

December 5, 2022

COMPANY INFO

Company Name	Blue Origin
Sector	SpaceTech
Segment(s)	Upstream
Ownership	Private
Patents globally	66
Funds Raised	\$8B+
Founder	Jeff Bezos
CEO	Bob Smith
Website	https://www.blueorigin.com
Employees	>8,000
Founded	September 2000
Est. Revenue (2021)	\$513 Mn

MAJOR MILESTONES

November, 2015	Successful re-landing of rocket booster
January, 2016	First reuse of booster
December, 2017	First commercial payloads sent on New Shepard
July, 2018	Successful test of Crew Escape System in space
December, 2019	100 th payload customer
July, 2021	New Shepard's first human spaceflight
October, 2022	First BE-4 engines delivered

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Blue Origin (Private)

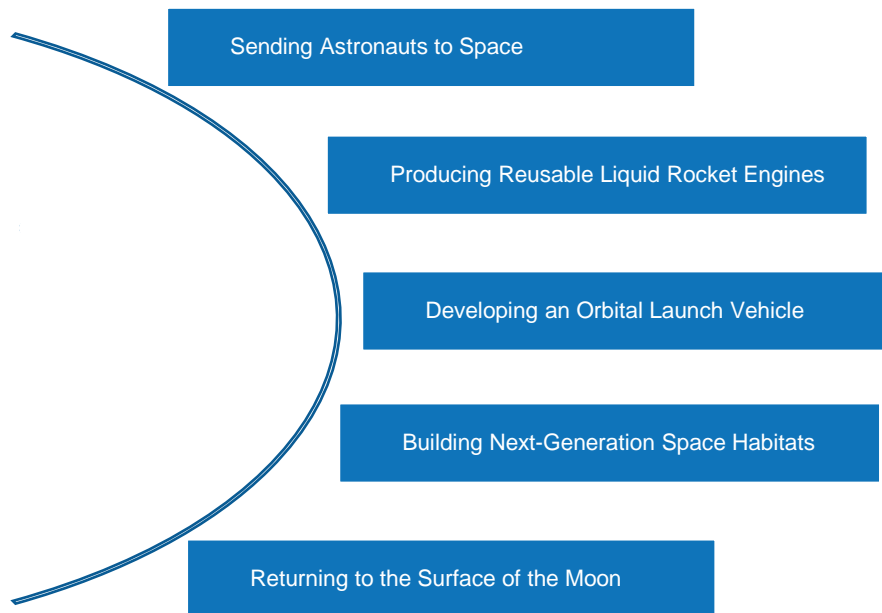
A Leading Player in the \$386 Billion SpaceTech Industry

- A pioneer in space tourism.** Established in 2000, Blue Origin is one of the first companies, along with Virgin Galactic and SpaceX, that has sent commercial human flights into space. In July 2021, Blue Origin launched its first crewed mission via its reusable New Shepard rocket and spaceflight system. The 10-minute flight reached a peak of about 66 miles, crossing the Kármán line. Jeff Bezos, founder of Blue, was part of the four-member crew. Since then, the company has successfully launched five more crewed missions, sending 31 unique astronauts/ 32 seats on suborbital hops so far.
- Orbital missions, and beyond.** Blue Origin doesn't plan to restrict itself to suborbital space. It has plans for orbital missions, and then sending missions to the Moon. The company is developing an orbital launch vehicle named New Glenn. Its fully reusable first stage is designed for a minimum of 25 flights, making it cost-competitive for a variety of launch markets. Further, Blue Origin aims to establish a sustained human presence on the Moon. It has been developing a flexible lander, Blue Moon, for several years. Blue Moon will be capable of delivering a wide variety of payloads to the lunar surface. Blue Origin lost NASA's lunar lander contract to SpaceX in 2021, and also lost a subsequent lawsuit against NASA. But it still has a chance to send its lander to the Moon, as NASA intends to bring a second entrant to market for the development of a lander in parallel with SpaceX. Further, the company has partnered with Sierra Space and others to build a commercial space station, Orbital Reef. Finally, Blue Origin has set up a rocket factory in Florida to manufacture and integrate rocket stages, payload fairings, and adapters. Its rocket engines can be used by other launch companies in their space vehicles. For example, United Launch Alliance's Vulcan is going to be powered by Blue Origin's BE-4 engines. Blue Origin delivered the first BE-4 engines to ULA in October 2022.
- Well-funded status allows the company to focus on innovation without investor pressure for quick results.** Founded by one of the richest men on planet Earth today, Blue Origin is well funded. Jeff Bezos has already made heavy private investments in Blue Origin, to the tune of an estimated \$7.5 billion as of 2021. In 2017, Bezos announced that he was selling \$1 billion a year of his Amazon stock to fund Blue Origin's development. Unlike rival billionaires Richard Branson or Elon Musk, Bezos has not taken any venture funding or other major investment for Blue Origin.
- Enormous revenue growth potential.** In July 2021, Blue Origin had already sold tickets worth more than \$100 million for its spaceflights. According to FactSet estimates, the company's revenue for 2021 was \$513 million. While the broader SpaceTech industry is expected to grow to over \$1 trillion by 2030, market for emerging segments, including commercial space tourism, is expected to reach over \$100 billion by 2040. Notably, revenue from Blue Origin's orbital missions via its New Glenn launch vehicle will make its suborbital revenue look miniscule. We believe that apart from space tourism, Blue Origin is targeting multiple emerging segments of the SpaceTech industry that significantly expand its potential target market and open avenues for enormous long-term growth.

Company Overview

- **Founded in 2000 by Jeff Bezos, Blue Origin aims to capture market in various segments of the SpaceTech economy.** Blue Origin's long-term vision is to enable millions of people to live and work in space for the benefit of Earth. According to the founder, Jeff Bezos, if we can shift environmentally damaging industries into the larger solar ecosystem, we can preserve the Earth more effectively. Bezos is following a vision laid out by Gerard K. O'Neill in the 70s and 80s, which has a number of adherents in the space industry. (To know more about Bezos' views on space, listen to [this discussion](#).) Today, Blue Origin's activities include space tourism, building space habitats, and developing rockets for orbital and Moon missions. The company is working on developing reusable launch vehicles and liquid propulsion engines that are safe and cost-effective to serve the needs of civil, commercial, and defense customers. The company's engines are designed and manufactured at its headquarters in Kent, Washington. It employs over >8,000 personnel and generated an estimated revenue of \$513 million in 2021. The Blue Origin motto is "**gradatim ferociter**," or "step by step, ferociously" in Latin. Blue is committed to realizing its vision in an incremental manner.
- **In July 2021, Blue Origin sent its first crewed mission into space via its reusable New Shepard rocket and spaceflight system.** As noted earlier, the 10-minute spaceflight reached a peak of about 66 miles, crossing the Kármán line. Jeff Bezos was part of the four-member crew, along with Wally Funk, Oliver Daemen, and brother Mark Bezos. The company sold the very first seat on New Shepard for \$28 million in an online auction, but the winner couldn't travel on the spaceflight due to a scheduling conflict. Instead, Oliver Daemen went, becoming at 18 the youngest person to make such a flight. Wally Funk had hoped to become a NASA astronaut in the 1960s, but was prevented from doing so because only men were being accepted at the time. She became the oldest person to make a spaceflight at the age of 82. The company has successfully sent six crewed missions and 22 uncrewed missions to space under its New Shepard program so far, but has paused its flights for now because of an abort of a recent cargo mission.

Chart 1: Blue Origin's Focus Activities



Source: Intro-act, Blue Origin

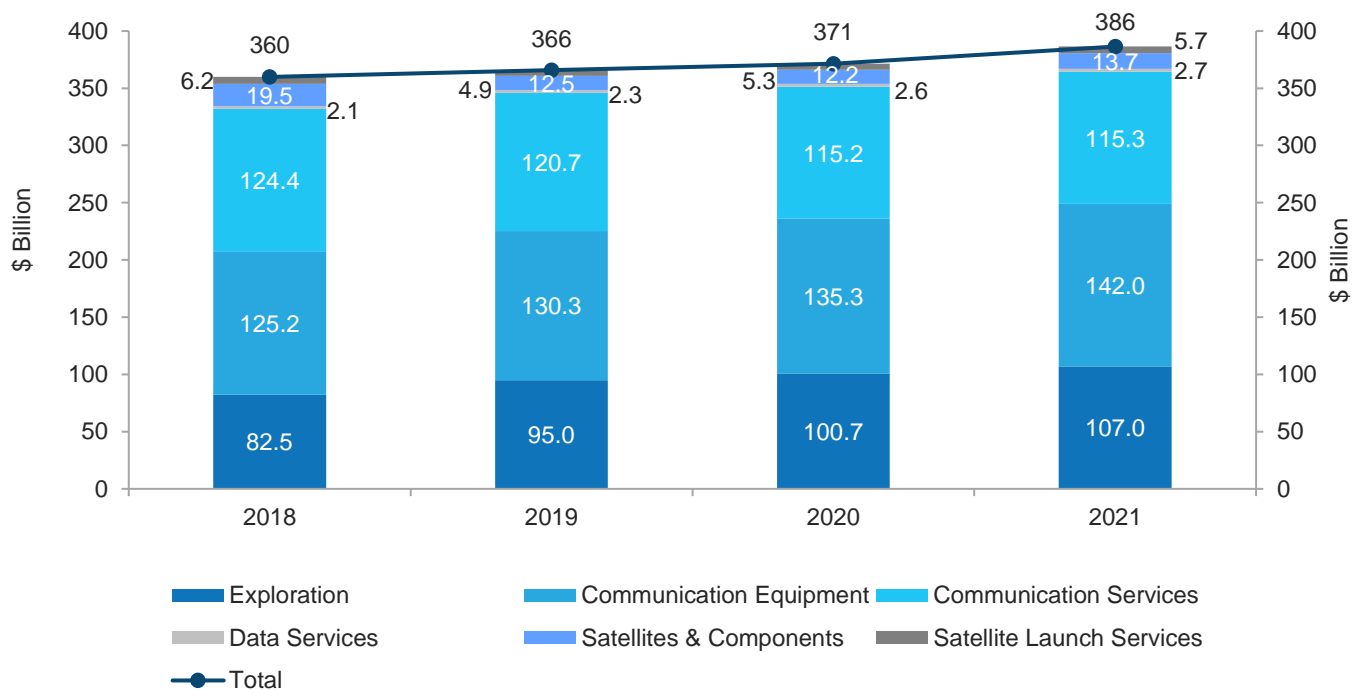
- **The company has been very considerate in naming its space vehicles.** The vehicles are named after the first Americans who achieved whichever mission the vehicle sets to accomplish. For example, New Shepard is named after astronaut Alan Shepard, the first American astronaut, and indeed, the first person, to fly on a suborbital mission. Similarly, its orbital launch vehicle New Glenn is named after astronaut John Glenn, the first American to orbit the Earth.

