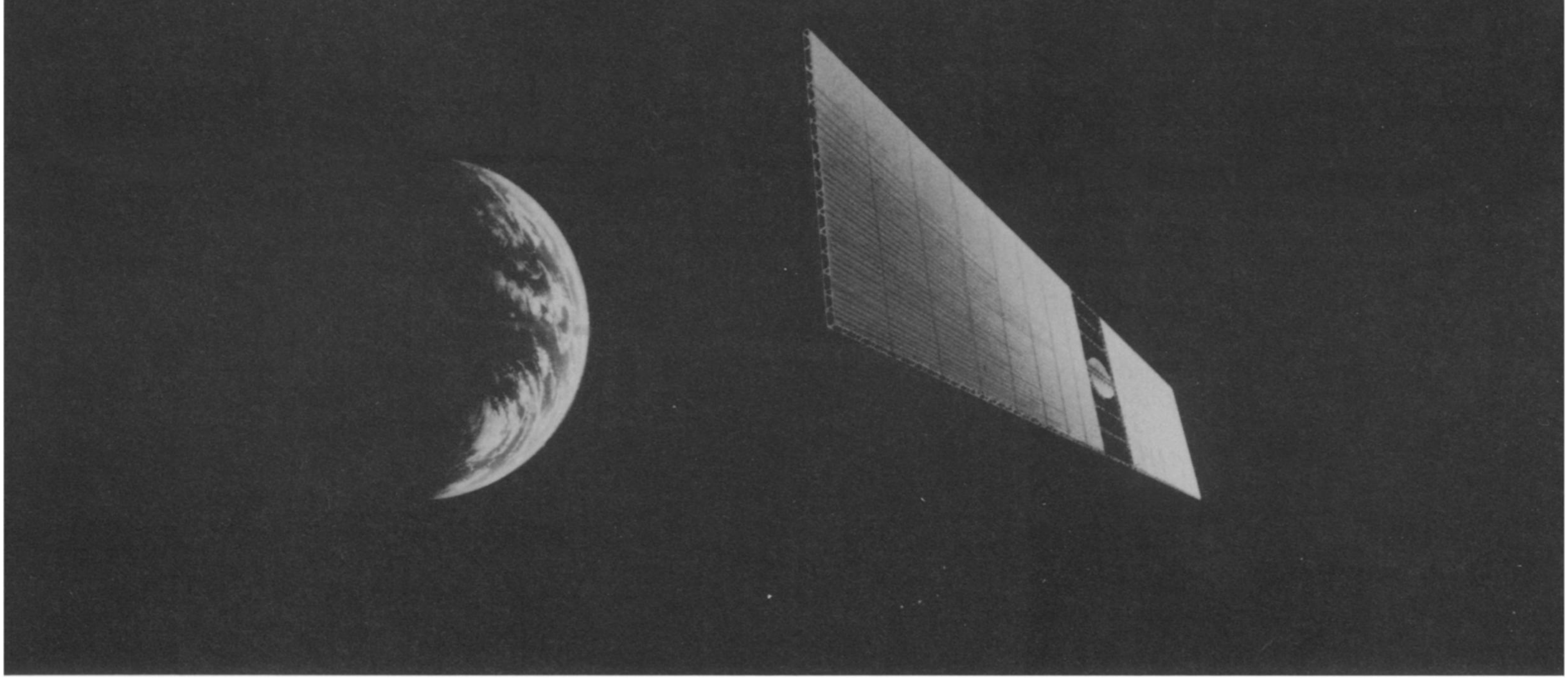
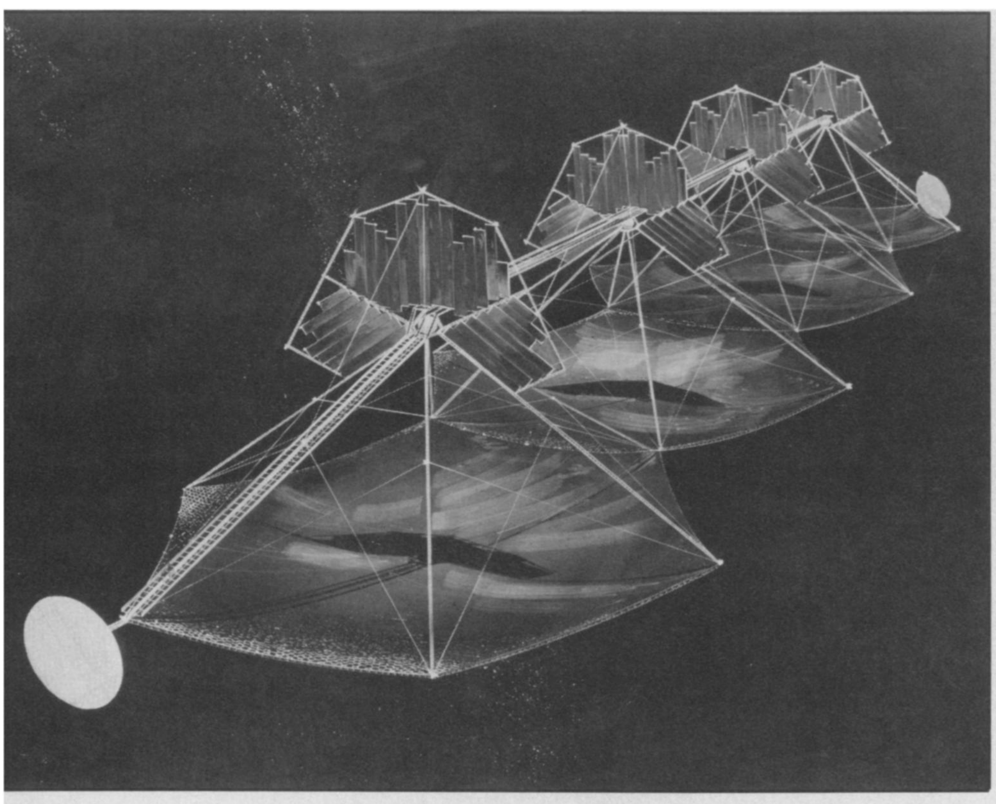
SUNSAT: COLLECTING SOLAR POWER IN ORBIT

