

## Spaceships Will Shoot Solar Energy to Earth With Ray Guns. That's Not Funny.

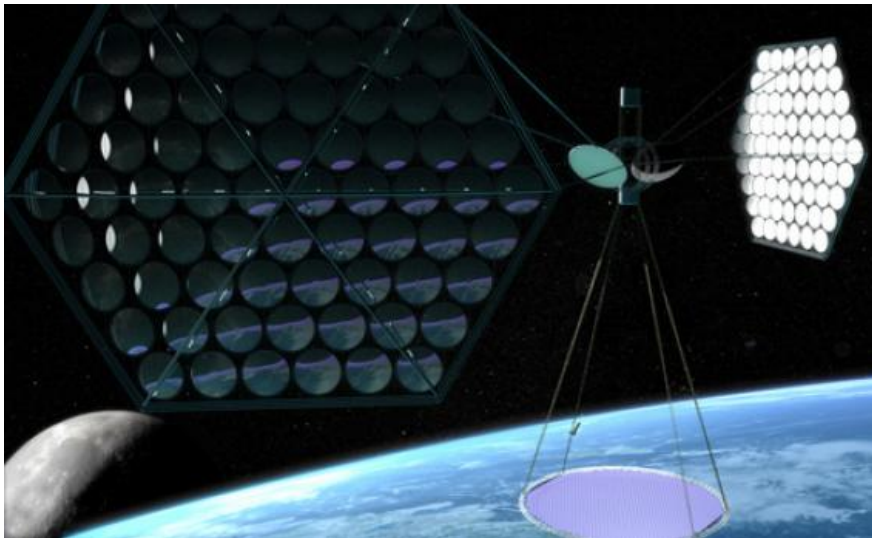
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**The entirely serious plan to collect solar energy by spaceship and beam it back to Earth with lasers.**



*Space solar power Courtesy of © Mafic Studios/National Space Society*

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One of the world's most ambitious plans for harvesting clean energy is largely stuck in the lab, despite decades of work and tens of millions of dollars in research spending. It faces many barriers, but one is particularly vexing: the giggle factor. Many people who hear the idea think it's loony.

The concept, delicious in its brashness, brings to mind an early James Bond

flick: shoot big pieces of solar-panel arrays into space, assemble them in orbit into massive power plants that are miles wide, let the floating facilities collect space's intense sunlight and convert it into electricity, and then beam that extraterrestrial juice—ray-gun-style—back down to an energy-hungry Earth.

As with many alluring energy technologies, the hurdle doesn't appear to be the underlying science. Panels on rooftops already turn solar energy into electricity, and several experiments have transmitted electricity through the air. The impediments are scale, which would need to balloon, and cost, which would need to plummet. Given the world's vast energy needs, harnessing meaningful amounts of solar power from space would require shooting solar-array components into orbit multiple times a day, over years, some studies suggest. And it would cost tens of billions of dollars.

Phil Chapman, a former NASA astronaut, is a longtime space-solar proponent. He resigned from NASA in 1972, in large part because he disagreed with the agency's decision to move forward with the Space Shuttle. By eclipsing another mission he was working on, the shuttle was killing his own chances of making it into space, he concluded. In addition, he says, he objected to the shuttle's use of technology he regarded as outdated. "I thought it was a stupid idea," he says.

Today, it's doubters of space solar power who are misguided, he says. If solar power were harnessed at large scale in space, he says, it could prove cheaper, more reliable, and more productive than solar power on Earth, which today serves up significantly less than 1 percent of the electricity the world uses. Chapman also contends that if the industrialized world doesn't develop space solar power first, other nations will, with potentially serious national-security implications. Over a Mexican lunch in Phoenix, where he lives, Chapman warned: "The consequences are sufficiently profound that we simply can't

afford to let hostile nations develop this technology.”

Chapman himself cites the giggle factor as perhaps the most significant challenge facing space solar power. Giggles aside, however, some prominent names have been looking into the concept. Among them: NASA; the Japan Aerospace Exploration Agency; and PG&E, a power company in California, a state that has mandated that utilities ramp up their production of renewable power.

