Harvesting Solar Power in Space

JAPAN HAS HIGH HOPES

BY MARTIN ROSENBERG

JAPAN IS WORKING HARD TO advance its laser and microwave research so that solar power generated in space can be beamed to Earth in two decades, *Scientific American* reported this summer. By 2030, the Japanese hope to generate 1,000 megawatts at an orbiting solar generator and transport it to Earth. To learn more about the effort, *EnergyBiz* e-mailed questions to Hiroaki Suzuki with the Japan Aerospace Exploration Agency, also known as JAXA. He is one of 180 Japanese scientists working on the program, according to *Scientific American*. It also reported that the ultimate cost of such a project could climb to tens of billions of dollars, but the Japanese are intent on mastering the technology first, and then driving down the cost to levels that are competitive. Because the orbiting power station would be geostationary it would work around the clock as it is hit with more powerful solar rays than reach the Earth.

Hiroaki Suzuki

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ENERGYBIZ Briefly describe how Japan intends to generate electricity from solar panels in space and then transmit that power to Earth.

SUZUKI We have investigated two types of space solar panel systems, laser and microwave.

With laser-based systems, Earth-orbiting solar condenser mirrors concentrate solar energy and divert it to laser amplifiers. A direct solar pumping solid-state laser diode uses the concentrated solar energy to amplify a low-power seed laser beam. The amplified laser beam is transmitted to Earth. Thus, this type of system uses no solar cell panels. Radiators dissipate the laser generator's waste heat into space. A ground-based photovoltaic device converts the transmitted laser beam into electricity. This system can also be used to produce hydrogen with photocatalytic hydrogen generation or water electrolysis.

With microwave-based systems, primary mirrors collect solar energy that solar panels convert to electricity that powers semiconductor devices to generate a microwave beam. A ground-based rectifying antenna array collects the transmitted microwave beam and converts it into electricity that is supplied to commercial power grids.

ENERGYBIZ How advanced is the technology?

SUZUKI A current space solar panel system study undertaken by JAXA consists of three main subjects, elemental technology development, ground energy transmission demonstration and concepts and architectures.

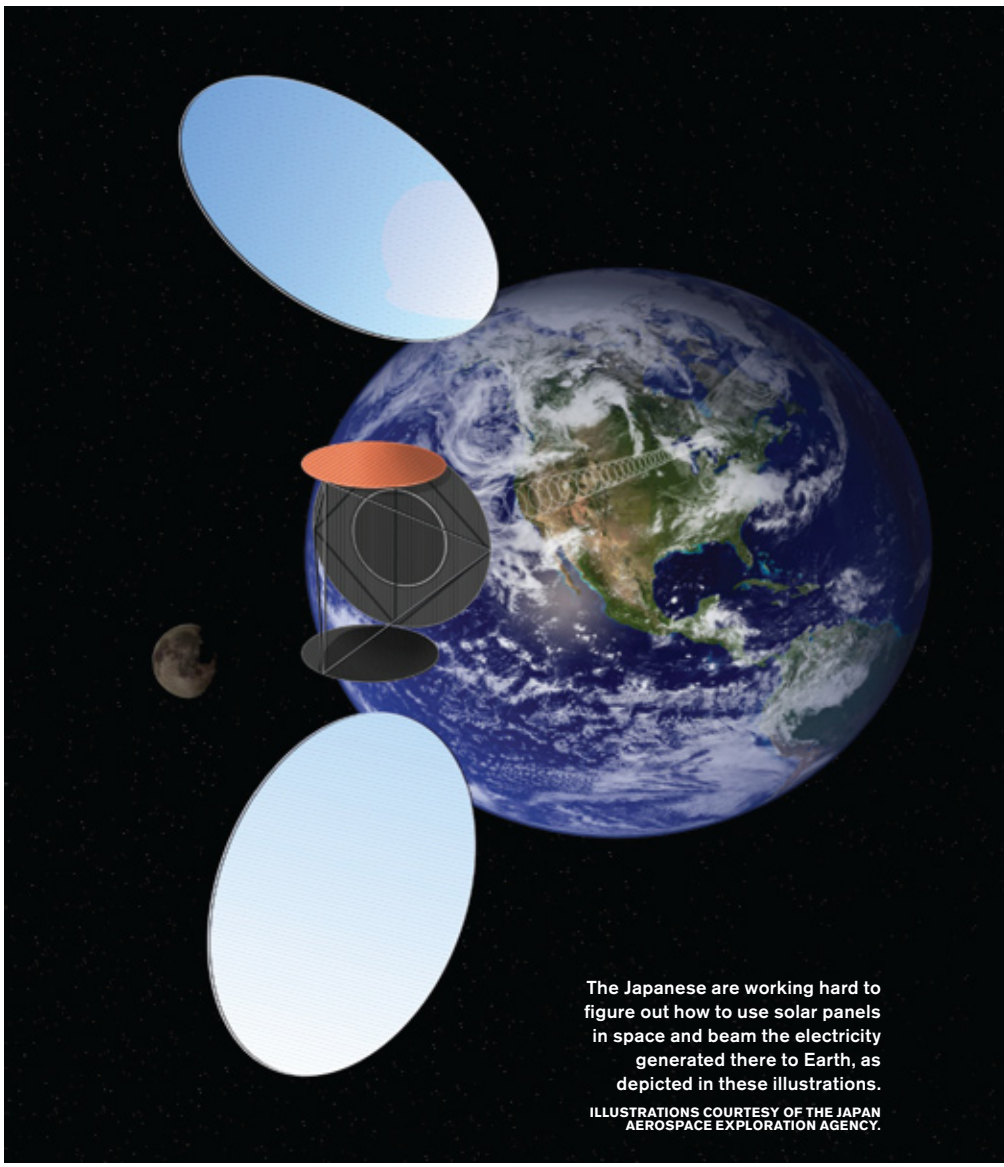
In the elemental technology development study, a laser amplifier with a direct solar pumping solid-state laser diode made of yttrium aluminum garnet ceramic doped with neodymium and chromium is being studied. The atmospheric transmittal properties of a high-energy laser beam and beam-pointing technology are studied for their applications in a laser-based system. For the microwave-based system, a large-scale phased array antenna, microwave amplifier, retro-directive beam control, and rectifying antenna are being studied. For both systems, a large-scale, ultra-light reflective mirror is also studied.