Industry Overview and Company Strategy

New Commercial Models Have Attracted Private Capital to The SpaceTech Ecosystem

- The SpaceTech Ecosystem has evolved rapidly in the past decade and has demonstrated resilient growth driven by accelerated participation of private capital.** The global SpaceTech ecosystem has seen strong continuous growth in the past decade, primarily due to increased private participation that has opened the space economy to several new commercial models. The private capital infusion is driven by the higher participation of private companies in space activities and commercial applications now accounting for more than two-thirds of the industry turnover. The strength of this market can be demonstrated by the fact that it continued to grow steadily, even in the tough COVID years and is now primed to achieve accelerated growth over the coming decade. We divide the SpaceTech ecosystem into six interacting business segments that includes three upstream components – Exploration, Satellites & Components, and Satellite Launch Services; and three downstream components – Communication Equipment, Communication Services, and Data Services. The ecosystem has grown from ~\$360 billion in 2018 to \$386 billion in 2021. This growth is driven by strong performance of the exploration and data services segments, coupled with acceleration in satellite demand and launch.

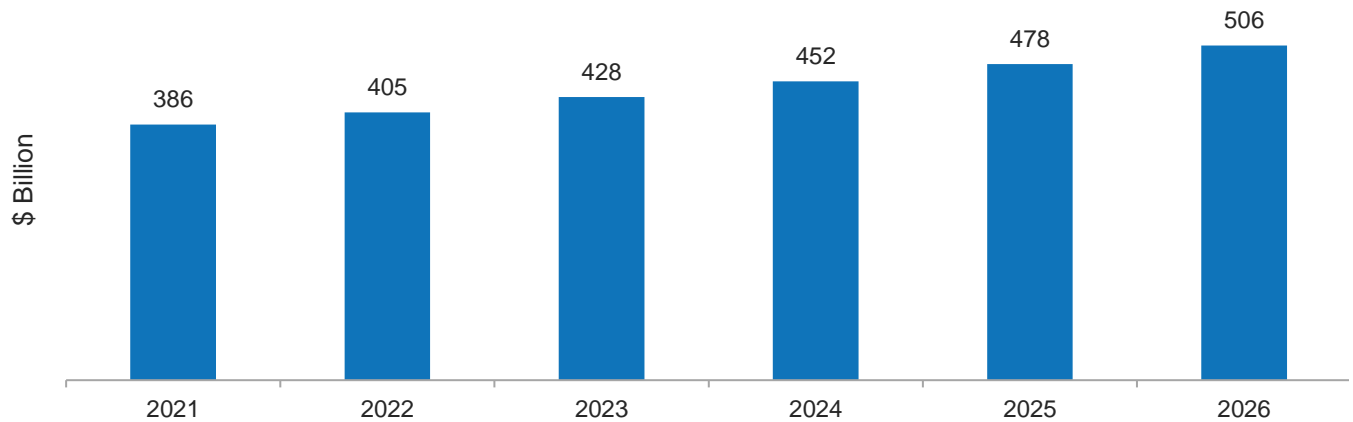
Chart 2: The SpaceTech Ecosystem Was Worth \$386 Billion in 2021



Source: Intro-act, BryceTech

- The global space economy is expected to grow to \$506 billion by 2026 and exceed \$1 trillion by 2030.** As space innovation goes beyond government space agencies, several industries are looking closely at companies to address long-standing and emerging needs that can be met through SpaceTech solutions. The space ecosystem is responding to this need with rapid technological innovation, fueled by private and government capital, to create new solutions and commercial models. **The deepening integration with many industries in the next few years will emerge as one of the key drivers of industry growth and will help expand the SpaceTech Ecosystem.** Our analysis of data from BryceTech and other sources indicates that the growth of the global space economy is set to accelerate to a 5.7% CAGR, suggesting that it will be worth \$506 billion in 2026. These growth rate projections are in line with those by leading banks and research houses that expect the space economy to be worth >\$1 trillion by 2030.

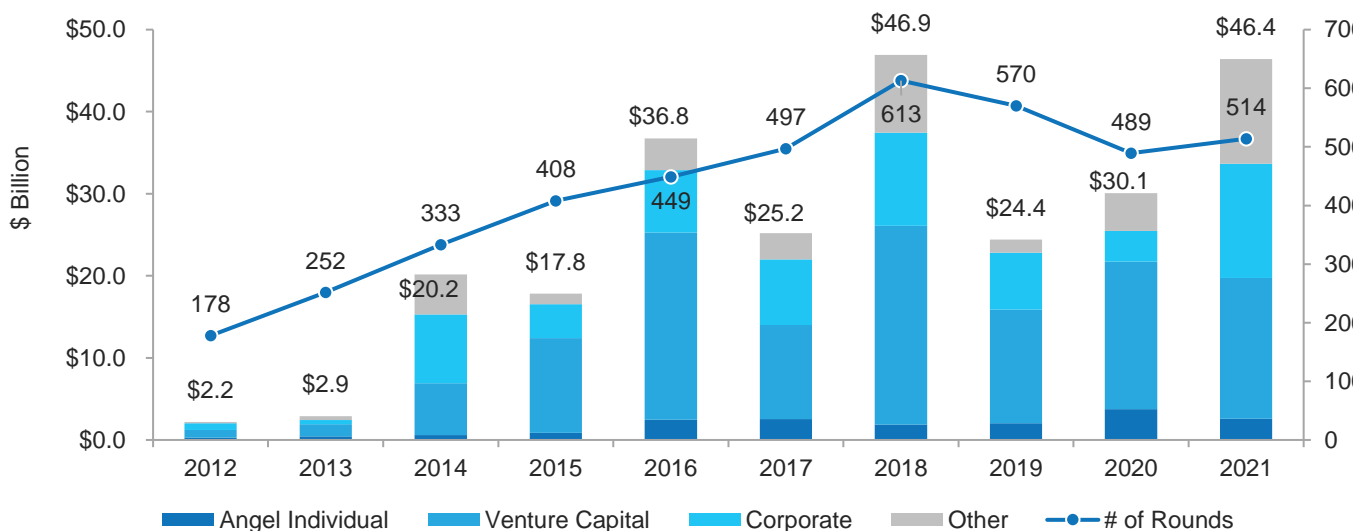
Chart 3: The SpaceTech Ecosystem is Expected to Grow to \$506 billion in 2026



Source: Intro-act, BryceTech

- Given the global SpaceTech industry's growth potential in the long term, investors are flocking toward space businesses – especially in the U.S. and China – to ride the growth wave.** In 2021, equity investments reached \$46.4 billion over 514 rounds across all space technology stacks, according to Space Capital. For each round, this implies \$90.3 million of capital raisings, which is significantly higher than the \$61.5 million equity raised per round in 2020 and is roughly 7.3x the 2012 figure. Over the last 10 years, there has been \$252.9 billion of equity investment across 1,694 unique companies over 4,000+ rounds in the broader space economy, driven by investment in companies based in the U.S. (\$116.1 billion) and China (\$77.3 billion), which collectively account for more than 75% of the global total in 2021. For the first half of 2022, equity investments reached \$13.8 billion over 236 rounds.

