



# AFPC Capitol Hill Briefing: Understanding the Multi-Trillion Dollar Space Economy—How can the U.S. successfully compete with China?

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**Related Categories:** Energy Security; Military Innovation; Science and Technology; SPACE; NASA; China

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On October 27th, the American Foreign Policy Council (AFPC) sponsored a virtual Capitol Hill briefing on *Understanding the Multi-Trillion Dollar Space Economy: How can the U.S. successfully compete with China?* The briefing examined the emerging space economy and how the U.S. can harness the economic resources of space to further its national interests and promote economic prosperity. AFPC Senior Fellow in Defense Studies and Co-Director of the Space Policy Initiative Peter Garretson moderated the briefing, whose panelists included Co-Founder and Managing Partner of Space Fund Meagan Murphy Crawford; President and CEO of Trans Astronautica Corporation Joel Sercel; President of Artemis Innovation Management Solutions LLC John C. Mankins; and CEO and Founder of GXO Inc. Mandy Vaughn. The following is a summary of their respective remarks as well as policy recommendations that will allow the U.S. to successfully compete in the emerging space economy.

## Garretson

During AFPC's first Space Policy Initiative briefing in October 2020, the burgeoning space race between the U.S. and China was discussed. It was noted that China's space roadmap entails asteroid mining, nuclear powered shuttles for space exploration, and the industrialization of the moon to fabricate satellites that can harness energy in space—thus exploiting a global space market poised to rise from \$350 billion annually today to trillions of dollars in the coming decades. The panelists concluded that the U.S. needs a “North Star” vision for space—a whole of government response in coordination with allied nations and private sector partners to counter the Chinese strategic space threat and to realize the great benefits space has to offer by empowering the U.S. space industrial base. AFPC's second Space Policy Initiative briefing in April 2021 examined the current role and mission sets of the Space Force, its capabilities, and how it can best be utilized to protect and advance U.S. national security and economic interests in the new space age. The panelists noted that the United States increasingly requires a dedicated military force to protect the current and future space architecture from hostile actors who are bolstering their abilities to disrupt and destroy U.S. space assets, as well as from large asteroids that can pose a threat to the Earth. The establishment of the Space Force will ensure that the U.S. military prioritizes this increasingly crucial domain, will bolster the commercial space sector, and will provide private space companies with the security assurances they need to have confidence in the emerging space economy.

Space has become essential to modern society. Nearly every sector of the economy, including telecommunications, aviation, healthcare, the financial system, transportation, agriculture, among others, all depend on space assets. Yet today the debate over space has been narrowly tailored and centered almost exclusively on the national security elements of space while neglecting its economic potential. There is now broad consensus that the space economy is poised to grow significantly on the back of space tourism, human settlement in space, space mining and space solar power. Major financial institutions have provided forecasts for what the space economy might look like circa 2040, and most peg the number in the trillion dollar range annually. For comparison, China sees its planned Earth-Moon space economic zone potentially generating \$10 trillion annually. The vast economic potential of space represents an opportunity to either extend U.S. primacy and prosperity, or provide an opening for China to surpass the U.S. as the dominant space power.

## Crawford

The future of space is a combination of humans and robots working together to create something completely new. In 1976, Princeton Professor Gerard K. O'Neill published a book called "The High Frontier: Human Colonies in Space," which outlined a future of millions of humans living and working in space. That future, in which environmentally harmful processes like mining are taken off Earth and the planet is effectively treated as a national park, is well within reach. Notable private space companies such as SpaceX, Blue Origin, Sierra Space, Axiom Space, among others are striving towards a future where space readily accessible for humans. Axiom is already working with NASA to develop the commercial successor to the International Space Station (ISS). Blue Origin also announced recently that it was partnering with Sierra Space, Boeing, Redwire Space, Genesis Engineering Solutions, and Arizona State University to develop a commercial space station known as Orbital Reef; and Nanoracks recently unveiled plans to partner with Voyager Space and Lockheed Martin to develop a commercial space station. Companies are increasingly demonstrating a willingness to invest billions of dollars in developing commercial space stations because of the potential return on investment generated by numerous commercial opportunities—such as space tourism, as well as, revolutionary research and development that can take place on these stations. Currently, projections for the total size of the future space economy tend to be more conservative \$1 trillion by 2040. In reality, the potential economic value of space is limitless, and it will likely become a multi-trillion-dollar sector in the very near future.