Interest in space solar power is growing. Over the past two years, solar power—the earthbound sort—has experienced a massive price drop, raising the possibility that even solar panels shot into space might prove less ridiculously expensive than previously presumed. Meanwhile, though interest in space solar power traditionally has come from long-industrialized players such as the United States, Japan, and Europe, now it’s coming particularly strongly from two new kids on the block: China and India, both of which have soaring energy appetites and grand geopolitical ambitions.

Here’s how space solar power would work. Large pieces of a space-solar-power station would be shot from a launch site on Earth into space. Once in orbit, they’d be assembled into facilities that likely would be miles wide. (Proposals differ about the setup and the particular solar-capturing technologies the facilities would use.) Freed from terrestrial limitations of clouds, bad weather, and nighttime darkness, the spacecraft would harvest sunlight essentially 24 hours a day. They’d send the electricity they produced back to Earth either as microwaves or as laser beams. Back on the ground, according to most designs, that energy would be caught by similarly massive agglomerations of mesh: huge rectifying antennas, or, in the lingo, “rectennas.” From there, the electricity would be fed into the grid.

Studies have found all of this is technically feasible. A 2011 report for the International Academy of Astronautics concluded that space solar power could reach working at scale within about 20 years—if governments and investors committed to ramp it up.

But even if the money flowed into developing the technology, wild cards would remain. A big one has to do with earthlings’ emotions: specifically, their not-in-my-backyard concerns. Many people today oppose large-scale solar projects because they don’t want acres of glass panels blanketing the landscape. Tomorrow they might oppose the notion of sprawling mesh antennas designed to catch rays of solar electricity beamed down from space. Sky watchers also might object because space-based power stations would be visible as moving points of light.

The concept of harnessing space solar power is generally traced to Peter Glaser, who worked at the consulting firm Arthur D. Little. He came up with it in the late 1960s while doing early work on solar power. He was struck by the fact that spacecraft in the right type of geosynchronous orbit could collect sunshine essentially all the time. In the decades since, attempts to realize the vision have waxed and waned. The enthusiasm has tracked the ups and downs in the price of a more earthly energy source: fossil fuel.

In the early 1970s, spurred by surging oil prices, NASA studied the idea. The United States lost interest a few years later, as oil prices fell.

In the late 1990s, NASA took another look. It concluded that technological improvements in the intervening two decades had made the idea of space solar power more plausible. Soon after that, Japan and Europe ramped up research efforts of their own. The Japan Aerospace Exploration Agency

announced several years ago a goal of supplying solar power from space to hundreds of thousands of Tokyo homes by the 2030s.

In 2009 came a seemingly obscure legal agreement that, among space-solar-power devotees, qualified as liftoff. With the approval of state regulators, California utility PG&E signed a contract with Solaren, a California-based space-solar-power startup. Solaren agreed to provide PG&E later this decade with 200 megawatts of space solar power. That's about one-quarter the output of a large coal-fired power plant. It would be hardly enough to affect the global energy mix. But, if it materialized, it would help answer the giggles. If Solaren succeeds in supplying the celestial surge, PG&E will pay the company for it. If Solaren fails, PG&E won't be out any money.

Last May, George Nield, the Federal Aviation Administration's associate administrator for commercial space transportation, listed space solar power as one of the big things that might emerge from space before the current decade is out. By 2020, he said in a speech, the world might see "a commercial proof of concept space solar power demonstrator that can transmit power from outer space to collection stations on the ground."

Chapman says it's time to get going. There's been "a steady, low-level discussion going on for years and years" about the technology, but little has been built, he laments. "The truth is that all you really need to get the costs down to an acceptable level is to start doing it."

Action may be on the way. This past November, in a move that raised eyebrows among the space-solar-power set, Chinese officials proposed working with their Indian counterparts on a program to harness space solar power. Some Chinese officials have warned that, if their country doesn't move fast to develop the technology, other countries—namely the United States and Japan—might seize the best spots first. Space is a big place. But already international authorities have input on where countries put satellites. And a country that wanted to harness lots of solar power from space would want to build its ground-based launch site in a particular region—and to put its space facility in a particular sort of orbit—so it could reliably beam the power back to its own soil.

It's unclear whether China's space-power aspirations are just chest-thumping or the makings of a serious technological push. But the rhetoric does evoke memories of the Cold War brinkmanship with the Soviet Union that a half-century ago led the United States to send a man to the moon. Geopolitical rivalry, history suggests, tends to spur action—both in the energy hunt and in the space race.



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