Chart 4: Equity Funding for Space Companies Reached \$46.4 Billion in 2021 Over 514 Rounds

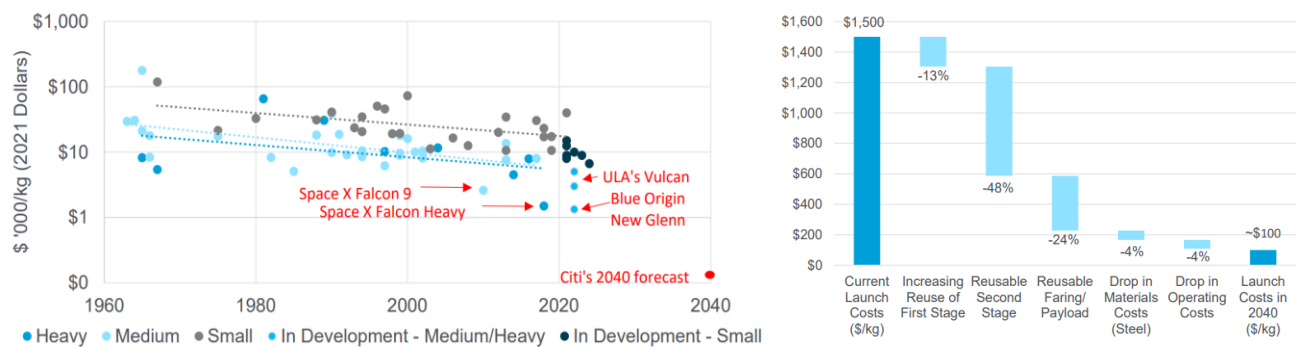


Source: Intro-act, Space Capital – Space Investment Quarterly: Q4 2021

Industry Overview and Company Strategy

- **One of the key factors helping the space industry is the reduction in launch costs seen in the past decade.** The private sector has been successful developing of reusable rockets, which have enabled significant cost reduction. Going forward, the launch costs are expected to plummet further with the increased use of reusable rocket stages, a drop in material costs, and economies of scale, which will result in a drop in operating costs. Lower launch costs are also contributing to the small satellite revolution that is spurring more research and innovation by making satellite launches more accessible for a larger cross-section of stakeholders – corporations, start-ups, universities, and non-profits. In a February 2020 presentation by the National Centre for Space Studies (CNES) on the Ariane 6 (developed by ArianeGroup on behalf of the European Space Agency to replace the Ariane 5), the French space agency estimated that **Blue Origin's New Glenn launch would cost ~\$60 million for its 45,000kg LEO payload, indicating a launch cost of ~\$1,300/kg.** Citigroup forecasts that launch costs will fall another ~95%, to ~\$100/kg by 2040, driven by reusability, scale, lower input costs, and cost-efficient production methods.

Chart 5: Launch Costs Continue to Plummet and Could Reach ~\$100/Kg by 2040



Source: Intro-act, Citi Research

- **New Glenn's fully reusable first stage is designed for a minimum of 25 flights,** making it competitive for a variety of customers, including those from the civil, commercial, and national security sectors. New Glenn's 7-meter fairing has 2x the usable volume of any existing launch vehicle. BE-4, one of the world's most powerful liquid oxygen / liquefied natural gas engines, will enable New Glenn to launch payloads over 13 metric tons to Geostationary Transfer Orbit and 45 metric tons to Low Earth Orbit.

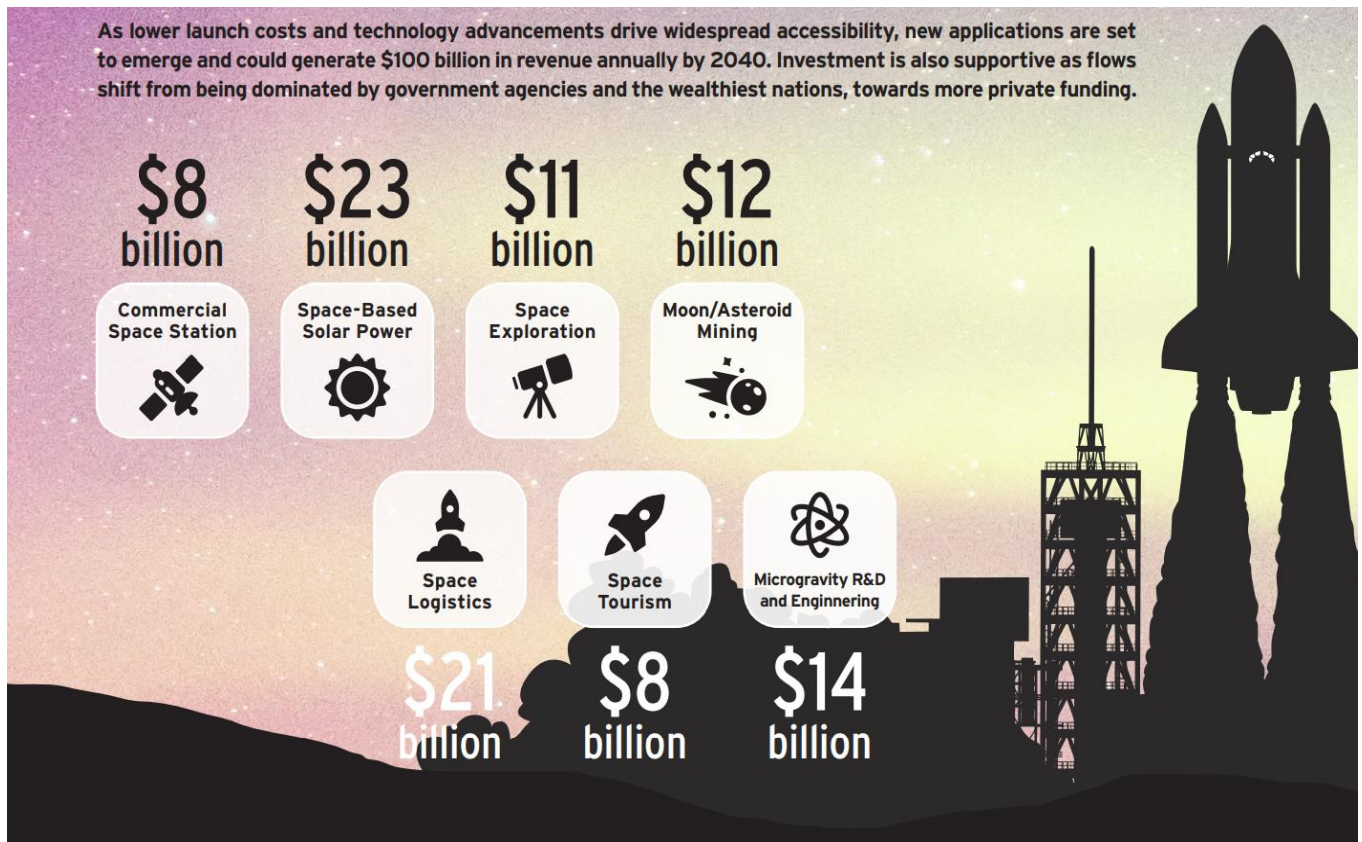
Huge Potential Market

The benefits of a reduction in cost and advancement in the launch segment are beyond just affordability. It has resulted in exponential growth in various related industries in the past. For example, the reduction in data prices globally resulted in the rise of various OTT content platforms that stream content online. With a reduction in launch costs, players such as Blue Origin and SpaceX will be able to increase their market to a larger audience. Additionally, the sectors that currently do not consider space as a growth opportunity will start exploring it for future growth. This will lead to a "growth chain reaction". So, companies like Blue Origin have a huge market potential.

Industry Overview and Company Strategy

- **Emerging applications in the SpaceTech market where Blue Origin focuses could generate \$100 billion in revenue annually.** The chart below illustrates various emerging avenues for growth in the SpaceTech industry driven by lower launch costs and technology advancements. These segments are still in a nascent stage of development. However, they provide a huge market potential. Space-based solar power market could reach \$23 billion and the market for space logistics is expected to grow to \$21 billion. The microgravity R&D and engineering market could reach \$14 billion by 2040, and Moon and asteroid mining could eventually be a \$12 billion market. Meanwhile, the space exploration market is expected to reach a size of \$11 billion, whereas space tourism and commercial space station markets are each expected to become worth \$8 billion. Citi estimates NASA's use of a private space station could mean \$3 billion in annual revenue, with new applications bringing another \$5 billion. It predicts that the private sector will dominate these SpaceTech areas by 2040.

Chart 6: Emerging Applications in the SpaceTech Market Could Generate \$100 bn in Revenue Annually



Source: Intro-act, Citi Research

- As previously noted, **Blue Origin is directly or indirectly involved, or can potentially become involved, in nearly all these emerging activities.** Thus, the company is into segments that will be worth billions of dollars by 2040. Blue Origin has already got a head start in these high-potential segments. Overall, we believe that Blue Origin has enormous growth opportunities in the coming years and decades. The company's activities are discussed in detail next.

Flying Astronauts to Space

- **Blue Origin is one of the few private players taking ordinary civilians into space to experience the “Overview Effect” firsthand.** This is being achieved with its vehicle, New Shepard. New Shepard is a reusable suborbital rocket system that is capable of taking astronauts and research payloads past the Kármán line. This line is used by the scientific community to define the border between outer space and the Earth’s atmosphere. Thus, anyone crossing it has officially reached outer space. The New Shepard flight has a very short duration of around 11 minutes.
- **New Shepard’s Design.** The capsule has room for six astronauts and is fully autonomous, with no pilots. It is equipped with the **largest windows to have been built on a space vehicle.** This gives the astronaut a wider view when in space. New Shepard’s BE-3PM engine is fueled by highly efficient and clean liquid oxygen and hydrogen. During the flight, there are no carbon emissions from New Shepard’s engine combustion. The only byproduct is water vapor. This makes the **engine highly environmentally friendly in terms of emissions.**

Chart 7: New Shepard Design: Capsule is Fully Autonomous With No Pilots



Crew Capsule

Pressurized crew capsule environmentally controlled for comfort with room for six and the largest windows to have flown in space.

