# Negative

**(I negate) Resolved: The appropriation of outer space by private entities is unjust.**

## If at the end of this debate there remains a single instance that private appropriation of outer space benefits humanity, you must Negate.

## FWK

Agree consequentialism

## Private Sector Key

#### Private sector has incentive to innovate, making markets accessible and cost-effective to all.

**Heartland 22** [Op Ed: Private Sector Is the Future for Space Exploration (heartlanddailynews.com)](https://heartlanddailynews.com/2022/01/op-ed-private-sector-is-the-future-for-space-exploration/)

But the public sector will never deliver the full potential benefits and excitement of humans venturing forth from Earth. Instead, ongoing **government-driven space efforts will be expensive and limited** to a few, select individuals. **For 50 years, government-run space exploration has been subject to** ever-**shifting budget and political priorities**. The space shuttle and the space station sucked up the lion’s share of resources, limiting exploration of alternative launch approaches or objectives beyond low-Earth orbit. In addition, given the high cost, only the most “deserving,” appropriately vetted candidates are chosen. Ordinary people will have almost no opportunity to ever venture into space, except in long-shot publicity stunts intended to gin up support for additional spending. Finally, **in the absence of competitive pressures, government efforts face little incentive to explore long-shot options** for dramatically lowering costs. With little potential upside from risk-taking, program managers instinctively stick to defensible, consensus-driven (and typically higher-cost) solutions. But today’s surge in space tourism is driven by market forces and has the potential to deliver(s) outsized benefits more affordably. These **private-sector space efforts are market driven, sustainable, broad-based and** increasingly **cost-effective.** While Branson and Bezos almost certainly enjoyed their trips to space, neither of them got wealthy by squandering their limited resources on products and services that had no hope of generating profits. Enduring prosperity has created a vast reserve of space and technology enthusiasts who also control enormous financial resources. The combination of dreams and resources provides the opportunity to build profitable space businesses. Developing this market is exorbitantly expensive. **Space entrepreneurs will continually** seek out opportunities to **expand the market** in order **to spread costs over the largest** possible **pool of** potential **consumers**. Finally, **private-sector competition is** primarily **a race to find** ever-**better ways to deliver higher-value services at** ever-**lower costs.** As initial entrants demonstrate, there is a market for space tourism and competitors will work relentlessly to deliver more affordable space services.

#### Because of this, public sector ALONE fails: Only Private-public partnership works (prevent company towns / abuse, accountability in modern day)

Kristin **Houser 17** (June 12, Futurism, Private Companies, Not Governments, Are Shaping the Future of Space Exploration, https://futurism.com/private-companies-not-governments-are-shaping-the-future-of-space-exploration)

**Private companies can generate revenue through government contracts —for example, NASA has contracted Boeing to transport astronauts to the International Space Station (ISS), and SpaceX just closed a deal with the U.S. Air Force to launch its secretive space drone. This leaves the government agencies free to pursue the kind of forward-thinking, longer-term research that might not immediately generate revenue, but that can be later streamlined and improved upon in the private sector.** Ultimately, Space Race 2.0 has no losers. The breakthroughs happening in space exploration benefit us all, and truly, a little friendly competition never hurt anyone (unless you count the egos bruised by those tweets).

## C1: Asteroid Mining Impacts / Extensions

#### Asteroid mining by private companies will happen soon

**Britt 21** https://www.thomasnet.com/insights/companies-are-preparing-for-space-mining/

[The Asteroid Mining Corporation](https://asteroidminingcorporation.co.uk/) (UK) is a venture currently crowdfunding for a 2023 satellite mission called “El Dorado,” which will conduct a spectral survey of 5,000 asteroids to identify the most valuable for mining.