## **Sercel**

Part of the reason people have a hard time understanding how important asteroid mining will be is because there's a misconception that traveling in space is a supremely expensive activity. As space industry leaders develop space vehicles that are fully reusable like airliners, and when these space vehicles go into operation with thousands of flights per year, space launch and travel costs will be comparable to air travel costs. At Trans Astronautica, we are currently working on a set of orbital transfer vehicles using our solar thermal rocket engine known as the Omnivore, which is powered by sunlight and can use anything, including water, as a propellant, thereby reducing orbital logistics costs below air travel costs. And since our asteroid mining technologies and rocket propulsion systems are powered by sunlight, we also plan on converting thousands of near-earth asteroids into orbital refueling stations, which would further reduce space transportation costs. As these developments take hold, asteroid resources will become an incredibly powerful and potent asset for the Earth. The utilization of precious metals from asteroids would provide immense benefits to the terrestrial economy. Once the asteroid belt becomes more accessible, massive systems such as space solar power satellites will be manufactured in orbit, and it will even make more sense economically to build terrestrial products in space out of asteroid minerals and ship those products to Earth. The asteroid belt will also be integral to U.S. national security and economic prosperity, as it contains all of the strategic materials that the U.S. needs to safeguard and advance its interests. Strategically for the U.S., nothing could be more important than controlling the high ground and dominating the emerging space economy.

It is our belief at Trans Astronautica that the current projections from major financial institutions and even the Chinese about the future size of the space economy are shallow. Within the next 20 to 30 years, we believe that the space economy will start to become a large fraction of the total terrestrial economy. The resources of space will allow for 1,000 years of exponential growth for our civilization, and there's enough resources in the asteroids to support a thriving population of a trillion people. The only three things that can limit human industrial potential in space are energy, material, and inspiration; we have virtually unlimited energy and material in space, and the inspiration is there, as seen by the space initiatives of the two wealthiest people on Earth: Jeff Bezos and Elon Musk. The real power and potential are in space, not here on the ground, and the biggest mistake the U.S. Congress can make is to fail to grasp this opportunity. The free people of the world need to win the space race; there's literally nothing more important to the survival and thriving of our civilization than winning this game.

Regarding China's space activities, the communist nation's approach to space is classic jingoistic colonialism. Chinese government officials have made public statements that its approach to space will be similar to its approach to the South China Sea—which is that it built islands to extend its national sovereignty, and then claimed those islands. Just as China's activities in the South China Sea are in gross violation of international rules and norms, its plans for the moon and asteroids are as well. The free world must use its creative energies to counter and compete with China, or we are going to lose. Right now, the greatest threat to the U.S. and all free nations is China's economic growth, which it is pouring into its national defense. The greatest potential we have for countering China's rise is to outgrow them economically using the resources of space. It's really important that our economic activities in space be private sector driven. And that means when we establish public-private partnerships, we have to avoid using antiquated contracting and acquisition processes, which lead to higher costs and greater inefficiencies.

In regard to space debris, we need changes in international law and regulation. One of the problems we have in space is that there's no law of salvage as there is at sea. At sea, if you abandon a vessel and someone finds it, it's salvage and they can keep it. In orbit, if you abandon a spacecraft 30 years later and someone approaches it from another country, it's thought of as an act of war. We have to change the economic incentives so that innovators and entrepreneurs can determine how to capitalize on that debris to good effect. This is a case where under regulation, or being behind the times on regulation, will lead to over regulation—as we are now seeing with the Internet; we have to implement just enough regulation to motivate the private sector to be good citizens and abide by space ethics. The stewardship of the space environment is one of the critical areas of space ethics that we have to turn into law. We also have to get ahead of human rights and bioethics in space before we can start establishing human settlements. I would invite all to review a discussion I participated in with the Acton Institute, and a panel discussion that was recently held with Humanity in Deep Space on space ethics. As humans, we need to get serious about being responsible citizens in space. In addition, we need individual countries to pass space liability laws, whereby if you leave a booster in orbit and then fail to deorbit it and it collides with a satellite, you are held financially liable for that inaction. Finally, our efforts to address space debris should not just be limited to low-earth orbit; we also need to address potential lunar debris as well.

## **Mankins**

Space solar power is the idea of going into space at a higher Earth orbit—geostationary orbit or one near geostationary orbit—where a satellite is in the sun the majority of the time and can see most of the Earth. Once in orbit, the satellite or platform harvests sunlight, converts it first into electricity and then into low intensity microwaves, and transmits that energy to large receivers on the Earth. The receivers then convert the energy back into electricity that can be provided to homes, businesses, and the like. A useful analog for space solar power is to think of it like hydroelectric power, but without water and with a smaller catchment area. For example, the Hoover Dam is about 400 square kilometers, and when it's got a full Lake Mead behind it, delivers about 2,000 megawatts of electrical power. A solar power satellite would deliver the same 2,000 megawatts but with a receiver which would be on the order of 28 square kilometers—just a small fraction of the comparable catchment area for a large hydroelectric plant.