Ring & Wedge Fins

Aerodynamically designed to stabilize the booster and reduce fuel use on its flight back to Earth.

Drag Brakes

Deploy from the ring fin to reduce the booster’s speed by half on its descent from space.

Engine

The BE-3 (Blue Engine 3) propels the rocket to space and restarts for a controlled pinpoint landing on the pad. The uniquely throttleable engine slows the booster down to just 8 km/h (5 mph) for landing.

Aft Fins

Stabilize the vehicle during ascent, steer it back to the landing pad on descent, and guide the rocket through airspeeds of up to Mach 4.

Landing Gear

All rockets take off, not all rockets land. As a fully reusable rocket, the New Shepard booster uses landing gear that deploys for touchdown.

Source: Intro-act, Blue Origin

Flying Astronauts to Space

- **Blue Origin has a window of opportunity in space tourism.** At the moment, Blue Origin is not revealing what people are paying for its flights. However, according to a Citigroup report, Blue's ticket prices could range between \$200,000 and \$300,000 for suborbital spaceflights. This is less than that of Virgin Galactic, which is charging \$450,000. This pricing might give Blue Origin an advantage in the space tourism competition. Additionally, even though Virgin Galactic has been successful in taking deposits from future space travelers, the company has yet to deliver on its promise. This gives players such as Blue Origin a window of opportunity to capture the market.

Unlike the Virgin Galactic flight that takes passengers to an altitude of 282,000 feet, Blue Origin's spaceflight actually crosses the Kármán line and reaches an altitude of 351,000 feet. Blue Origin also boasts of having the largest windows ever built on a space vehicle. These factors could potentially lead customers to preferring Blue Origin over Virgin Galactic or others.

- **Safety given due importance.** One of the issues that affected the space exploration industry in the past is concern over safety. New Shepard is designed with passenger safety in mind. The two major points in safety are discussed below. The company has been testing the rocket and its safety systems since 2012. The capsule escape system successfully worked in the company's NS-23 mission on September 12 when the rocket suffered anomalies. It was a payload mission with no astronauts on board.

Crew Escape System: New Shepard is equipped with a crew escape system. In case of an issue being detected, this system pushes the capsule away from the booster, getting the crew onboard away from any potential danger. Blue Origin has tested this system successfully from launch pad, mid-flight, and even in the vacuum of space. Thus, the company assures the system functions as required in various test conditions.

Chart 8: Crew Escape System



Source: Intro-act, Blue Origin

Chart 9: Redundant Landing System



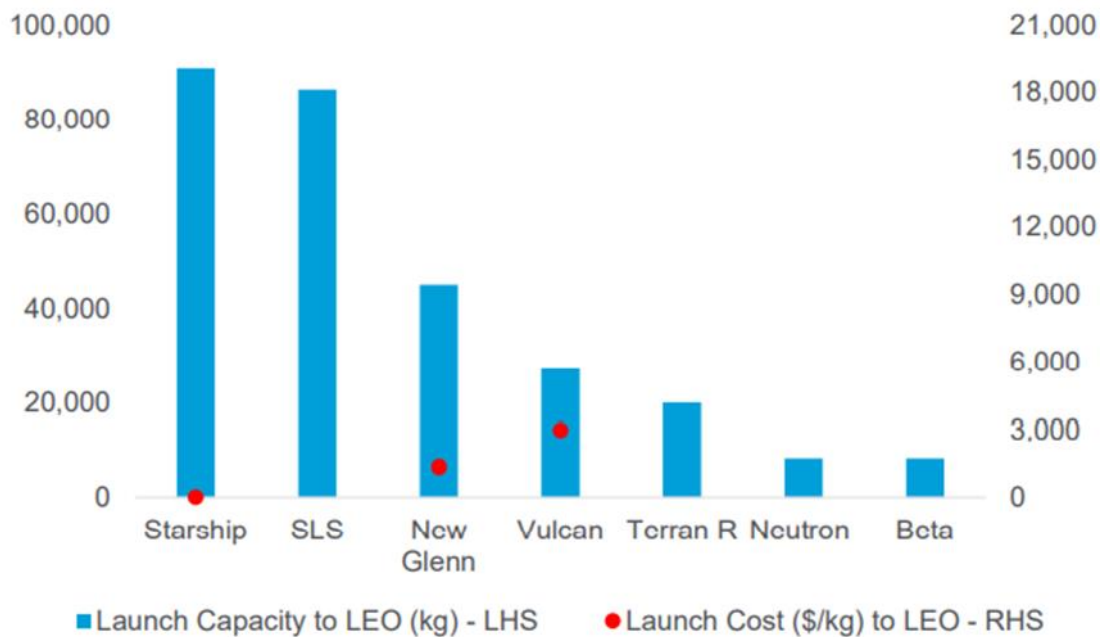
Source: Intro-act, Blue Origin

Redundant Landing System: The capsule has multiple mechanisms to make the landing as smooth as possible. The bottom of the capsule has a retro-thrust system. This expels air so that the capsule lands at just 1.6 km/hr. Additionally, the capsule has three parachutes. It can land with two of these three chutes out of commission. The company has also worked on the seat design to improve the landing experience. The seats have been designed to flex and absorb shock in the event of a rough landing. These landing mechanisms add to safety during the landing process.

Developing an Orbital Launch Vehicle

- **Orbital launch capability is another area where private participation has resulted in significant improvements in the past decade.** Private players such as Blue Origin and SpaceX have brought down the launch costs dramatically. Reusable rockets and launch vehicles, new materials and fuels, more cost-efficient production methods, and advancements in robotics and electronics systems are combining to drive these costs even lower. Blue Origin is currently building a reusable Orbital Launch Vehicle named New Glenn.

Chart 10: Next-Generation Vehicles Offer Greater Capability and Likely Better Affordability



Source: Intro-act, Citi Research

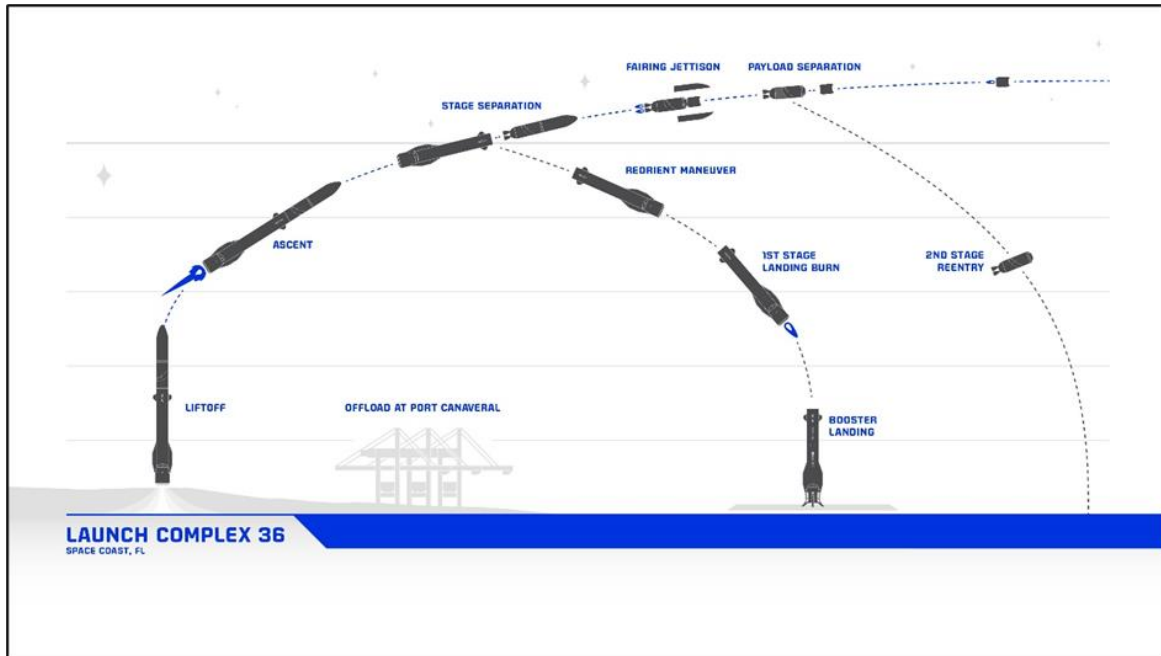
- **Blue Origin's New Glenn launch vehicle is designed to be capable of carrying people and payloads routinely to the Earth's orbit.** New Glenn is a single configuration heavy-lift launch vehicle. The vehicle will be capable of carrying people and payloads to the Earth's orbit and beyond.

After lifting off from Launch Complex 36 at Cape Canaveral, New Glenn's first stage separates mid-air and flies back to Earth landing nearly 1,000 km away on a platform. Following the separation of the first stage, the second stage engines ignite and the fairing separates. The mission is complete when the payload is delivered to orbit.

Reusability Reducing Costs

New Shepard and New Glenn have been designed with reusability in mind. The throttleable liquid fuelled engines allow precision landing. The first stage of the launch vehicles can be used around 25 times with minimal refurbishments. This results in less waste.