#### Guaranteed property rights are needed to reassure companies and incentivize space investment

**Wall 15** <https://www.space.com/30213-asteroid-mining-planetary-resources-2025.html>

Asteroid mining may be a reality by 2025. "We have every expectation that delivering water from asteroids and creating an in-space refueling economy is something that we'll see in the next 10 years — even in the first half of the 2020s," said Chris Lewicki, Planetary Resources president and chief engineer Chris Lewicki. "After that, I think it's going to be how the market develops," Lewicki told Space.com, referring to the timeline for going after asteroid metals. "If there's one thing that we've seen repeat throughout history, it's, you tend to overpredict what'll happen in the next year, but you tend to vastly underpredict what will happen in the next 10 years," he added. "We're moving very fast, and the world is changing very quickly around us, so I think those things will come to us sooner than we might think." Planetary Resources is now working on its next spacecraft, which is a 6U cubesat called Arkyd-6. (One "U," or "unit," is the basic cubesat building block — a cube measuring 4 inches, or 10 centimeters, on a side. The Arkyd-3R is a 3U cubesat.) The Arkyd-6, which is scheduled to launch to orbit in December aboard SpaceX's [Falcon 9 rocket](https://www.space.com/18962-spacex-falcon-9.html), features advanced avionics and electronics, as well as a "selfie cam" that was funded by a wildly successful Kickstarter project several years ago. The cubesat will also carry an instrument designed to detect water and water-bearing minerals, Lewicki said. The next step is the Arkyd 100, which is twice as big as the Arkyd-6 and will hunt for potential mining targets from low-Earth orbit. Planetary Resources aims to launch the Arkyd-100 in late 2016, Lewicki said. After the Arkyd 100 will come the Arkyd 200 and Arkyd 300 probes. These latter two spacecraft, also known as "interceptors" and "rendezvous prospectors," respectively, will be capable of performing up-close inspections of promising near-Earth asteroids in deep space. If all goes according to plan, the first Arkyd 200 will launch to Earth orbit for testing in 2017 or 2018, and an Arkyd 300 will launch toward a target asteroid — which has yet to be selected — by late 2018 or early 2019, Lewicki said. "It is an ambitious schedule," he said. But such rapid progress is feasible, he added, because each new entrant in the Arkyd series builds off technology that has already been demonstrated — and because Planetary Resources is building almost everything in-house. "When something doesn't work so well, we don't have a vendor to blame — we have ourselves," Lewicki said. "But we also don't have to work across a contractural interface and NDAs [non-disclosure agreements] and those sorts of things, so that we can really find a problem with a design within a week or two and fix it and move forward." For its part, Deep Space Industries is also [designing and building spacecraft](https://www.space.com/19368-asteroid-mining-deep-space-industries.html) and aims to launch its first resource-harvesting mission before 2020, company representatives have said. Extracting and selling asteroid resources is in full compliance with the Outer Space Treaty of 1967, Lewicki said. But there's still some confusion in the wider world about the nascent industry and the rights of its players, so he's happy that the U.S. Congress is taking up the asteroid-mining issue. (The House of Representatives recently passed a bill recognizing [Asteroid miners' property rights](https://www.space.com/26644-moon-asteroids-resources-space-law.html), and the Senate is currently considering the legislation as well.) "I think it’s (is) more of a protection issue than it is an actual legal issue," Lewicki said. "From a lawyer's interpretation, I think the landscape is clear enough. But from an international aspect, and some Investors — I think they would like to see more certainty."

Space mining by private entities will be full scale in a few years

Krishnan 20 CA Krishnan, former Deputy Chief and advisor defense industries, 8-6-2020, Space mining: Just around the corner?, https://www.theweek.in/news/sci-tech/2020/08/06/Space-mining-Just-around-the-corner.html, 12-30-2021

Fast paced developments **are** taking place in the field of space mining technology with **private players** in the lead. Optical mining using concentrated sunlight, robotics, automated mining applications, advanced drilling machines etc are just a few examples. Participation of private players has reduced the investment burden and greatly **enhanced** the width and **pace** of innovation. It is believed that launch of the first asteroid mining vehicle as well as setting up of the first fuelling stations on the Moon and in low earth orbit could become a reality **within a decade**.

