Online Journal of Space Communication

Volume 9
Issue 16 *Solar Power Satellites (Winter 2010)*

Article 18

Legal Issues for Space Based Solar Power

Mark I. Wallach

Legal Issues for Space Based Solar Power

Mark I. Wallach
Calfee, Halter & Griswold LLP

When Pacific Gas & Electric Co. (PG&E) entered into a May 2009 contract with Solaren Corp. to purchase power for 150,000 homes starting in 2016, public attention was abruptly focused on a potential major new source of energy: space based solar power (SBSP). First proposed in 1968 by Dr. Peter E. Glaser, Vice President for Advanced Technology at Arthur D. Little, SBSP is based on the simple facts that solar power, the most abundant source of energy on our planet, cannot be collected on the earth's surface at night, and that the sun's rays lose much of their energy while traveling through our atmosphere. As a result, the same solar collector located in a geosynchronous earth orbit (GEO) some 36,000 Km in space can produce between 5 and 10 times as much electric power as can be produced on the earth's surface. Solaren's innovative relationship with PG&E is based on a 40-year-old concept that a solar power satellite located in space can be designed to deliver a base load source of electrical power 24 hours of every day and night.

SBSP System Design

In space based solar power systems, a very large array of solar collectors - as large as multiple square miles of collection surface - is placed into a geosynchronous orbit to collect massive amounts of solar energy. Modern solar power technology has produced new thin films, no more than a few millimeters thick, capable of serving as efficient and reliable solar collectors in space. Because of their flexibility and low weight per kilowatt (kW) of electricity produced, such films are thought to be ideal for SBSP applications. A number of designs for the solar collection portion of an SBSP system have been proposed, some involving multiple interconnected collector units, some involving concentrator lenses to intensify the solar energy received by each collector cell. Once the solar energy has been collected, it is converted by the collector cells to electrical energy and transmitted wirelessly to an earth-based receiving antenna, called a rectenna.

While most SBSP system designs contemplate use of microwave beams to convey solar energy to earth, some propose to utilize laser beams instead. The advantage of a microwave frequency beam is the near transparency of earth's atmosphere to electromagnetic radiation, thereby reducing energy loss as the beam passes through the atmosphere. Microwave beams also create no measurable health threats, and are virtually impossible to use as weapons. In contrast to microwave beams, laser beams are better suited to smaller power production systems, but

their high intensity introduces the possibility of property damage or even personal injury from diverted beams.

The main disadvantage of microwave beams is the large area required to efficiently receive and convert them into usable energy on the earth's surface. A microwave rectenna sized to replace the energy production potential of a typical coal-fired electricity producing plant can cover several square miles, though it should be noted that the land beneath the wire grid that makes up the rectenna can be utilized for other purposes, such as growing crops or concentrating the space solar energy onto solar panels located beneath the rectenna.

Indeed, it is contemplated that rectennas will be owned by electric utilities, which will convert the received energy into alternating (AC) current that can be fed directly into the existing power grid. Available energy delivered from space to ground is intended to be in the one-gigawatt (1GW) range in many SBSP designs. One GW per hour approximates the electricity produced by a single nuclear power plant.

SBSP and Renewable Energy Requirements

The increasing shortage in world energy supplies expected during the coming decades, the result of increasing world population, increased energy usage and the "peaking" of existing energy sources like oil, has led to a search for new sources of energy. At the same time, concern about human-induced climate change has led many state governments to set target dates for utilities to achieve mandated levels of energy produced from renewable sources as part of their energy portfolios, commonly referred to as renewable portfolio standards (RPS).

At least 32 U.S. states have already ordered their electric utilities to meet minimum requirements for percentages of renewable power delivered. These can be simple targets by a specified date, such as the Connecticut requirement of 27 percent by 2020 and Delaware's 20 percent by 2019. Or they can be a complex series of milestones, like Ohio's set of 15 consecutive annual benchmarks, progressing from 0.25 percent in 2009 to 12.5 percent in 2024. Many of these states have an additional requirement that a fixed percentage of the renewable energy must come from solar energy sources, ranging from as little as 0.2 percent of sales by 2018 in North Carolina to as high as 4 percent of total sales by 2020 in New Mexico.

Even though a working, commercial-class SBSP satellite system has yet to be put in place, because of state RPS requirements, contracts such as the PG&E/Solaren deal are likely to proliferate in years to come. These contracts, and the untested SBSP systems on which they are based, will have to deal with a number of complex and occasionally novel legal issues.