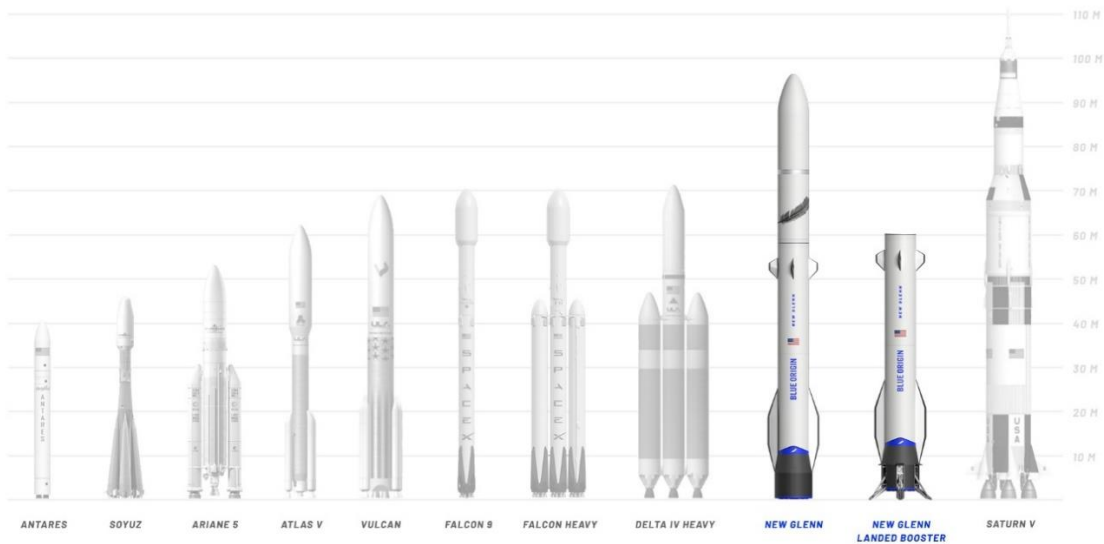
Chart 11: New Glenn's Flight Trajectory



Source: Intro-act, Blue Origin

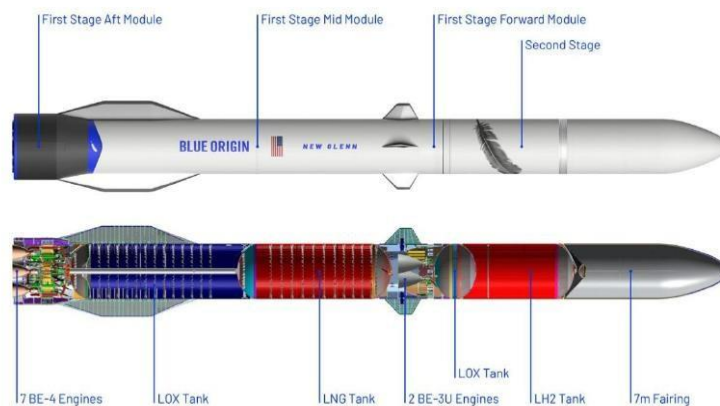
- As noted earlier, **New Glenn is a big rocket that will be capable of delivering 45 MT to Low Earth Orbit and around 13 MT to Geostationary Transfer Orbit.** The figure below compares the size of New Glenn relative to other space vehicles. The company expects to launch New Glenn in 2023.

Chart 12: New Glenn is Huge: Its 7-Meter Fairing has 2x the Usable Volume of Any Existing Launch Vehicle



Source: Intro-act, Blue Origin

Chart 13: New Glenn Configuration

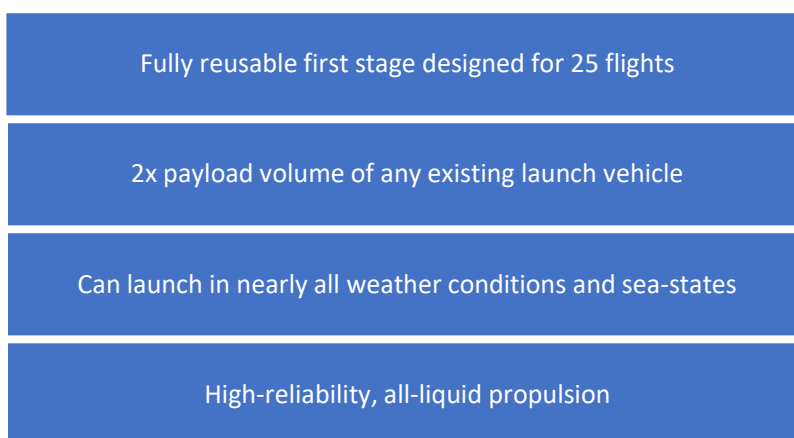


Source: *Intro-act, Blue Origin-New Glenn Payload User Guide*

- **New Glenn is designed such that the first stage can be used for 25 flights.** This capability reduces launch costs drastically as the first stage is often one of the major cost components in a rocket. The vehicle is capable of taking twice the payload of existing launch vehicles with its seven-meter fairing. That means more room for satellites and the freedom to build in more capacity. New Glenn will also be able to launch and land in 95% of weather conditions, making it a reliable option for payload customers. The use of an all-liquid propulsion system enables the rocket to precisely control the magnitude of thrust.

Blue Origin has built a 180,000 sq. meter complex to manufacture, integrate, and operate New Glenn on Florida's Space Coast. Rocket stages, payload fairings, and adapters will be built and integrated in Florida, nine miles from the launch pad. The complex is also home to the company's launch and mission control centers.

Chart 14: Advantages of New Glenn



Source: *Intro-act, Blue Origin*

Producing Reusable Liquid Rocket Engines

- Rocket engines have evolved significantly over the years.** It is now possible to control the rockets for re-landing and re-use, bringing down launch costs. Blue Origin has also improved its engines over time. The company's engines are designed, developed, and manufactured at its headquarters in Kent, Washington. It is now preparing for serial production of its most powerful engine, BE-4, in Huntsville, Alabama.

Chart 15: Blue Engine Development History

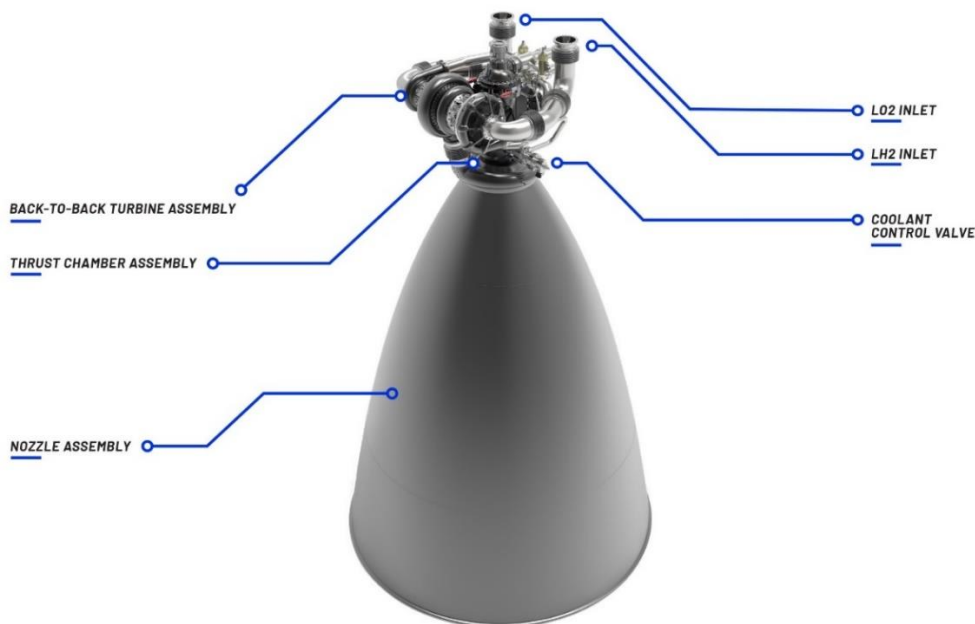
Engine	Propellant	Thrust
BE – 1	Peroxide	9 kN (2,000 lbf) at Sea Level
BE – 2	Kerosene + Peroxide	140 kN (31,000 lbf) at Sea Level
BE - 3PM	Liquid Hydrogen + Liquid Oxygen	490 kN (110,000 lbf) at Sea Level
BE - 3U	Liquid Hydrogen + Liquid Oxygen	710 kN (160,000 lbf) in Vacuum
BE – 4	Liquefied Natural Gas + Liquid Oxygen	2,400 kN (550,000 lbf) at Sea Level
BE – 7	Liquid Hydrogen + Liquid Oxygen	40 kN (10,000 lbf) in Vacuum

Source: Intro-act, Blue Origin

- BE-3 Engine:** Blue Origin's BE-3 engine generates a thrust of 490 kilonewtons (kN). While returning to Earth, it uniquely throttles down to 90 kN enabling a gentle vertical landing. Similar to the Space Shuttle's main engine, BE-3PM uses high-performing liquid oxygen and liquid hydrogen.

The company is currently testing the newest member of the BE-3 family, BE-3U (Upper Stage), optimized to operate in the vacuum of space. Two BE-3U engines power New Glenn's restartable upper stage.

