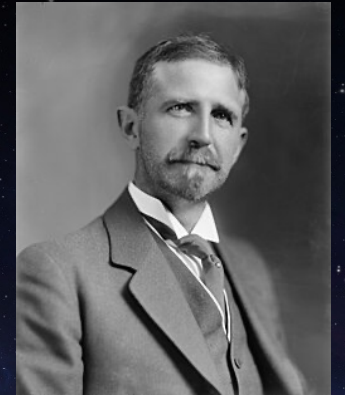


# Wrap up

## Can We Achieve Economic Sustainability in the Space Economy?

*"It is wise to keep in mind that neither success nor failure is ever final".*

- Continued capital flows
- Transition from Govt contracts to market expansion
- Technological/operational successes
- Continued focus on long term
- Carrying capacity quantification
- Rigorous ethics debates
- Legal framework advancements
- Market-based resource allocation
- Increased stakeholder engagement



*Roger Babson  
(1875 – 1967)*



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