### Climate Change Impact

#### 1) Mining on Earth is the biggest waste producer, contributing to climate change – space mining solves

MacWhorter 16 Kevin MacWhorter 16, J.D. Candidate, William & Mary Law School, "Sustainable Mining: Incentivizing Asteroid Mining in the Name of Environmentalism", William & Mary Environmental Law and Policy Review, Vol 40, Issue 2, Article 11, https://scholarship.law.wm.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1653&context=wmelpr

A. Rare Element Mining on Earth In the next sixty years, scientists predict that certain elements crucial to modern industry such as platinum, zinc, copper, phosphorous, lead, gold, and indium could be exhausted on Earth. 12 Many of these have no synthetic alternative, unlike chemical elements such as oil or diamonds.13 Liquid-crystal display (LCD) televisions, cellphones, and laptops are among the various consumer technologies that use precious metals.14Further, green technologies including wind turbines, solar panels, and catalytic converters require these rare elements. 15 As demand rises for both types of technologies, and as reserves of rare metals fall, prices skyrocket.16 Demand for nonrenewable resources creates conflict, and consumerism in rich countries results in harsh labor treatment for poorer countries.17 In general, the mining industry is extremely destructive to Earth’s environment.18 In fact, depending on the method employed, mining can destroy entire ecosystems by polluting water sources and contributing to deforestation.19 It is by its nature an unsustainable practice, because it involves the extraction of a finite and non-renewable resource.20 Moreover, by extracting tiny amounts of metals from relatively large quantities of ore, the mining industry contributes the largest portion of solid wastes in the world.21 The Environmental Protection Agency (EPA) describes the industry as the source of more toxic and hazardous waste than any other industrial sector [in the United States], costing billions of dollars to address the public health and environmental threats to communities. 22 Poor regulations and oxymoronic corporate definitions of sustainability, however, make it unclear as to just how much waste the industry actually produces.23 Platinum provides an excellent case study of the issue, because it is an extremely rare and expensive metal—an ore expected to exist in vast quantities in asteroids.24 Further, production of platinum has increased sharply in the past sixty years in order to keep up with growing demand for use in new technologies.25 In fact, despite their high costs, platinum group metals are so useful that [one] of [four] industrial goods on Earth require them in production. 26 Scholars do not expect demand to slow any time soon.27 Among other technologies, industries use platinum in products such as catalytic converters, jewelry production, various catalysts for chemical processing, and hydrogen fuel cells.28 While there is no consensus on how far the Earth’s reserves of platinum will take humanity, many scientists agree that platinum ore reserves will deplete in a relatively short amount of time.29 With the rate of mining at an all-time high,30 it is increasingly clear that historical patterns of mineral resources and development cannot simply be assumed to continue unaltered into the future. 31 The platinum mining industry, however, has a strong incentive to increase its rate of extraction as profits grow with the rate of demand. Without any alternative, this destructive practice will continue into the future.32 So-called platinum-group metal (PGM) ores are mined through underground or open cut techniques.33 Due to these practices, all but a very small fraction of the mined platinum ore is disposed of as solid waste.34 The environmental consequences of platinum production are thus quite significant, but like the mining industry in general, the amount of waste is typically under-reported.35 While this is due to high production levels at the moment, those levels will only increase given the estimated future demand of platinum.36 In spite of the negative consequences, mining continues unabated because it is economically important to many areas.37 The future environmental costs provide a major challenge in creating a sustainable system. Relegating at least some mining companies to near-Earth asteroids would reduce the negative effects of future mining levels on Earth. The economic benefits of mining need not be sacrificed for the sake of the environment.38

#### 2) Asteroid mining solves environmental degradation, acquires resources needed for renewable energy

**Calma 21** Calma, Justine. Justine Calma is a science reporter at The Verge covering the environment and climate change. “2021 Was the Year Clean Energy Finally Faced Its Mining Problem.” The Verge, December 29, 2021. <https://www.theverge.com/22858437/2021-mining-critical-minerals-clean-energy-renewables-climate-change>.