Chart 16: BE-3U Upper Stage Variant



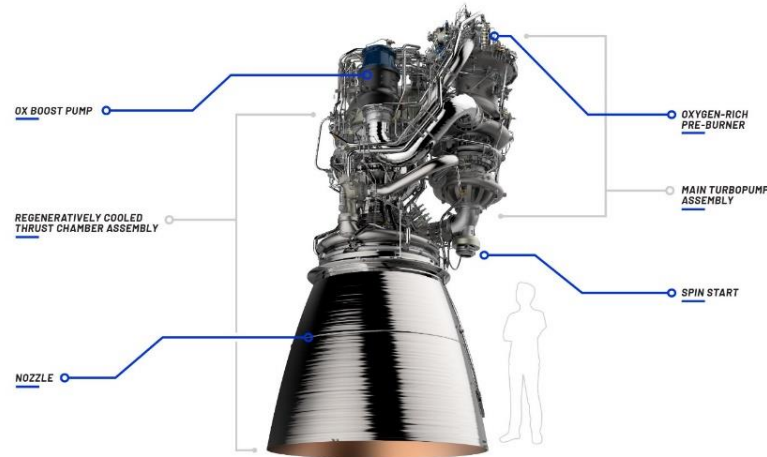
Source: Intro-act, Blue Origin

- BE-4 Engine:** BE-4 is the most powerful liquefied natural gas-fueled rocket engine ever developed. Using an oxygen-rich staged combustion cycle, BE-4 is capable of producing 2,400 kN thrust with deep throttle capability. Seven BE-4 engines will power New Glenn's reusable booster, whereas two BE-4 engines will drive the first stage

Producing Reusable Liquid Rocket Engines

of United Launch Alliance’s Vulcan launch vehicle. Originally scheduled for 2017, the delivery of BE-4 engines to ULA was delayed; however, the company delivered the first BE-4 engines to ULA in October 2022.

Chart 17: BE-4 Engine Design



Source: Intro-act, Blue Origin

- The charts below compare Blue Origin’s BE-4 engine with SpaceX’s Merlin and Raptor, Russian engine RD-180, and Rocketdyne’s F-1 and RS-25 engines. RD-180 and F-1 engines are not reusable. **With a reusability of 25 flights, BE-4 is next only to Raptor on this front. Both Raptor and BE-4 are cost-effective as compared to other engines.** So, once in use, they are expected to significantly bring launch costs further down.

Chart 18: BE-4 Engine Peer Comparison-1

EVERYDAY
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	Merlin	RD-180	F-1	Raptor	BE-4	RS-25
Cycle	Open	Closed (LOX rich)	Open	Closed (Full Flow)	Closed (LOX rich)	Closed (Fuel Rich)
Fuel Type	RP-1	RP-1	RP-1	Methane	Methane	Hydrogen
Total Thrust	0.84 MN	3.83 MN	6.77 MN	2.00 MN	~2.40 MN	1.86 MN
Thrust : Weight	198 : 1	78 : 1	94 : 1	107 : 1	~80 : 1	73 : 1
Specific Impulse (ISP)	282 sl 311 vac	311 sl 338 vac	263 sl 304 vac	330 sl ~350 vac	~310 sl ~340 vac	366 sl 452 vac
Chamber Pressure	97 bar	257 bar	70 bar	270 bar	~135 bar	206 bar

Source: Intro-act, everydayastronaut.com

Chart 19: BE-4 Engine Peer Comparison-2

EVERYDAY
ASTRONAUT

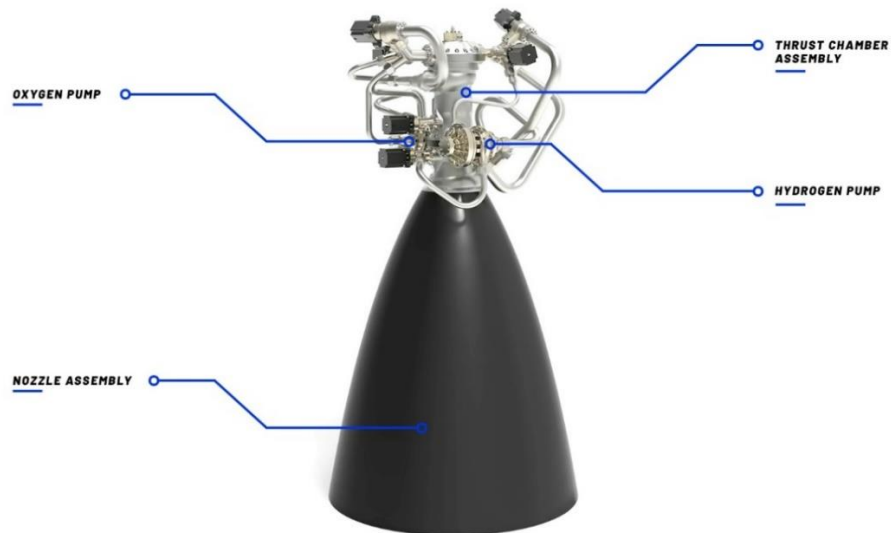


	Merlin	RD-180	F-1	Raptor	BE-4	RS-25
Price <i>(2019 dollars)</i>	< \$1M	\$25M	\$30M	~ \$2M	~ \$8M	>\$50M
Reusability	10 flights	No	No	50 flights	25 flights	19 flights
\$ / kN Ratio	\$1,170 : 1kN	\$6,527 : 1kN	\$4,431 : 1kN	~\$1,000 : 1kN	~\$3,333 : 1kN	\$26,881 : 1kN
Potential cost <i>(per flight)</i>	\$117 : 1kN	\$6,527 : 1kN	\$4,431 : 1kN	~\$20 : 1kN	~\$133 : 1kN	\$1,414 : 1kN
Flight Record	71	79	17	Yet to fly	Yet to fly	135
Reliability	99.9%	100%	100%	N/A	N/A	>99.5%

Source: Intro-act, everydayastronaut.com

- BE-7 engine:** This will be an additively manufactured, high-performance, dual-expander cycle engine. It will generate a thrust of 40 kN. The company is maturing the design and manufacturing hardware, and has begun hotfiring the engine. The high specific impulse, deep throttling, and restart capabilities make it ideal for large lunar payload transportation.

Chart 20: BE-7 Engine Design



Source: Intro-act, Blue Origin

Building Next-Generation Space Habitats

- **For decades, the International Space Station (ISS) has been the destination for any research work and international projects in Low Earth Orbit.** The ISS is set to be decommissioned by 2030. With that deadline in mind, NASA is exploring private players' capabilities in building a commercial space station. The ISS has been built in collaboration with various space agencies, and has been in orbit since the first module's launch in 1998. It has been continuously occupied by a human crew ever since 2000. The ISS has cost more than \$159 billion over its lifetime. It has a roughly \$3 billion operating cost per year. According to a NASA report, transitioning to commercial platforms will help the agency save up to \$1.8 billion annually. Having commercial space stations will thus help government agencies to allocate resources for other missions, such as going back to the Moon and creating a sustained presence there.
- **Several nations are already building their own space stations.** China is about to complete its own space station, Tiangong, and is opening it up to companies and allies. On July 26, 2022, the Russian space agency Roscosmos announced that a decision had been made to withdraw from the ISS program after 2024. A new space station, named Russian Orbital Space Station, operated entirely by Roscosmos, would be launched in the mid-2020s. The first crewed mission is planned for 2026. Since that announcement, the Russians have backtracked to some extent, but their future participation in the ISS is clearly problematic. In 2019, Indian space agency ISRO's chief announced plans of India's space station deployment by 2030. Thus, with various national governmental agencies planning to launch their own space stations, NASA has opened up the segment for private players. This will facilitate the US having smooth access to the space environment even after the retirement of the ISS.

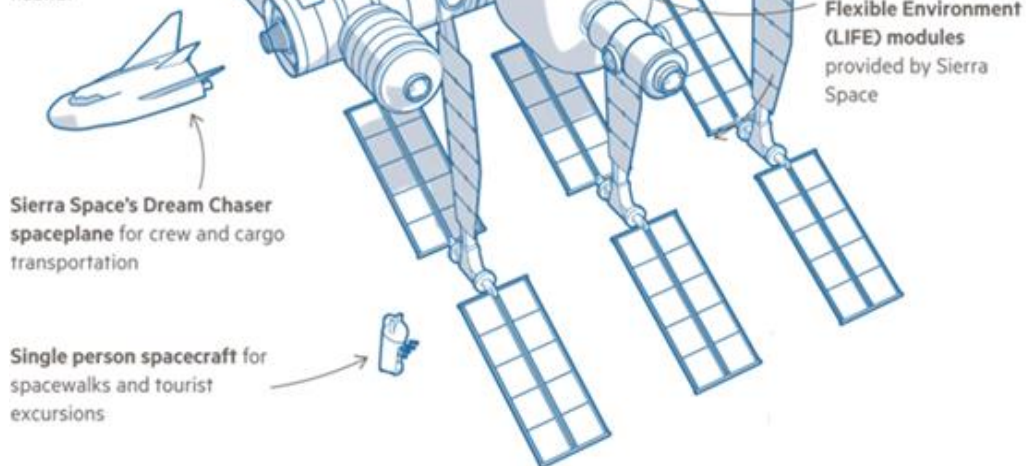
With this backdrop, NASA has signed agreements with four U.S. companies to develop designs of space stations and other commercial destinations in space. The companies that received awards are Blue Origin (\$130 million), Nanoracks LLC (\$160 million), Northrop Grumman Systems (\$125.6 million), and Axiom Space.

