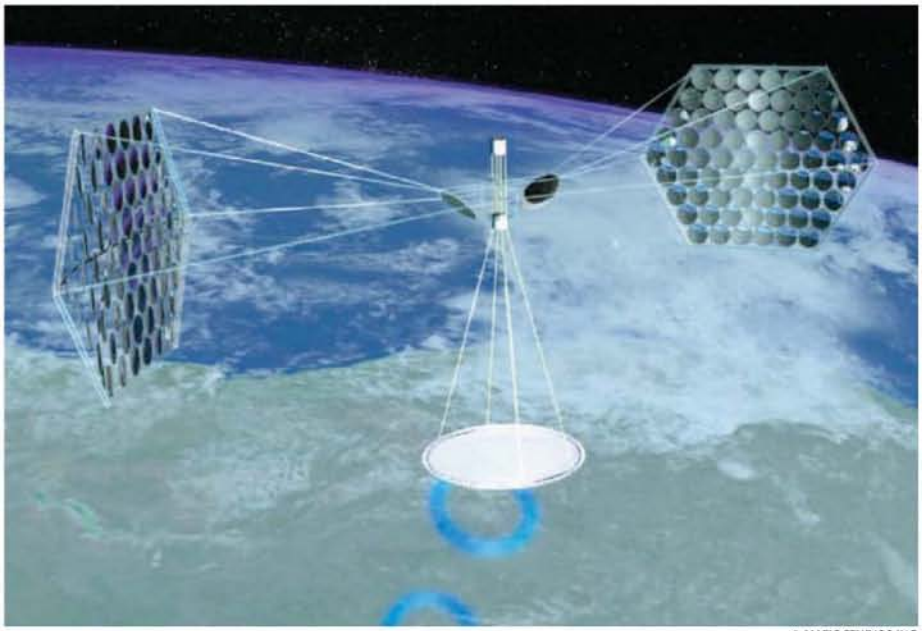
'Soft Power'

Pentagon continues space solar power effort to drive expeditionary forces

FRANK MORRING, JR./WASHINGTON



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This space solar power spacecraft measuring 5 km. across would, if built, require advances in large-scale assembly and operations in orbit.

Military planners responsible for finding space resources to support troops on the ground wonder if a convergence of events may give new life to an old idea that could dramatically reduce the logistics train behind forward-deployed forces.

First suggested 40 years ago, the concept of collecting solar energy above the atmosphere and beaming it to the ground as microwaves or lasers has long been seen among military free-thinkers as a way to get electricity to remote airfields, fire bases or other distant outposts without having to haul fuel for diesel generators.

But that out-of-the-box concept may be gaining new life as the incoming administration looks for "green-energy" technologies to reduce reliance on foreign oil, and technologists home in on the hardware that would be needed to orbit deployable sunlight collectors kilometers across while getting power down from them without frying birds, wildlife and humans that get in the way.

President-elect Obama has proposed a $150-billion effort "to build an American green-energy economy," while engineers studying the technology known as space solar power (SSP) believe a pilot plant could be orbited fairly soon.

"The end game needs to have a pilot plant in operation within 10 to 12 years," says John Mankins, chief operating officer of Managed Energy Technologies and a longtime SSP advocate. "By pilot plant I mean a small but full-scale operational system delivering megawatts of power to the Earth."

For the first Obama term, the price tag would be relatively small. Mankins has said an end-to-end systems study, with some early lab work and low-cost flight tests, would require about $100 million and take about three years (*AW&ST* Sept. 22, p. 20).

The Pentagon's National Security Space Office proposed just such a study in a report on SSP as "an opportunity for strategic security" released in October 2007. "It's being talked about," says a defense official, speaking on condition of anonymity in the absence of policy guidance. "Part of the problem has to do with perception. . . . It's [about] roles and responsibilities, and having people get over the giggle factor, that this is actually something that's real."

Mankins says a pilot plant delivering 5-10 megawatts "does mesh nicely" with a notional military requirement for a system to deliver power from space to forward-deployed forces. To meet the 10-year timeline for a pilot plant, he says, it would take another three years after the systems study to put together a flight demonstration in low Earth orbit, and another four to six years after that to get a pilot plant in geostationary orbit.