Instead of cutting through landscapes with oil and gas wells and pipelines, clean energy industries and their suppliers will open up the Earth to hunt for critical minerals like lithium, cobalt, and copper. Compared to a gas-fired power plant, an onshore wind turbine requires nine times more mineral resources, according to the International Energy Agency. Building an EV requires six times more minerals than a gas-powered car. MOVE FORWARD WITHOUT THROWING CERTAIN COMMUNITIES UNDER THE BUS It’s about time to scrutinize what that hunger for minerals might cause, given the recent boom in pledges from countries and companies alike to reach net zero greenhouse gas emissions. Digging up the necessary minerals is already proving to be a minefield. Protests are popping up at proposed mines that no one really wants in their backyard. The conflicts that cropped up in 2021 are just the beginning of a challenging road ahead. In May, the International Energy Agency (IEA) issued a warning: **the world isn’t mining enough of the minerals that are the building blocks of a clean energy future**. And supply chains for many critical minerals are vulnerable, according to the IEA’s report. “Left unaddressed, these potential vulnerabilities could make global progress towards a clean energy future slower and more costly – and therefore hamper international efforts to tackle climate change,” Fatih Birol, executive director of the IEA, said in a statement at the time. “This is what energy security looks like in the 21st century.” The cobalt used in EV batteries, for example, mostly comes from the Democratic Republic of Congo. A majority of the world’s rare earth minerals, used in EV motors and wind turbines, are produced and processed in China. So if anything rattles production in those countries, the whole world might feel the effects. On top of that, the concentration of power over vital resources in specific countries and companies creates the potential for environmental and human rights abuses, which have plagued supply chains for cobalt and rare earth minerals. Investigations into cobalt mines that are essential suppliers to the EV battery industry have already found widespread labor abuses. To make things harder, the COVID-19 pandemic has put even more pressure on clean energy supply chains. Rising shipping and commodity prices could delay or even cancel solar projects slated for 2022, according to research firm Rystad Energy. Soaring metal prices could slow down the entire transition to renewable energy throughout the decade, says the International Monetary Fund.

#### Climate change leads to extinction

**Staedter 21** https://now.northropgrumman.com/climate-change-may-have-pushed-ancient-humans-into-extinction/

Life on this planet has gone through many extinction-level events over time. Most of these phenomena were caused by natural, cataclysmic forces beyond the control of any of the lifeforms existing at that time. The current cataclysmic forces are anything but natural and they are well within our control. The question is not, "will global warming cause extinction?"— it’s, "how can we prevent that inevitability from happening?" Article continues below advertisement will global warming cause extinction Will global warming cause extinction? Eventually, yes. Global warming will invariably result in the mass extinction of millions of different species, humankind included. In fact, the Center for Biological Diversity says that global warming is currently the greatest threat to life on this planet. Global warming causes a number of detrimental effects on the environment that many species won’t be able to handle long-term. Article continues below advertisement Extreme weather patterns are shifting climates across the globe, eliminating habitats and altering the landscape. As a result, food and fresh water sources are being drastically reduced. Then, of course, there are the rising global temperatures themselves, which many species are physically unable to contend with. Formerly frozen arctic and antarctic regions are melting, increasing sea levels and temperatures. Eventually, these effects will create a perfect storm of extinction conditions. will global warming cause extinction SOURCE: GETTY IMAGES Article continues below advertisement What species will go extinct if global warming continues? The melting glaciers of the arctic and the searing, unmanageable heat indexes being seen along the Equator are just the tip of the iceberg, so to speak. The species that live in these climate zones have already been affected by the changes caused by global warming. Take polar bears for example, whose habitats and food sources have been so greatly diminished that they have been forced to range further and further south. Increased carbon dioxide levels in the atmosphere and oceans have already led to ocean acidification. This has caused many species of crustaceans to either adapt or perish and has led to the mass bleaching of more than 50 percent of Australia’s Great Barrier Reef, according to National Geographic. Article continues below advertisement According to the Center for Biological Diversity, the current trajectory of global warming predicts that more than 30 percent of Earth’s plant and animal species will face extinction by 2050. By the end of the century, that number could be as high as 70 percent. will global warming cause extinction SOURCE: GETTY IMAGES Article continues below advertisement Will global warming cause humanity’s extinction? We won’t try and sugarcoat things, humanity’s own prospects aren’t looking that great either. According to The Conversation, our species has just under a **decade** left to get our CO₂ emissions under control. If we don’t cut those emissions by half before 2030, temperatures will rise to potentially catastrophic levels. It may only seem like a degree or so, but the worldwide ramifications are immense. The human species is resilient. We will survive for a while longer, even if these grim global warming predictions come to pass, but it will mean less food, less water, and increased hardship across the world — especially in low-income areas and developing countries. This increase will also mean more pandemics, devastating storms, and uncontrollable wildfires. Article continues below advertisement It’s difficult to calculate the numbers in these cases or to assess precisely what risks we will all be facing, but this is because we have never experienced anything like it before.