Chart 21: NASA Contracted Blue Origin to Develop Designs of Commercial Space Stations

Nasa contracts to develop commercial space modules (continued)

Blue Origin

\$130mn awarded, Dec 2021. Planned to be operational by 2027, the Orbital Reef station, a collaboration with Sierra Space, is designed to support a crew of 10 in an 830 cubic metre habitat



Source: Intro-act, Financial Times, NASA, Companies. Graphic: Ian Bott, Bob Haslett

Building Next-Generation Space Habitats

- **Blue Origin is currently planning to build a commercially developed, owned, and operated space station called Orbital Reef.** The company intends it to be a mixed-use business park. The company has partnered with Sierra Space for the project. According to NASA, this space station is expected to start operating by 2027, supporting a crew of 10. In addition to Sierra Space, Orbital Reef teammates include Boeing (NYSE: BA), Redwire Space (NYSE: RDW), Genesis Engineering, Amazon/AWS, and Arizona State University (Arizona State will lead a consortium of higher education institutions). The station's shared infrastructure will support the proprietary needs of diverse U.S. and international users, tenants, and visitors, including those representing research, industry, government, and the commercial sector. Features such as reusable space transportation and advanced automation can minimize cost and complexity to enable the widest range of users. Accommodations, vehicle docking ports, and utilities can all be scaled with growth in market demand.

Chart 22: Orbital Reef Internal Design



Source: Intro-act, Blue Origin

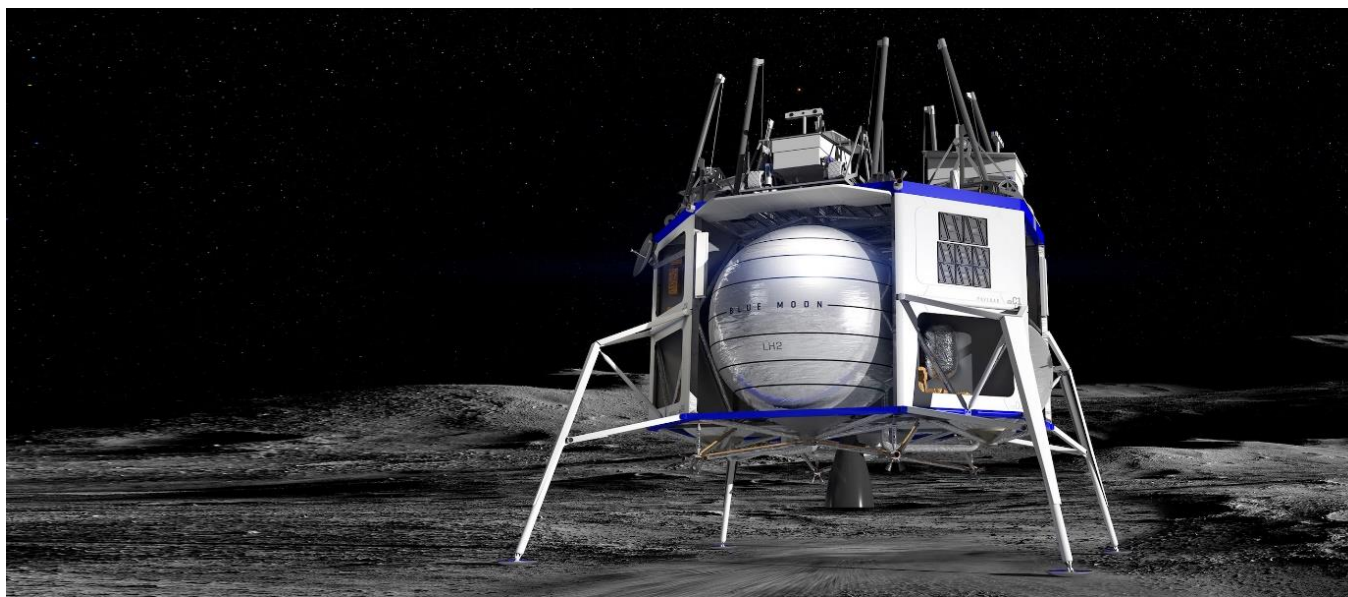
- **One of the major competitors of Blue Origin in this segment is Axiom Space.** Axiom intends to build the world's first commercial space station by 2028. Axiom is building a private commercial space station named the "Axiom Station." The station will have its spacecraft modules individually launched and assembled in-orbit, first attaching to the ISS. The mission is part of NASA's Next Space Technologies for Exploration Partnerships initiative under which NASA awarded Axiom a \$140 million contract in 2020 to provide at least one habitable spacecraft to attach to the ISS. Before ISS retirement (and atmospheric reentry), Axiom plans to detach its modules and commence orbit on its own as Axiom Station. Axiom is preparing for a late 2025 launch of the first section of the Axiom Station to be attached to the ISS.

According to Financial Times, the forecast for annual sales for commercial space stations is estimated to be around \$8 billion.

Returning to the Surface of the Moon

- **Blue Origin has ambitions to return humans to the Moon.** The company has designed a flexible lander for the same named Blue Moon, which will deliver a wide variety of small, medium, and large payloads to the lunar surface. Blue Moon is designed to land multiple metric tons of payload on the lunar surface. The top deck and lower bays can accommodate a wide variety of payloads, large and small. There are lower mounting locations for these payloads, useful for closer access to the lunar surface and off-loading. The lander will be powered by the liquid oxygen/liquid hydrogen rocket engine, BE-7. The Blue Moon lander provides kilowatts of power to payloads using its fuel cells, allowing for long mission durations and the ability to last through the lunar night. Jeff Bezos believes that the water on the Moon can be used to produce hydrogen and oxygen, thereby making it possible in the future to refuel the vehicle on the lunar surface itself, making it a viable transportation medium.

Chart 23: Blue Moon Can Land Multiple Metric Tons of Payload on the Lunar Surface



Source: Intro-act, Blue Origin

- **Back in the race to the Moon.** In October 2019, it was announced that Blue Origin, Lockheed Martin, Northrop Grumman, and Draper Laboratory would collaborate on a proposal for the “Human Landing System” (HLS) for NASA’s Artemis program. Blue Origin would serve as the primary contractor with a variation of its Blue Moon Lunar Lander serving as the descent stage. Lockheed Martin would build the ascent stage, in part based on its Orion crew capsule technology. Northrop Grumman would build a transfer stage based on its Cygnus spacecraft technology. The lander was projected to launch on Blue Origin’s reusable New Glenn rocket. In April 2020, Blue Origin won a design contract of \$579 million from NASA to advance the design of a human lunar lander for the Artemis program during a 10-month period in 2020–21. Blue’s proposal was for the “Integrated Lander Vehicle (ILV).” This lander was described as a multi-element spacecraft consisting of an in-space transfer element and ascent element in addition to the Blue-provided descent element. The NASA-paid design work started in 2020 and continued into 2021. NASA had to thereafter evaluate which contractors would be offered contracts for initial demonstration missions and select firms for development and maturation of lunar lander systems.

The ILV descent element was a variant of the Blue Moon lunar lander that Blue had been developing for nearly three years by early 2020. At the end of the year-long program, in April 2021, NASA did not select the Integrated Lander Vehicle design and instead selected SpaceX’s Starship HLS for crewed lunar lander development, plus the two lunar demonstration flights, in a contract valued at \$2.89 billion over several years. Blue Origin filed a protest with the Government Accountability Office, which eventually denied the protest.

However, in March 2022, NASA announced its intention to bring a second entrant to market for the development of a lunar lander in parallel with SpaceX. NASA is asking American companies to propose lander concepts capable of ferrying astronauts between lunar orbit and the lunar surface for missions beyond Artemis III. The agency is pursuing two parallel paths for continuing lunar lander development and demonstration, one that calls for additional work under an existing contract with SpaceX, and another open to all other U.S. companies to provide a new landing demonstration mission from lunar orbit to the Moon's surface. Blue Origin is one of the most suitable candidates for this mission. This development re-opens a path for Blue Origin to fulfil its Moon mission ambitions.

Lunar Presents a New Untapped Market for the SpaceTech Industry

According to a report by PwC, "...the markets for lunar goods and services are expected to rapidly expand in an effort to match the demand, growing to a cumulative \$170 billion over up to 2040. Revenues in this timeframe will be primarily driven by the market for lunar transportation, expected to be cumulatively worth roughly \$100 billion by 2040, and the SRU market, expected to be cumulatively worth about \$63 billion by 2040, driven primarily by the demand for propellant. The appealing perspectives of these two markets are supported by the expected growth in the frequency and number of missions to the Moon, as well as the increasing scale of the missions, targeting larger payloads with the aim of enabling a sustainable human presence."

*SRU - Space Resource Utilization

Financials and Valuation

- **With estimated sales of \$513 million in 2021, Blue Origin’s valuation could well be over \$25 billion.** Blue Origin is working in more than one sub-segment of the SpaceTech industry. It competes with various players in the different segments where it operates. For example, Virgin Galactic is one of its major competitors in the suborbital space tourism segment, whereas it competes with SpaceX in orbital and lunar missions, as well as rocket engines and orbital launch vehicles. Likewise, it competes with other companies involved in rocket manufacturing. Axiom is one of its major competitors in the area of commercial space stations. Even though there are listed companies operating in one or more of these various segments, it is difficult to determine how much the market is valuing each of these businesses separately. One way to look at Blue Origin’s estimated valuation is to compare it with SpaceX. SpaceX generated an estimated revenue of \$2.5 billion in 2021 and the company’s estimated valuation is \$127 billion. So, with an estimated sales of \$513 million in 2021, Blue Origin’s valuation could be around \$25 billion.

