Space-Based Solar Power

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Much attention has been placed on space tourism of late, with recent spacecraft flights taken by Richard Branson and Jeff Bezos. Many have criticized the two men for what may seem on the surface as joy rides. Some have also criticized these trips for their high carbon footprint. Less attention has been placed on the prospect of using space as a viable solution to our energy needs. With no clouds and a sun that never sets, the earth's orbit could provide access to incredible solar energy resource. A team at the California Institute of Technology's Space Solar Power Project plans to prove the viability of this case use with their aim of launching a test solar power array into orbit in late 2022 or 2023.

Patience and Funding

To be sure, space-based solar power is not a new idea. The thought of harnessing the sun's power from space has long been hypothesized. If possible, it would be a tremendous feat. It would, no doubt, require a great deal of patience and funding. But it would seem that these requirements may already be in place.

Caltech recently announced that wealthy California real estate developer, Donald Bren – together with his wife Bridgitte – have given Caltech more than $100 million since 2013 to help make photovoltaic power from orbit a reality.[1]

Design

A key hurdle has been the sheer size and weight of systems imagined by engineers. What has changed is the shift in attention toward the development of solar arrays that are modular. The current Caltech design centers around photovoltaic cells that would be attached to "tiles" – 'each of which might be as small as 100 square centimeters, the size of a dessert plate'.[2]

Each tile would act as a miniature solar station, including a microwave transmitter. Tiles would be linked to form larger "modules", and thousands of modules – not even needing to be physically connected – would together form a much larger power station. With no physical connection, there would further be no need for much of the structural infrastructure of previously imagined designs. Caltech professor harry Atwater, a leader of the project, likens this design to 'a school of fish': "It's a bunch of identical independent elements flying in formation".[3]

Atwater further explained that transmission of power to receivers on the ground would be through microwave signals that are inherently safe, with the energy density being "equal to the power density in sunlight".[4]

Incentive

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[1] Potter, Ned. "Solar Power from Space? Caltech's $100 Million Gambit Billionaire makes secret donation for electricity from orbit". IEEE Spectrum. August 11, 2021. Accessed on August 31, 2021. Available at: https://spectrum.ieee.org/solar-power-from-space-caltechs-100-million-gambit

[2] Ibid.

[3] Ibid.

[4] Ibid.

The science around global warming is increasingly accepted across the political spectrum and around the world. Global initiatives on the part of governments and companies have centered around reducing our carbon footprint for years, with increasing traction each year. Fossil fuel energy resources are limited in nature, and access to these resources present geographical and political challenges that are problematic to say the least.

Space-based solar power may be the single most impactful technology breakthrough of this century in terms of preserving our global environment and meeting the energy needs of our planet's population. Caltech's design is promising, but the incentives for a solution have JAXA, Japan's space agency, as well as China working on this same opportunity.

For some perspective on the opportunity, the US Department of Energy has compiled some interactive graphics and relevant facts[5], including:

- Every hour, more solar energy reaches the Earth than humans use in a year.
- About 30% of this energy is reflected back into space by the atmosphere.

The Caltech design improves upon the example of the microwave transmitting solar satellite depicted on the Department of Energy's primer. For more information, the primer also compares the pros and cons of microwave solar satellites and an alternate approach involving the use of laser solar satellites.

For the pros, it is clear that the Caltech design is better, as the scalable modular design would have the ability to more easily increase the available energy supply. As for the cons, Caltech's design is an improvement on all fronts:

- Production cost would be high, but it would likely involve fewer launches and assembly would be easier due to the elimination traditional structural components.

- The difficulty of repair might be less of an issue, as the modular components may be able to function independently and may not be as detrimentally impacted by the malfunctioning of individual "tiles" or modules.

[5] Space-Based Solar Power. US Department of Energy Website. Accessed on August 31, 2021. Available at: https://www.energy.gov/maps/space-based-solar-power