## C2: Solar Power Satellites

#### Space-Based Solar Power (SBSP) is a going to happen within 10 yrs. Aff banning private satellites kills the necessary tech – David 21:

David, Leonard. 11/03/21 Space Solar Power’s Time May Finally Be Coming.”https://www.space.com/space-solar-power-research-advances // LHP BT + LHP PS

The sun never sets in space. **The idea of** Harvesting solar energyvia power-beaming satelliteshas therefore long intrigued researchers looking for ways to feed an energy-ravenous [Earth](https://www.space.com/54-earth-history-composition-and-atmosphere.html). That reflection has fomented for decades but is now garnering new looks all over the world: Technologists in the U.S. and China, experts in Japan and researchers within the European Space Agency and the United Kingdom Space Agency are all working to make space-based solar power a reality. Related: [Solar power stations in space could be the answer to our energy needs](https://www.space.com/solar-power-stations-in-space-could-be-the-answer-to-our-energy-needs.html) History machine Peter Glaser, the father of the solar power satellite concept. (Image credit: Arthur D. Little Inc.) The idea of wireless power transmission dates back to [Nikola Tesla](https://www.livescience.com/45950-nikola-tesla-biography.html) near the end of the 19th century. Fast-forwarding to 1968, the notion of a solar power satellite was detailed and patented by U.S. space pioneer Peter Glaser. He blueprinted a novel way to collect energy from sunlight using solar cells and beam down an energetic muscle of microwaves to receiving antennas ("rectennas") on Earth. Those microwaves could then be converted to electrical energy and supplied to the power grid. Then, in the mid-1970s, microwave power transmission experiments in the tens of kilowatts were successfully conducted at the Goldstone Deep Space Communications Complex in California, a facility of NASA's [Jet Propulsion Laboratory](https://www.space.com/16952-nasa-jet-propulsion-laboratory.html). And this "power trip" doesn't stop there.The Space Solar Power Incremental and Demonstrations Research (SSPIDR) project is designed to beam power from space to Earth. SSPIDR consists of several small-scale flight experiments that will mature technology needed to build a prototype solar power distribution system. (Image credit: Air Force Research Laboratory (AFRL)) Impressive **advances Over the past decade,** researchers have made impressive advances **that** increase **the** likelihood **that space solar power (**SSP**)** will be realized during the next decade, said John Mankins, president of Artemis Innovation Management Solutions of Santa Maria, California. His view: the longstanding vision for SSP as a sustainable energy alternative should be revisited in light of such recent advances.Bolstering that outlook is a set of key perspectives, Mankins told Space.com. "Climate change is really going to be a disaster. Nations are committed to go [carbon net-zero](https://www.livescience.com/climate-report-net-zero.html) … and they have no idea how to do it."**The** rapidly unfolding value of "NewSpace**" is also** reshaping the landscape of 21st century space activities**, he added. "Two of the biggest hurdles to the realization of SSP have always been the cost of launch and the cost of hardware**," said Mankins. "Add flight rate, and all of a sudden you're looking at numbers always talked about for solar power satellites."Related: [What is climate change?](https://www.livescience.com/climate-change.html) Megaconstellations **Another** recent change isthedawn of the megaconstellations, Mankins added. **That's** exemplified by SpaceX's [Starlink](https://www.space.com/spacex-starlink-satellites.html) broadband network**, a** mass-production effort that now cranks out 30 tons of satellites a month**. SpaceX is on course to potentially manufacture 40,000 satellites within five years, and launch all of them. "The path to low-cost hardware has been shown," Mankins said. "It's modular and mass-produced. The hurdles of less-expensive launch and lowering hardware costs have been overcome.**"Mankins said that the economics of SSP concepts in the near term, within the next decade, have never been more viable. He flagged advances in space launch capabilities; progress in robotics for space assembly, maintenance and servicing systems; and the growth in various component technologies, such as high-efficiency solid state power amplifiers. **As a result, SSP is ready to see the light of day,** Mankins said.Astroelectricity An early entrant in focusing on understanding the energy policy needed and establishment of SSP is James Michael Snead, president of the Spacefaring Institute. He's adopted the use of the term "astroelectricity" to describe the transmitted electrical power produced by SSP systems.In looking at what he terms the "[coming age of astroelectricity](https://www.youtube.com/watch?v=5E-0NYnAaUA)," he sees a world needing a replacement for oil and natural gas, the two primary sources of energy currently maintaining an industrial standard of living. Snead envisions a world in the year 2100 where about 20% of electrical power comes from terrestrial nuclear and renewables, with 80% supplied by astroelectricity."Just as the military, economic and diplomatic control of Middle East oil has substantially influenced world events for the past 80 years, the control of space solar power platforms will come to dominate outer space activities this century," Snead told Space.com. Wanted: high-priority leadershipIf SSP becomes a reality later this century, Snead said, the U.S. military will be required to protect and defend these new sources of national energy security