The National Security Space Office concluded that "while significant technical challenges remain, space-based solar power is more technically executable than ever before and current technological vectors promise to further improve its viability," according to the 2007 report. "A government-led demonstration of proof-of-concept could serve to catalyze commercial sector development."

For the Pentagon, the benefits of a pilot plant would be twofold. At the tactical level, it could be a "disruptive game-changer on the battlefield," providing "energy on demand" across a military theater and potentially supporting "entirely new force structures and capabilities such as ultra long-endurance airborne or terrestrial surveillance or combat systems to include the individual soldier himself."

Strategically, the report found, SSP could tackle the same sort of dependence on foreign energy sources that Obama says he wants to reduce with his green-energy economy, for the good of both the U.S. and the overall world economy.

"It's not only those niche applications," says the defense official. "This is a strategic security provider in that it helps to stave off some of those potential conflicts over resources in the future. It's soft power, if you will."

The Pentagon report shied away from using lasers to transmit power from space to Earth because of the relative immaturity of the technology and potential "negative associations" with lasers from space among the public. But the microwave approach also has technical drawbacks, including the need for "extremely large apertures, and therefore large on-orbit weights, to mitigate the beam divergence."

For the spaceborne end of the system, that would mean payloads too large for today's fleet of Atlas V and Delta IV Evolved Expendable Launch Vehicles to handle with the required cost efficiency, the Pentagon found. Building collectors in space with the multiple-kilometer aper-

tures needed would require advances in space-deployable structures and robotic assembly, it said.

The ground footprint of the rectifying antenna that would convert the microwave beam into direct current "would probably require a fair amount of space in order to do a rectenna," says the defense official. "It's not trivial in size, the rectenna. It could be fairly large, but it's not a complex piece of equipment either. It's just a wire mesh that's laid over the ground, elevated a little bit over the ground, that captures all the microwave energy."

Since the Pentagon report came out, the Air Force Research Laboratory has started fleshing out potential military applications for SSP and working with industry to evaluate the technologies needed to generate it. Next up at the Pentagon will be finding money to support an end-to-end study.

The 2007 study didn't address using NASA's planned Ares V heavy lifter, a shuttle-derived launch vehicle planned to be able to lift more than 400,000 lb. to low Earth orbit. The space-science community already is suggesting potential uses for the big new rocket (*AW&ST* Dec. 1, p. 27), and it is likely to figure into future studies of launch requirements for an SSP system as well.

The National Security Space Office already is working with NASA on a possible orbital demonstration of SSP transmission, taking advantage of the International Space Station's "national laboratory" status that makes it available to other government agencies for experiments. The $55-million ISS effort could save the government more than $400 million below what a clean-sheet mission would cost, but it probably would need to fly before the shuttle fleet is retired. Since that is now scheduled by the end of 2010, the schedule for getting a demonstration together would be very aggressive, to say the least.

Still, there is a chance that NASA may be more willing to work with the Pentagon on SSP under the incoming administration. Two members of the Obama transition team at NASA—consultant Alan Ladwig and George Whitesides, executive director of the National Space Society—took part in a press conference on an SSP power-transmission demonstration in September. Mankins says he briefed NASA transition team chief Lori Garver on SSP developments before the election, and has found her "very supportive" of the concept in the past.

As the next administration takes shape at NASA and the Pentagon, the SSP concept is likely to find its way into the briefing books as a potential source of green energy and perhaps national security as well. Mitigating against action are the wheezing economy and the falling price of oil, which tends to take public attention off the need for renewable sources of energy. But the potential wealth available directly overhead continues to make SSP attractive.

"A single kilometer-wide band of geosynchronous Earth orbit experiences enough solar flux in one year to nearly equal the amount of energy contained within all known recoverable conventional oil reserves on Earth today," the 2007 Pentagon report states.

"This whole space station, this massive concept, as impressive as it is, it's running free on solar power the whole time," said NASA astronaut Greg Chamitoff, just before completing a tour as flight engineer on the orbiting outpost in November. "A lot of the technologies and the capabilities that are going to lead us to the future are out here."