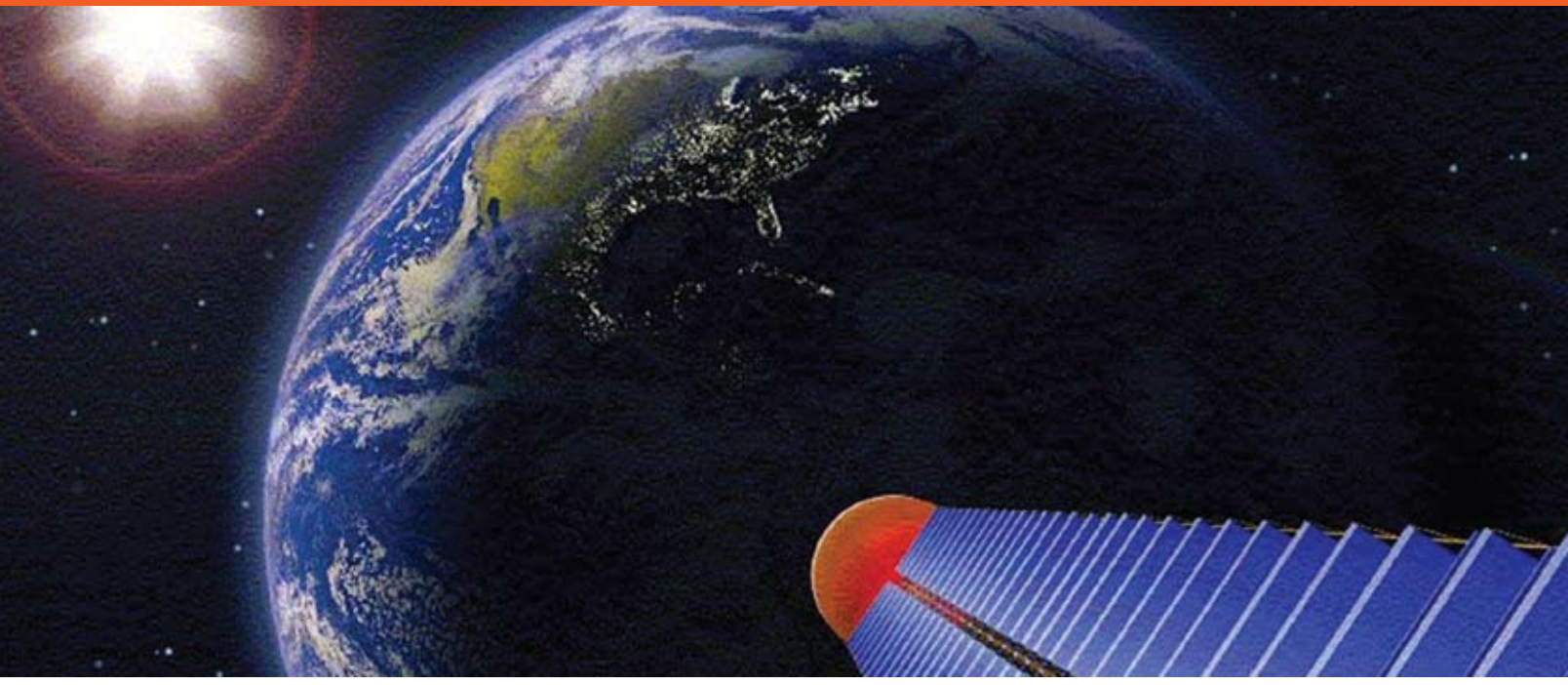
Harnessing the sun

The decades-long quest to power Earth from solar power satellites in space



By Eve Dumovich

GRAPHIC: In this artist's rendition of a proposed Boeing Sun Tower satellite, many solar panels would collect and beam down solar energy to Earth. BOEING

Imagine a series of satellites, each the size of a small city, which together produce and beam down enough electricity to power a whole country. Boeing scientists designed such a system almost 30 years ago and, though it never went into production, Boeing today remains at the forefront of exploring solar power.