just as it guards oil infrastructure in the Persian Gulf today."While some people are developing SSP concepts that would be launched from the Earth and autonomously assembled in geostationary Earth orbit, I do not see this as a successful proposition," said Snead. He believes that building the thousands of SSP platforms needed requires a substantial [space industrialization effort](https://www.space.com/nasa-low-earth-orbit-iss-commercialization.html) involving more than a million people in space by the end of the century. The starting point, Snead said, will be establishing the enabling "astrologistics" infrastructure operating throughout the Earth-moon system. He stressed that those astrologistics require high-priority U.S. Air Force — not [Space Force](https://www.space.com/42089-space-force.html) — leadership to draw upon nearly a century of human flight/operational logistics experience and expertise.That is necessary to manage industry's efforts to design and build the required new human spaceflight systems, with a clearly needed emphasis on safety and effectiveness, Snead said. As these new military astrologistics capabilities begin, Snead contends, commercialization of these capabilities will extend these safety and operational benefits to support the coming space industrial revolution needed to undertake SSP. "This is exactly what happened to enable U.S. airline manufacturers to dominate the airline and air cargo industry for decades. It is a successful model to now replicate in space — a model that neither NASA nor the U.S. Space Force can effectively execute," Snead said. The U.S. Naval Research Laboratory’s Paul Jaffe holds a module designed for space solar power investigations in front of a customized vacuum chamber used to test the device. (Image credit: NRL/Jamie Hartman) 'Performing like a champ' While new artwork, economic plots and conceptual SPS thinking and visions flow, there's an in-space technology experiment already underway. On its latest mission, which launched in May 2020, the Space Force's robotic [X-37B space plane](https://www.space.com/25275-x37b-space-plane.html) is toting the Photovoltaic Radio-frequency Antenna Module Flight Experiment (PRAM-FX), a Naval Research Laboratory (NRL) investigation into transforming solar power into radio-frequency microwave energy. The focus of that X-37B investigation is not establishing an actual power-beaming link, but more on appraising the performance of sunlight-to-microwave conversion. "It is performing like a champ," said Paul Jaffe, an NRL electronics engineer working on power beaming and solar power satellites. "We are getting data regularly, and that data is exceeding our expectations," he told Space.com. [PRAM-FX](https://www.space.com/x-37b-space-plane-solar-power-beaming) is principally made out of commercial parts, not "space-grade" hardware. "The fact that it is continuing to operate and give us positive results is quite encouraging," Jaffe said. Commercial parts are mass-produced, while many space-grade parts are one-offs. Solar power satellites, like those envisioned in high Earth orbit, would have thousands of elements made out of similar components being tested onboard the X-37B, Jaffe said. [The US Space Force's secretive X-37B space plane: 10 surprising facts](https://www.space.com/x-37b-military-space-plane-surprising-facts) Space-based solar power could help the UK achieve net-zero emissions by **2050**, according to a leading British systems, engineering and technology company. (Image credit: Frazer-Nash Consultancy) Making the economics work There's much more work ahead, of course. "The big strike against space solar power has always been making the economics work. People who have looked at the idea seriously do understand that, from a physics standpoint, there is no reason you couldn't do it," Jaffe said. "With mass production of space hardware, and with the cost reduction of space access, it is more plausible that it could work," he added. "I would caution against excessive optimism … but also point out that things are changing. There are a lot of encouraging developments." SPS will assuredly be compared to a "levelized cost of energy" metric, Jaffe concluded. "There's just not enough data to come up with a levelized cost of energy basis for space solar power. It's premature. What you are seeing now is laying the foundation for that sort of evaluation." Clear, affordable path To that end, Mankins of Artemis Innovation Management Solutions has rolled out SPS-ALPHA ("Solar Power Satellite by means of Arbitrarily Large Phased Array"), a design he showcased at the 72nd International Astronautical Congress, which was held from Oct. 25 to Oct. 29 in Dubai, United Arab Emirates. Detailing a business model and step-by-step SSP roadmap, he feels the concept promises a clear, affordable path to deploying a critically needed new energy option. "**I believe you could have operational solar power satellites to scale within a decade,"** Mankins said. That possibility, combined with the fact that multiple nations are eying SSP as a promising power generation system of the future, begs a question: Is there a solar power satellite race afoot? It is close to that, Mankins said. "I think it has to be cooperation among friends and allies. But I think it's very likely to end up being competition with China. The longer we wait with regard to the urgency of policies on [climate change](https://www.space.com/climate-change-dimming-earth), the more likely it is we're going to miss the boat." Mankins is a 26-year veteran of assessing SSP and the technologies required. "The moment has come," he said. "I think the right answer is really clear: We need to just go do it."