In the ground energy transmission demonstration, a kilowatt-class experiment for laser and microwave system is planned and is expected to be conducted within five years.

System concepts and architectures of commercial-grade microwave- and laser-based space solar panel systems have been studied for years. System concepts and architectures have been developed and associated key technologies have been identified.

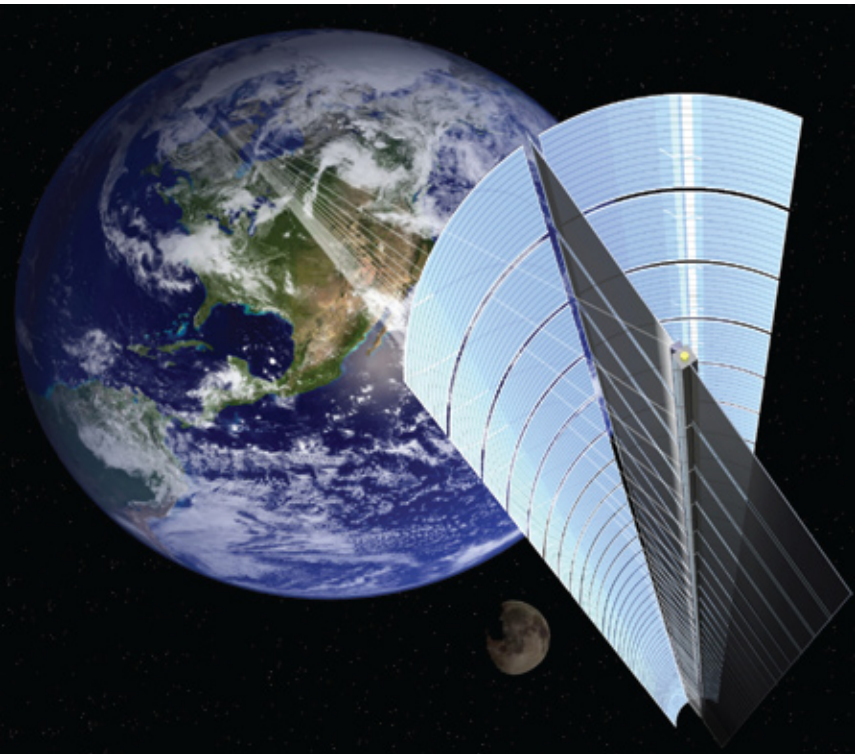
ENERGYBIZ How expensive will this be? How long before it is competitive with other forms of electric generation, like coal-fired generation or nuclear power?

SUZUKI Although a preliminary cost estimate has been conducted, it includes a lot of ambiguities. We are not ready to show you our cost analysis. We expect space solar panel systems will be competitive with the existing power plants in 20 to 30 years, if the space transportation cost is considerably reduced. It should be noted that solar systems do not emit CO_2, nor do they create nuclear waste.



The Japanese are working hard to figure out how to use solar panels in space and beam the electricity generated there to Earth, as depicted in these illustrations.

ILLUSTRATIONS COURTESY OF THE JAPAN AEROSPACE EXPLORATION AGENCY.



ENERGYBIZ Ultimately, what percentage of Japan's electricity can be generated from space? As much as 5 percent by 2030? Any predictions?

SUZUKI We are proposing a roadmap that consists of a stepped approach to achieve 1-gigawatt-class commercial space solar panel systems in 20 to 30 years. That means 2030 would see the very beginning of commercial systems. We expect the ultimate percentage of electricity derived from space will be more than several tens of percent. By the way, Japanese total electricity generation was about 275 gigawatts or 990,000 gigawatt-hours in 2005.