Unmanned satellites the size of small cities would convert sunlight to microwave energy and beam it to earth. The idea is controversial, expensive — and gaining momentum.

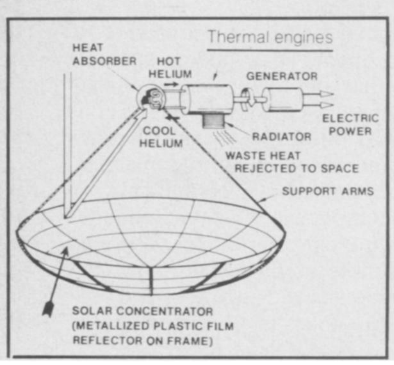
BY JONATHAN EBERHART

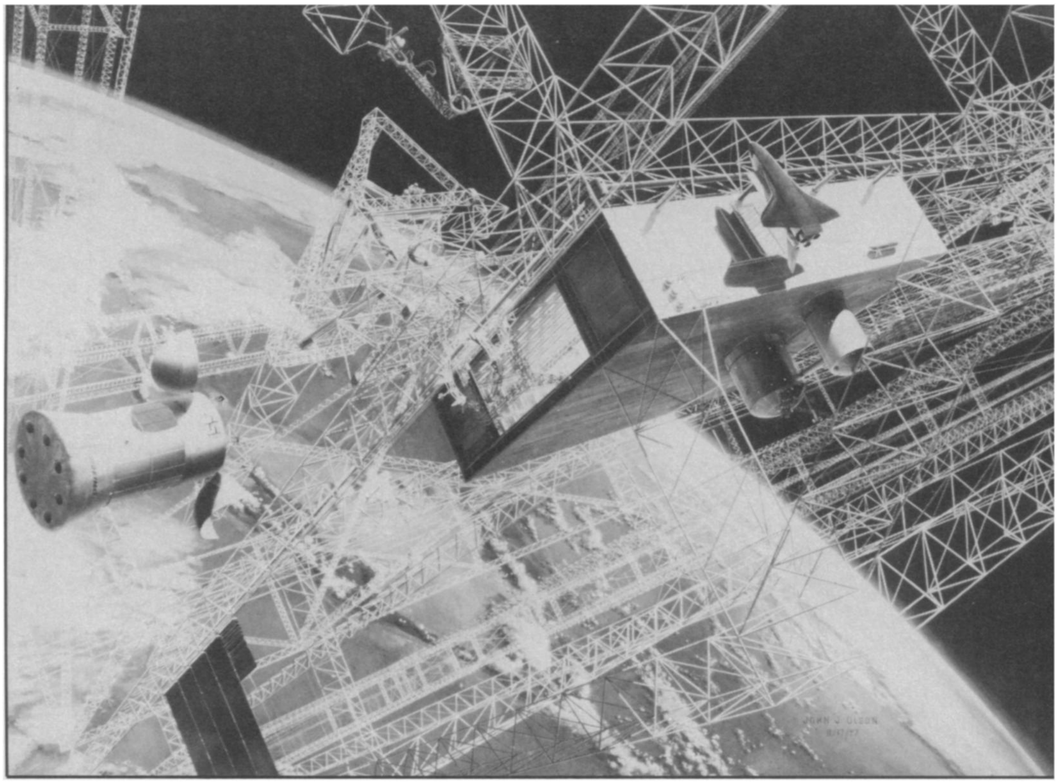


High above the clouds that overlie much of the surface world, the proposed solar power satellites would be in full sunlight about 99 percent of the time. Converting the sun's energy to microwaves, they would beam the result down to huge receiving installations on the earth below. The photovoltaic approach shown here would combine about 14 billion *solar cells into a raft-like array some five kilometers wide and 25 km long, providing 10,000 megawatts of usable power at the ground. A growing number of corporations, other institutions and individuals are taking an interest in such schemes — the cost of providing the total U.S. electrical supply this way has been estimated as high as $100 billion — and a number of them this month joined in an organization called the Sunsat Energy Council to push for development studies. (One bill now in Congress seeks $200 million in funding over five years.) The idea's advocates estimate that the first operational solar power satellite could be in orbit by the year 2000.*



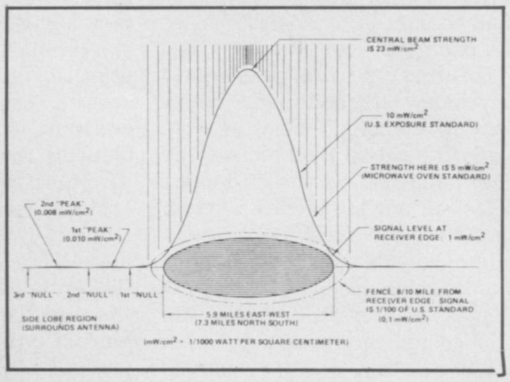
An alternative approach would use reflectors to focus the sun's heat onto solar furnaces, superheating gases in a closed-loop system that would produce electricity by driving a series of turbine generators (see diagram below). From that point on, the conversion to microwaves and transmission to earth would be essentially the same as with the photovoltaic system. The thermal design would be more complex than photovoltaics, but not necessarily more expensive; one of the sunsat concept's many uncertainties is the cost of producing solar cells in such quantities. The thermal design shown at left combines four parabolic reflectors, each 5.6 km across, into an array extending for 23.7 km overall. After passing through the turbines, the gases would be circulated through large radiator panels for cooling, then back to the furnaces (actually spherical "cavity absorbers") to continue their cycle. The disks pictured at the ends of the array are the microwave transmitting antennas.