#### SBSP key to solve climate change – Katete 21

Katete, Esthere. (December 17 2021) “Space-Based Solar Power: The Future Source of Energy?”https://www.greenmatch.co.uk/blog/2020/02/space-based-solar-power // LHP BT + LHP PS

Space-based solar power (SBSP) involves collecting the sun’s energy in space, and then wirelessly transmitting it to Earth. There are several [advantages to solar energy](https://www.greenmatch.co.uk/blog/2014/08/5-advantages-and-5-disadvantages-of-solar-energy). Although expensive, it **is** **a** great source of [clean energy](https://www.greenmatch.co.uk/blog/clean-energy) that has the capacity to provide more energythan the world consumes **or is predicted to consume in the future**. A space-based solar power technological process includes using [solar panels](https://www.greenmatch.co.uk/solar-energy/solar-panels) to collect solar energy in space with reflectors or inflatable mirrors that direct solar radiation onto solar panels, and then beaming it on Earth through a microwave or laser. The energy is then received on Earth via a microwave antenna (a rectenna). **According to the** [**National Space Society**](https://space.nss.org/space-solar-power/)**,** space-based solar power **has the** potential to dwarf all the other sources of energy combined**. They argue that space-based solar power can provide large quantities of energy** with very little negative environmental impact**. It can also** solve our current energy and greenhouse gas emissions problems**.** The infographic below highlights information about space-based solar power, current related trends, and what different countries are doing in terms of research and funding. Current Global Energy Consumption and Trends **The** world’s energy consumption is only growing. According to a report by the University of Oxford’s Our World in Data, on the global primary energy consumption, the current world consumption is over 160,000 TWh annually. Solar energy contributes only 585 TWh. Although there is an increase in renewable energy solutions, investments, and usage, oil, coal, and gas still generate more than 80% of the global energy that is consumed - with solar energy generating less than 1%. Between 2004 and 2015, investments in renewable energy increased by 600% from £36.2 billion (US$46.7 billion) to £220.6 billion (US$284.8 billion). Current predictions indicate that the world population will reach [9.7 billion by 2050](https://www.un.org/development/desa/en/news/population/world-population-prospects-2019.html). With the increase in population, the world energy consumption is also predicted to grow by 50% by 2050. In addition, climate change impacts are accelerating. Although we generate a big percentage of the world energy from fossil fuels, fossil fuels contribute significantly to the increase of climate change. **Comparatively,** solar energy is the [safest source of energy](https://ourworldindata.org/uploads/2020/02/Safest-source-of-energy.png) today - though it still only contributes a small percentage of the global energy production. The death rates from solar production are 1,230 times lower than coal, and it has one of the lowest CO2 emissions, at 5g CO2 eq per kWh. Why Space-Based Solar Power? Space-based solar power has several benefits; unlike solar panels on our roofs that can only generate electricity during the day, space-based solar power can generate continuous electricity, 24 hours a day, 99% of the year. This is because, unlike Earth, the space environment does not have night and day, and the satellites are in the Earth's shadow for only a maximum of 72 minutes per night. **Space-based solar panels can generate** 2,000 gigawatts of power constantly. This is **40 times more energy than a solar panel would generate on Earth annually**. This is also several folds higher than the [efficiency of solar panels](https://www.greenmatch.co.uk/blog/2014/11/how-efficient-are-solar-panels) today. **What’s more, is that space-based** solar power would generate [0% greenhouse gas emissions](https://space.nss.org/space-solar-power/) unlike other alternatives **energy like nuclear, coal, oil, gas, and ethanol**. The current source of energy that generates the lowest CO2 is nuclear power, which generates CO2 of 5g CO2 eq per kWh. **Space-based solar power** generates almost 0% hazardous waste to our environment **compared to nuclear power**. Why Are We Not There Yet? While space-based solar power is an innovative concept, we are not able to fully launch a system into space yet. Launching a space-based solar system is very expensive. In fact, the cost is estimated to be about 100 times too high to compete with current utility costs. One of the causes of