The Alliance for Space Development
1455 Pennsylvania Ave NW, Ste 400
Washington, DC 20004

Space Solar Power Initiative

Initiate a clean energy technology demonstration of Space Solar Power beamed to Earth from low Earth orbit, deployed within three years.

$300M over 3 years to develop technology and demonstrate a ~300kW pathfinder solar power station in low Earth orbit, beaming energy to Earth. This proposal is based on the work of Mr John C. Mankins, a former NASA physicist and advanced technology manager, and a leading space solar power expert.[1]

Cost: $75M FY24; $300M over 3 years

The Alliance for Space Development (ASD) proposes **the United States initiate technology demonstration of Space Solar Power (SSP) beamed from low Earth orbit (LEO) to the Earth's surface, and deployed within 3 years.** This initiative would provide the opportunity for the US to

- Lead the international community in technology
- Establish rules of the road
- Jump start new commercial industries in space solar power and on-orbit assembly

In the United States, there is no clear plan to pursue SSP. A variety of independent projects are in work, both inside and outside the government. The US government should augment these plans by filling engineering gaps, while developing capabilities that would hasten the commercial deployment of SSP. The ultimate goal of SSP is to provide abundant, clean electricity, available 24/7, at perhaps less than 10 cents per kilowatt hour.

An October 2020 **report from The Aerospace Corporation** called for a government-industry partnership to develop SSP technologies:

> *"[the]* ***U.S. government must decide whether the nation should attempt to lead the pursuit of this potential game-changer, collaborate with others, or pass up this opportunity to focus instead on other energy solutions.****"*[2]

The Aerospace report also highlighted an alternative future: ***"China intends to become a global SPS leader"*** with a ***"dual use—military and civil"*** strategy.[3]

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[1] This proposal is based on Phases 1 and 2 of "A Practical Near-Term Roadmap to Space Solar Power" proposed by Mr John C. Mankins, former NASA physicist and manager of advanced technology projects and leading world expert in space solar power.

[2] James A. Vedda and Karen L. Jones, *Space-Based Solar Power: A Near-Term Investment Decision*, The Aerospace Corporation (2020), p 9, https://csps.aerospace.org/papers/space-based-solar-power-near-term-investment-decision

[3] Vedda and Jones, p 3

Significant American SSP efforts to date include Department of Defense agencies pursuing research, including on-orbit experiments and demonstrations, and an initiative underway at Caltech.

- Caltech Space Solar Power Project[4] has more than $100M private funding, and with partner Northrup Grumman, is developing SSP technology. On 3 Jan 2023, a prototype device launched on a SpaceX rocket for their first in-space test. Further progress hasn't been announced.[5]
- Air Force Research Laboratory: High efficiency solar cells and power transmission technology, including a $100M contract awarded to Northrop Grumman, part of *Solar Power Incremental Demonstrations and Research (SSPIDR)*.[6]
- Naval Research Laboratory: *Photovoltaic Radio-frequency Antenna Module (PRAM),* the first orbital SSP experiment, flew on the X-37 in 2020;[7] *Lectenna* converted radio waves into electric power on the International Space Station in 2020, and *Power Transmitted Over Laser (PTROL)*, transmitting power by laser in 2019.[8]

Today, **SSP technology is under active development around the world, by both partners and competitors**:

- Japan's space agency, JAXA,[9] and Japan Space Systems are working to demonstrate SSP microwave wireless power transmission to Earth from LEO by 2024.[10]
- The United Kingdom's Space Energy Initiative is developing SSP to deploy an in-space demonstration by 2030 and supply their national grid by 2040.[11]
- European Space Agency SOLARIS program will mature enabling technologies and concepts to inform a 2025 decision on large scale SSP deployment.[12]

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[4] Caltech Space Solar Power Project, https://www.spacesolar.caltech.edu/
[5] Caltech to Launch Space Solar Power Technology Demo into Orbit in January, https://www.caltech.edu/about/news/caltech-to-launch-space-solar-power-technology-demo-into-orbit-in-january
[6] Vedda and Jones, p 2
[7] Leonard David, "Military spaceplane experiment sheds light on space solar satellites," *SpaceNews*, 4 July 2020, https://spacenews.com/x-37b-experiment-sheds-light-on-space-solar-satellites
[8] Vedda and Jones, p 2
[9] Research on the Space Solar Power Systems, https://www.kenkai.jaxa.jp/eng/research/ssps/ssps-index.html
[10] Japan Tackles Clean Energy From Space, NSS Press Release, Jan 2022, https://space.nss.org/japan-tackles-clean-energy-from-space/
[11] Space Energy Initiative, https://spaceenergyinitiative.org.uk/space-based-solar-power/
[12] Plan to research solar power from space, European Space Agency, https://www.esa.int/Enabling_Support/Space_Engineering_Technology/SOLARIS/Plan_to_research_solar_power_from_space

- China plans to deploy a 10 kilowatt technology demonstration by 2028, and deploy a 10 megawatt geostationary solar power station by 2030. This would be followed by a 2-gigawatt station by 2050—capable of powering a large city.[13]

The engineering challenge of constructing large structures in space is a source of significant risk yet to be addressed. Other risks include reduction of launch costs, satellite component manufacturing cost, high-energy beaming from orbit, and autonomous in-space construction. SpaceX **Falcon Heavy has already reduced launch costs** by a factor of 14 compared to shuttle and a factor of 7 compared to current heavy lift rockets.[14] With Starlink, **SpaceX has demonstrated a 95% reduction in per-unit satellite manufacturing costs**. These techniques can be applied to SSP satellites consisting of huge numbers of identical modules. **Made In Space, Inc., has developed tools for autonomous construction in space**. As previously addressed, **DoD has conducted research into power beaming**. For large-scale SSP deployments, these innovations will need to be further developed and scaled up for very large orbital structures—of kilometer-scale—to be efficient and impactful.

We believe **this demonstration initiative could jumpstart a new American energy industry and advance on-orbit assembly capabilities, ushering in unprecedented economic benefits**. The ultimate goal of economically viable SSP is possible in a few short years. Through this initiative, the United States would enjoy a leadership position in SSP, which could grow to supply clean, carbon-free energy to much of Earth's population.

More information on Space Solar Power can be found in this National Space Society paper: https://space.nss.org/wp-content/uploads/NSS-Position-Paper-SSP-Clean-Energy-from-Space-2021.pdf.

Note on terminology: This paper uses the term Space Solar Power (SSP). The term Space-Based Solar Power (SBSP) is also widely used. SSP and SBSP are equivalent. Orbiting solar power platforms are generally known as Solar Power Satellites (SPS).

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[13] Mark R. Whittington, "China's space-based solar power project could be a clean energy game-changer," *The Hill,* 19 June 2022, https://thehill.com/opinion/technology/3526022-chinas-space-based-solar-power-project-could-be-a-clean-energy-game-changer/

[14] Roberts, Thomas G. "Cost for Space Launch to Low Earth Orbit - Aerospace Security Project." CSIS Aerospace Security, 1 September 2022, https://aerospace.csis.org/data/space-launch-to-low-earth-orbit-how-much-does-it-cost