Those early Boeing efforts began after the oil embargo of 1973 made it clear that alternative energy sources would be needed. Boeing Advanced Space programs began work on highly innovative solar power satellites capable of transforming the sun's energy into electricity on Earth. Boeing engineers already had proved their experience with launch systems during the Apollo program moon landings, and in placing hardware in orbit which used solar energy for power.

At the time, Boeing and the aerospace business of Rockwell International, now part of Boeing, competed for a contract from the U.S. Department of Energy and NASA's Satellite Power System Concept Development and Evaluation Program. Rockwell won a study contract issued by Marshall Space Flight Center in Huntsville, Ala., and Boeing won a contract with Johnson Space Center in Houston.

The Boeing study proposed satellites, "each giving an output of 5,000 megawatts of electricity—the equivalent of five nuclear power plants. These huge satellites, covered with 20 square miles of solar cells, would be placed in geosynchronous orbit—22,300 miles above the equator," said Ralph Nansen, a former Boeing engineer and manager of Advanced Space Programs who worked on solar power satellites during the 1980s.

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– Dean Davis, Boeing Phantom Works Analysis, Modeling, Simulation & Experimentation

The proposal called for Boeing solar power satellites to be constructed either in low-Earth orbit for later transfer to higher geosynchronous orbit, or constructed directly at the higher orbit. Large space freighters, known as heavy-lift launch vehicles, would carry outsized cargo pallets into low-Earth orbit where they would be deposited at a space construction base. A modified Space Shuttle Orbiter would carry the personnel needed to the orbiting construction site.

"Everything was falling into place," Nansen said. "Applications poured into the company from engineers and scientists who wanted to work on solar power satellites."

Early studies indicated that the revenue from one solar power satellite, producing and beaming down to earth 10,000 megawatts of electricity sold then at a rate of 4 cents per kilowatt hour, would produce $105 billion in 30 years, according to Boeing reports.

In 1995, NASA began a "Fresh Look" study of space solar power techniques and concepts. In 1998, Congress authorized modest funding for further concept definition and technology development.

Boeing studies included not only a constellation of satellites but also solar power satellite technology applications in a laser-powered lunar rover and solar-powered propellant production depots in low-Earth orbit and on the moon that would use solar power to convert water into cryogenic propellants for moon and Mars exploration.

Fast-forwarding to present day, Boeing continues to lead in solar power research and technology. In November 2008, Boeing's wholly owned subsidiary, Spectrolab Inc., in Sylmar, Calif., received the 2008 SpotBeam Award for Space Innovation from the California Space Authority in recognition of its 50 years of advancements in photovoltaic solar cell technology, solar panels and related products. Spectrolab has long been the world's leading supplier of solar panels for communication satellites. Continuing advances in solar cell efficiency (now demonstrated at more than 40 percent under concentrated solar radiation), along with many other advances in space technology, have made the prospects for an economical space solar power system better than ever.

PHOTO: German Rivera, wafer processing technician at Spectrolab in Sylmar, Calif., inspects a semiconductor wafer that will yield numerous solar cells used to generate power for telecommunications satellites and spacecraft such as the Spirit and Opportunity rovers currently exploring Mars. BOB FERGUSON/BOEING

Recently, the U.S. Defense Advanced Research Projects Agency selected Boeing to conduct the second phase of the Fast Access Spacecraft Testbed program, a multiphase effort to design and develop a ground-test prototype of a new high-power-generation, ultra-lightweight spacecraft solar array. Boeing is also developing both radio frequency and laser power transmission and reception technologies, which will allow space- and Earth-based users to request and receive satellite-generated power on demand.

"Boeing is currently combining these capabilities into a network-centric power system for near-term space solar power demonstrators," Dean Davis said. He's senior principal aerospace scientist/engineer and Space Solar Power study leader with the Boeing Phantom Works Analysis, Modeling, Simulation & Experimentation team in El Segundo, Calif.

Davis added, "We hope these projects will lead to full-scale power satellites that, when combined with terrestrial solar, hydroelectric, geothermal and wind-power sources, will be able to provide independence from fossil-fuel energy within the next 50 years." ■

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