the high costs is the high cost of launching the panels to space, which is mostly due to the high mass per watt generated by the current solar panels. In other words, the solar panels are currently too heavy per watt generated to make it feasible. Currently, the cost of launching in space is estimated to be £7,716 per kilogram - approximately £154 per watt. In comparison to the cost that homeowners pay today, which is approximately £2 per watt peak, the cost in space is extremely high to be competitive. In UK homes, the [installation cost of solar panels](https://www.greenmatch.co.uk/blog/2014/08/what-is-the-installation-cost-for-solar-panels) can be as low as £1.5 per watt. Other reasons for high costs include the overall high transport costs to space. This is because transporting all other materials that are needed to space would require many space shuttle launches, and these space shuttles are currently not reusable. So, not only is the launch of solar panels themselves expensive, but the additional materials needing to be transported is also expensive. A lot of research and engineering is still ongoing to find the most feasible way to launch space-based solar panels and launch systems, at a lower cost. The environment out in space also has several hazards that could cause damage to the solar panels. These include space debris and extreme solar radiation, which could degrade the solar panels up to 8 times faster than panels installed on Earth. Finally, there is a potential of wasting large amounts of energy when transporting or during transmission from space to Earth. Therefore, scientists and engineers must continue their R&D efforts to ensure little to no energy is lost during the process. Current SBSP Projects and Progress The key players in SBSP include China, the US, and Japan, who have shown progress in terms of technology advancements, partnerships, and launch plans. China is already progressing to launch into space. The China Aerospace Science and Technology Corporation plans to launch small to medium solar satellites in the stratosphere that can harness energy in space between 2021 and 2025. China also plans to generate one megawatt of energy from space-based solar panels by 2030, and to be operating a commercially viable solar space station by 2050. In the US, there are ongoing partnerships and investments. For example, a $100 million partnership between Northrop Grumman and U.S. Air Force Research Laboratory has been established to provide advanced technology for SBSP. Also in the US, a $17.5 million collaboration between Northrop Grumman Corporation and Caltech was set up to develop the space solar power project called ‘The Space Solar Power Initiative’. The initiative’s goal was to develop scientific and technological innovations that would enable a space-based solar power system generate electricity at a cost comparable to current sources of electricity. There has been ongoing research and technological advancements. In the US, the development of the SPS-ALPHA Mark-II concept is underway. This, if successful, would enable construction of huge platforms in space that can remotely deliver tens of thousands of megawatts of electricity to Earth, using wireless power transmissions. This will also enable delivery of affordable power to Earth and on space missions. In addition, progress is being made to build reusable launch systems. Success in this will lower the cost of transport to space and overall cost of space-based solar power. An example is SpaceX, that is currently working on reusable launch vehicles that can be used for transport to space. In Japan, researchers successfully transmitted electric power wirelessly using microwaves. Researchers transformed 1.8 kW of electric power into microwaves and accurately transmitted it into a receiver that was 55 metres away. This was a technological advancement towards bringing SBSP closer to reality. Japan also made space-based solar systems part of its future space exploration vision. Future Outlook for SBSP Fossil fuels are finite and can eventually run out. According to predictions, oil and natural gas could run out in 50 years and coal production in 115 years. With ongoing research and investments, there is a high possibility that space-based solar power is the viable [future of solar power](https://www.greenmatch.co.uk/blog/2015/01/the-future-for-solar-power-in-the-uk). If the cost of space-based solar power can be lowered, it is likely to be a major source of sustainable energy that cannot diminish. Major players like China, who already have timelines of implementing the technology in space, may be able to provide some key learnings for future improvements in the technology.