Construction of the solar power satellites, if it ever comes to pass, could be one of the largest industrial projects ever undertaken. Current proposals envision each satellite weighing as much as 100,000 metric tons, meaning that they would have to be built in orbit, either "on site" at their geosynchronous position about 36,000 km above the earth or in low orbit for later transfer to working altitude. Either way, the task could require developing facilities to house large work crews in space, and getting the raw materials from earth to orbit would almost surely necessitate a new family of "heavy-lift" shuttlecraft with many times the payload capacity of the present space shuttle. Another likely need would be orbiting "factories" that could turn out the vast quantities of girders, panels and other large components. Even a single solar power satellite might require all of these advances, and the general concept envisions more like 45 to 50, if their energy output is to justify the staggering costs of research, development and production.

Illustrations: Boeing and NASA



The "rectenna," or microwave receiving antenna (left), for the satellite's beam would transform the microwaves to electricity for distribution to users. Studies are already underway of possible consequences to animals and plants in the region, though proponents claim that the land beneath the elevated rectenna grid could be used for grazing or farming. Other environmental concerns about the essentially permanent beam's effects include communications disturbances, as well as heating of electrons in the stratosphere and ionosphere. Cross-section (diagram above) of the microwave beam relaying power from orbit to earth shows the pattern of power density across the beam of a typical proposed system producing 5,900 megawatts. The receiving rectenna in this version would be in the shape of an oval measuring 5.9 miles by 7.3 miles. At the edge of the oval, the power density would be 1.0 milliwatt per square centimeter, one-tenth of the current U.S. continuous-exposure safety standard for microwaves. Even the maximum density of 23 mw/cm², says one proponent, would only cause a person in the beam to feel "a little warm." Even so, researchers are considering the use of "side-lobe suppression" to minimize power peaks outside the primary oval "footprint."

Stationed in high orbits of near-permanent sunlight, the huge sunsats may be visible from the ground at night, even to the naked eye. This artist's view envisions 30 of them as seen from eastern Washington state.