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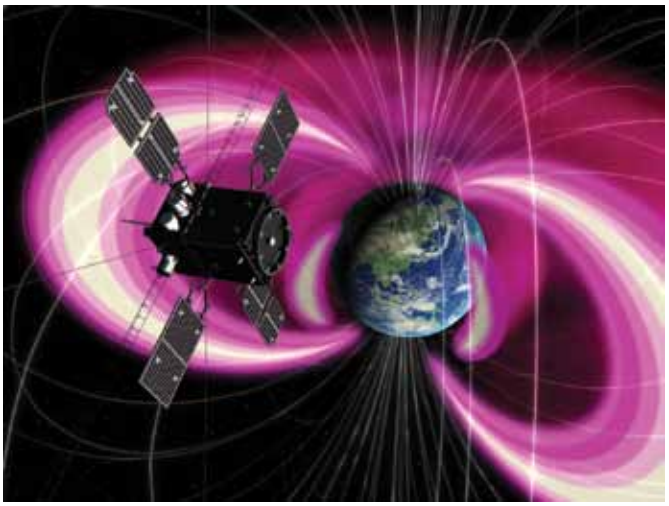
Japan to Build an Orbiting Electricity-Generating Station

I chose the topic of this month's column on May 25, 2014, the 53rd anniversary of President John F. Kennedy's historic speech about landing a man on the moon before the end of the 1960s. In many ways, the Japanese initiative described here is just as historic. If Japanese scientists and engineers achieve their goal, our world could transistion away from depending on fossil fuels to meet our energy needs.



Photos courtesy of JAXA

Photo 1—The solar energy that surrounds our planet could meet all our energy needs if we could capture it outside of the Earth's atmosphere.

Just as in 1961, when all the technology necessary to put a man on the moon wasn't in place, many problems still need to be solved for Japan's Microwave Space Solar Power System Initiative to become operational. Japan doesn't expect to have a fully operational system delivering electricity to earth from space until 2040.

If we could effectively harness the energy from the sun, we could meet all of our energy needs without ever burning another drop of oil or coal. To make this possible, people need to find a way of removing the variability of how much solar energy reaches collection systems during the day and also keep the sun shining on them at night. The Sci-Fi solution to this problem is to move our solar collection generating systems into Earth's orbit where the sun always shines. (See Photo 1.)

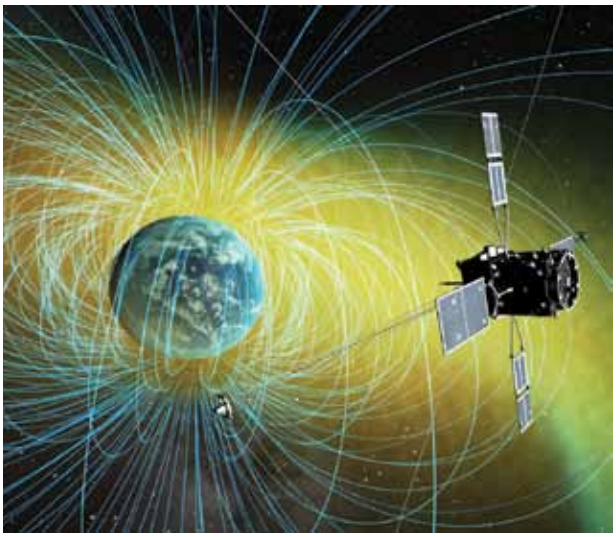


Photo 2—Photovoltaic panels attached to a satellite in geosynchronous orbit could generate much more electricity than any ground-based collection system currently in existence. The problem is getting this energy back to Earth.

Scientists and technologists in Japan are now hard at work to turn this dream into a reality. The Japanese Aerospace Exploration Agency (JAXA) is now performing Earth and space experiments to test specific components of an orbiting electric generating satellite system. (See Photo 2.) If they don't hit any insurmountable problems in the next 26 years, they plan on having the first space-based system that can generate an amount of electricity equal to that produced by a nuclear power plant.

The engineers at JAXA plan to generate electricity using an array of photovoltaic panels attached to a satellite in geosynchronous orbit. (Again, see Photo 2.) Since a satellite in a geosynchronous orbit matches the 24-hour rotational velocity of our planet, the amount of sunlight it receives varies as it spins with our planet from daylight into night.

To keep the sun shining on the panels of their satellite, the Japanese system will also include other satellites with space mirrors that will use a computerized system to keep sunlight focused on the photovoltaic panels at all times. At night, people on Earth below the satellite would see the JAXA satellite shine like a small second moon. Photo 3 shows what the mirror array might look like viewed from space.

The most difficult problem that the engineers will need to overcome is the creation of a transmission system that can beam the energy to a collection system located back in Japan. You can't accomplish this task by running a 22,236 mile long (35,786

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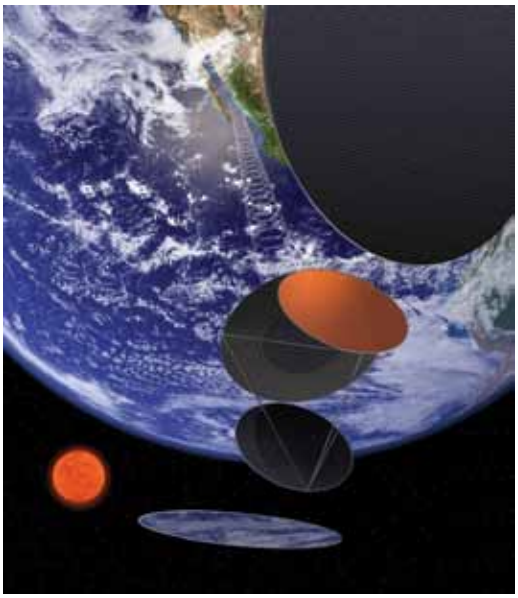

Photo 3—Space mirrors, attached to separate satellites flying in formation with the electricity-generation satellite, would keep the sun fully shining on the photovoltaic panels even at night.

km) cable; it must be done wirelessly.

The photovoltaic panels on the satellite will generate direct current (dc) electricity and then convert the current into microwave energy. Japanese scientists currently think that microwave is the best form of energy for long-distance transmission. The parts of the satellite not covered with photovoltaic panels will be covered with small microwave antennas. Each antenna will transmit part of the generated microwave energy down to its designated receiver located at the receiving station back on Earth.

The geosynchronous orbit will keep the electricity-generating satellite over the same spot on Earth so that it will be in proper position to beam the electricity that it creates as microwave energy down to the collection system. The collection system will be located on a 1.8 mile (3 km) long artificial island in Tokyo Bay. The energy beam will be directly aimed at the receiver and individual energy beams will be so small that birds flying directly through the beam will not be physically affected. People working on the island receiving station will have to wear special protective gear when working directly inside the full antenna array where the beam will be concentrated.

On this island, the engineers plan to use 5 billion small antennas to catch and convert the microwave energy that the satellite transmits into alternating current (ac). An underwater cable will then carry the electricity from the bay into Japan's electric grid.

Recalling the Facts

1. Do you think people here on Earth will embrace this new technology or try to prevent its full implementation? Why?

2. Why are scientists, engineers, and technologists working so hard to find alternative ways of generating electricity that doesn't burn fossil fuels?