Solar power is critical to the U.S. for a number of reasons. First, solar power will play an important role as we try to move toward carbon net zero energy. Although ground-based solar power is a cheap renewable energy source, it depends on the availability of other energy sources to provide baseload power during the night and seasons and days with less sunlight. This dilemma is a barrier to transitioning to ground-based solar power in a significant way. This requires us to explore novel baseload energy options, such as the concept for modular space solar power I've been pursuing called SPS Alpha—these systems would operate in partnership with ground-based wind and solar power. Another reason why space solar power is important to the U.S. is that there is an urgent requirement to solve the carbon net zero challenge for the whole world and not just for the U.S. Space solar power also has the potential to create tens of thousands of quality jobs in the U.S. Moreover, space solar power is important to the U.S. because it is the second key to national leadership in cislunar space—the first being affordable and regular space transport. Space solar power also has the potential to drastically reduce energy costs.

The U.S. needs to devote resources to space solar power now in order to remain competitive globally and because there is an emerging international consensus on the benefits of space solar power. For comparison, Japan is regarded as a leader globally in R&D for space solar power. China has also developed a major program on space solar power, formed a national committee led by the Chinese Academy of Space Technology this year, and is completing a new research center focused on space solar power. China is planning on placing a 1 megawatt solar energy station in space by 2030. South Korea, Australia, the European Space Agency, among others are also working on developing space solar power capabilities. There is an opportunity here for the U.S. to establish international rules and norms for space solar power. In addition, space solar power has tremendous near-term potential, and prototypes could be developed and demonstrated in the next few years, and an operational SPS could be deployed within 10 or 11 years.

To advance space solar power, Congress, in coordination with the White House, could establish as a program goal, the development of commercial space solar power technology and systems in this decade. This could be accomplished through a program of public private partnerships. The maturation of space solar power can occur in a matter of years not decades, and billions of dollars, not hundreds of billions of dollars. One avenue to consider is a draft presidential policy directive on space solar power published in August by the Beyond Earth Institute that lays out all of the government initiatives to realize this vision, to achieve it within a decade, to devise an interagency action plan, and to develop public-private partnerships. There is probably no more urgent issue related to the new space economy than the potential benefit of space solar power to address the urgent need for clean energy.

## **Vaughn**

We are at an inflection point here in the near-term to make sure we get this new space ecosystem and economy moving along. The U.S. needs to internalize what it is up against in space in order to be successful and reform some of its industrial behaviors and economic policy to allow the commercial space sector to flourish. U.S. adversaries, particularly China, look at the role of the commercial space industry as part of their larger strategic architecture, and as such, do not view their commercial capabilities separately from their national security capabilities. This is very different from how the U.S. views its commercial space sector. China also seeks to become the partner of choice for other nations in the space domain. The U.S. needs to work toward setting rules and norms in a variety of space-related areas including human presence in space, asteroid mining, and space solar power, and focus on expanding public private partnerships. Legislatively, Congress should declare space as critical infrastructure to link all of the many facets of the space sector and U.S. space activities. From a government perspective, the U.S. needs to remove legacy barriers and create financial incentives for investment in the space sector and space technologies. The State of the Space Industrial Base report, organized by NewSpace New Mexico in conjunction with the Space Force, Air Force Research Laboratory, and Defense Innovation Unit, proposed a range of action items for the U.S. to develop a "North Star" strategy for space, harness the economic resources of space, expand its interests in space, and increase the competitiveness of the commercial space sector in the near, medium, and long term. It is important to remember that the space sector is about people—we need people to want to come into this industry. Whether it's to serve in the Space Force or invent the next innovative technology, we need to make space an attractive area for people. Going forward, we have to make hard decisions in terms of the role of the commercial space sector, the role of allies and partners, and how we can help jumpstart the space economy from a foundational level.

## **Policy Recommendations**

- Develop a whole-of-government "North Star" vision for space in conjunction with allies and private sector partners
- Designate space as critical infrastructure
- Expand public-private partnerships between the U.S. government and the commercial space sector
- The White House should establish a space solar power public private partnership program with a goal of developing space solar power technology and systems in this decade
- Enhance interagency coordination on space policy
- Create financial incentives for investment in the commercial space sector

- Remove barriers to entry for new commercial space companies
- Reform antiquated government contracting and acquisition processes to create more efficiency
- Create incentives for space debris management
- Reform gaps in relevant international law and regulation to adopt a law of salvage for space, similar to the maritime law of salvage
- Adopt the “Declaration of Human Rights in the Universe”—proposed by Space Fund co-founder Rick Tumlinson