Chart 24: Blue Origin’s Peers: Key Metrics

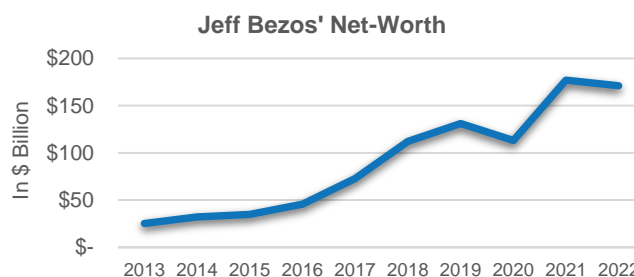
S. No.	Company Name	Mkt Cap (\$ Mns)	Ent Val (\$ Mns)	Sales (LTM)	Sales (NTM)	EV/Sales
1	LOCKHEED MARTIN CORP	109,850	119,719	64,167	66,882	1.8
2	BOEING CO	85,681	131,530	60,743	82,747	1.6
3	NORTHROP GRUMMAN CORP	75,066	88,399	34,957	37,313	2.4
4	AEROJET ROCKETDYNE HLDGS INC	3,559	3,478	2,175	2,223	1.6
5	VIRGIN GALACTIC HOLDINGS INC	1,374	877	3	7	130.8
6	OHB SWEDEN	569	862	1,016	1,156	0.7
7	ROCKET LAB USA INC	2,369	1,974	129	268	7.4
8	VIRGIN ORBIT	1,230	1,171	7	36	32.5
9	SPACE X (PVT.)		127,000	2,500		50.8

Source: Intro-act, FactSet, Yahoo Finance

- **Blue Origin is a well-funded company with future funding commitments from the founder.** Founded by one of the richest men on planet Earth today, Blue Origin is well funded. Jeff Bezos has already made heavy private investments in Blue Origin to the tune of an estimated \$7.5 billion as of 2021. In 2017, Bezos announced he was selling \$1 billion a year of his Amazon stock to fund Blue Origin’s development. In addition to investments from Bezos, Blue Origin has received \$181 million in contracts from the United States Air Force and \$26 million of funding from NASA.

The chart below shows the rise in the fortune of Jeff Bezos, predominantly due to a rise in Amazon’s stock price. With a net worth of over \$100 billion since 2018, Jeff Bezos is in good financial health. So, Bezos looks well-placed to continue funding Blue Origin until it becomes profitable. Bezos believes that in the long run, Blue Origin should be a profitable enterprise. However, he understands that it will take some years to achieve that, and intends to continue investing in the company until it stands on its own feet.

Chart 25: Jeff Bezos’ Net-Worth



Source: Intro-act, Forbes

Key Personnel

- **Jeff Bezos, Founder.** Jeff Bezos founded e-commerce giant Amazon in 1994 out of his garage in Seattle. He stepped down as CEO to become executive chairman in July 2021. He now owns a bit less than a 10% stake in Amazon and is the world's second-richest person as per Forbes' 2022 Billionaires list. In July 2021, Bezos went to space in Blue Origin's New Shepard rocket. The 10-minute spaceflight reached a peak of about 66 miles, crossing the Kármán line.
- **Bob Smith, CEO.** Smith holds an MS degree in Applied Math/Engineering from Brown University. After completing a PhD in Aerospace Engineering from the University of Texas at Austin, Smith obtained a Master's in Business from the Massachusetts Institute of Technology. Smith was previously president of mechanical systems & components and chief technology officer at Honeywell Aerospace. He left Honeywell in September 2017 to join Blue Origin.
- **Susan Knapp, CFO.** Knapp was earlier a vice president, business management at Northrop Grumman, and vice president of finance at Orbital ATK. She joined Blue Origin in 2018.

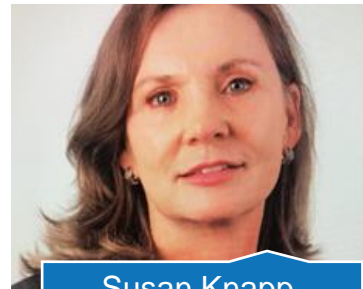
Chart 26: Key Personnel



Jeff Bezos,
Founder



Bob Smith,
CEO



Susan Knapp,
CFO

Source: Intro-act, Multiple web sources

In December of 2020, Blue Origin announced the formation of its Board of Advisors, which will guide the company to radically reduce the cost of access to space and the utilization of in-space resources. The members of the advisory board include:

- **The Honorable Kari A. Bingen.** Former deputy undersecretary of defense for intelligence and security
- **Dr. Charles Elachi.** Former director, Jet Propulsion Laboratory
- **Dr. Dan Hastings.** Aeronautics and Astronautics Department Head, Massachusetts Institute of Technology, and former chief scientist, U.S. Air Force
- **Major General Sue Mashiko, USAF (Ret).** Former deputy director, National Reconnaissance Office
- **Todd May.** Senior vice president, space and mission solutions, KBR, and former director, NASA Marshall Space Flight Center
- **Bill Smith.** Former president, Primex Technologies Aerospace Division
- **The Honorable Heather Wilson.** President, University of Texas at El Paso, former Secretary of the U.S. Air Force, and former Member, U.S. House of Representatives

Risks

- **Funding may be constrained in the future.** Being privately funded makes the company highly dependent on its founder for any future capital requirements. Bezos is funding Blue Origin by selling \$1 billion worth of his Amazon shares each year. According to FactSet, Bezos owns Amazon shares worth \$114.7 billion. Thus, prima facie, Blue Origin looks well-funded. However, any downside in the valuation of the Amazon stock could limit the funding of Blue Origin. Depending on a single person for the company's funding needs is risky.
- **Need for significant capital investments and financial risks.** Blue Origin generates limited revenue from its commercial payloads and human spaceflights, making it difficult to predict its future operating results. Moreover, the company has been investing heavily in R&D to develop new technologies, procure high quality talent, and run costly operations. As a result, the company's losses may be larger than anticipated, and it may not achieve profitability when expected, or at all. Even if it does become profitable, Blue may not be able to maintain or increase its profitability. Its ability to generate profit will depend on growing operations and driving operational efficiencies in the business to generate better margins. Any failure to increase its revenue sufficiently to keep pace with its investments and other expenses could prevent it from achieving or maintaining profitability or positive cash flow. The future growth and operating performance may fail to meet investor or analyst expectations.
- **There is stiff competition in the segments where Blue Origin operates.** The space industry is highly competitive, with many strong private players trying to make a mark. Virgin Galactic is one of Blue Origin's major competitors in the suborbital space tourism segment, whereas it competes with SpaceX in orbital and lunar missions, as well as rocket engines and orbital launch vehicles. Likewise, it competes with other companies involved in rocket manufacturing, and Axiom is one of its major competitors in commercial space stations.

One of the company's major competitors, SpaceX, has also been chosen by NASA for its lunar mission instead of Blue Origin. Going forward, SpaceX can threaten Blue Origin in other segments such as space tourism and space habitats. SpaceX founder Elon Musk has ambitions of creating a city on Mars. This makes him a potential competitor in space habitats. SpaceX flew a private 4-member mission that lasted more than three days and reached around 364 miles altitude. The company has also sent 14 government astronauts to the ISS. Thus, going forward, potential customers might opt for higher-reaching SpaceX carrier as against the experiences provided by Blue Origin.

- **Accidents can change investors' perception towards the industry.** The space tourism industry is in a nascent stage and any incident such as in-flight malfunctions can cause serious reputational and financial damage to the future of the industry. Recently, the booster engine of Blue's NS-23 malfunctioned and crash landed. It was an uncrewed mission and the Crew Escape System functioned as expected, detaching the capsule from the booster. However, Blue Origin's New Shepard spacecraft is grounded until further notice. Such incidents of malfunctioning remind people of the risk of fatal accidents, negatively impacting investors and customers' perception of the space tourism industry.
- **Acquiring and retaining talent can become a problem.** The space industry overall is in a nascent stage, with many areas still under research and development. This makes having a talented tech team a prerequisite to grow and capture the market. With several companies targeting the same talent pool, including non-space organizations like Google and Apple, there is competition to acquire and retain top talent which can increase the costs in future.
- **Space tourism will get newer players and options in the future.** China is planning to begin private spaceflights to space, as are European companies. A Chinese company, CAS Space, plans to charge passengers in the range of \$285,000 to \$427,000, with operations estimated to start by 2025. An entirely different experience will be offered in the future by companies like Space Perspective, World View, and Zero 2 Infinity, which will use balloons to lift customers into the stratosphere. Competition from these and other lower-cost providers could be a risk for Blue in the long term.
- **Regulatory risks.** The business of the company is subject to a wide variety of government laws and regulations. With the SpaceTech industry evolving rapidly, so are the laws. Failure to comply with these laws and regulations can adversely affect the business. Moreover, an evolving regulatory/legal environment could affect the company's operations and increase compliance costs.

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