Legal Issues Facing SBSP

Perhaps the first issue raised by SBSP power contracts will be whether those contracts can be used to satisfy regulatory targets for renewable energy. Unlike more conventional (if less promising) renewable sources, to some extent, this question may be answered by the specifics of state regulatory requirements. Some states may insist that power actually be produced and purchased to meet renewable energy targets, while others may only require that those utilities have entered into good-faith contracts with providers of qualifying energy.

In California, for instance, public opinion holds that the PG&E/Solaren contract is useful, whether or not it could be performed. (The California Public Utilities Commission approved the contract on April 10, 2009.) The law appears to be fairly stringent; that is, Section 399.15 of the California Public Utilities Code requires that the specified purchase levels "are procured from eligible renewable energy resources." Further, a report published by the California Energy Commission discusses the risks of signed renewable energy contracts failing to meet the timelines in the contracts. The report notes that "this risk of contract failure could cause individual load-serving entities, or entire states, to fall short of their renewable energy targets." The report suggests that companies anticipate a contract failure rate of 20 to 30 percent. This leads to the conclusion that simply because a company has a contract in place to procure renewable energy, the contract will not, by itself, satisfy the regulation unless it is actually procured.

GEO Slot Rights

Another major, yet still largely undeveloped, legal question is who owns the right to the "slot" located at the geosynchronous orbit above a particular rectenna. The highly prized equitorial orbit at approximately 36,000 kilometers above mean sea level has the unique characteristic of appearing to maintain the same position relative to the earth's surface, since the object in that orbit has an orbital period matching the earth's rotation period. Ideally, SBSP satellites collecting energy and converting it into a microwave beam for transmission to the surface will be positioned in a suitable location over the equator from which they can reach their targeted receiving rectennas by way of movable "spot beams."

Who owns - or who controls - the "air rights" to the space far above the atmosphere at GEO? If there is, for example, a communications satellite already located there, does it have primacy by reason of prior arrival? If a company receives approval to locate its SBSP collecting satellite at a particular spot, is it entitled to that location in perpetuity, or for the life of the satellite? In general, since most of the orbital slots in GEO have already been assigned to interested nations, and not to individuals or companies, it will fall to the International Telecommunications Union (ITU) and the regulatory agencies of nations to adjudicate such questions.

The ITU, an agency of the United Nations, holds responsibility for assigning both orbital and electromagnetic spectrum positions. The ITU is governed by a

constitution and the International Telecommunications Convention. The rights and obligations therein are binding on all member states. Currently, the ITU appears to apply a "first-in-time, first-in-right" system to orbital allocation. However, the ITU's primary considerations are supposed to be equitable access and efficient use of a limited resource. Many argue that these considerations obligate the ITU to reserve spaces for developing nations.

The matter of crowding is already a contentious issue for present and future operators of satellites at GEO. Telecommunications satellites need to be positioned far enough away from one another to ensure that their signals do not interfere with each other. The ITU Radio Communication Sector interprets, administers, and enforces the policies and agreements of the ITU, and also oversees coordination of the use of the spectrum and assists in solving conflicts with orbital position in the "Master Register."

The Space Treaty, a legally binding international agreement that provides the legal framework for the access and use of outer space and celestial bodies, does not allow for the allocation of orbital slots "either as a property right or through appropriation by national sovereignty." Article II of the Space Treaty provides that outer space "is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means." The Space Treaty also appears to prevent private companies from selling slots in the geostationary orbit: "Under the current treaty regime, the geostationary orbit is a scarce resource that no nation or individual can claim a legal right to beyond that of a squatter, which does not work to allocate the orbital space either efficiently or equitably."

While the ITU presumably will govern the allocation of GEO slots to SBSP satellites, it is by no means clear how conflicts between communications satellites and their vastly larger SBSP cousins will be decided, or what criteria will be used to make those decisions.

SBSP Beam Transmission

Another issue relates to the operation of SBSP systems. Transmission of microwave beams to the ground may be subject to the jurisdiction of the Federal Communications Commission (FCC), which has asserted the right to regulate even very small-scale demonstrations of wireless power transfer. What degree of possible interference with other wireless power transfers - such as radio broadcast signals, cell phone communications, and television broadcasts - will or should be tolerated? What is the extent of FCC jurisdiction over an activity that is typically thought of as within the jurisdiction of state public utilities commissions: supplying electric power?

Certain federal regulations, specifically 47 C.F.R. §§ 101.4- 101.97, govern the application and licensing of fixed microwave services. Likewise, 47 C.F.R. §§ 25.110-25.165 govern the application and licensing for all satellite

communications. Under these regulations, the FCC is charged with granting such licenses. There are also temporary options during the pendency of licensing applications. For example, 47 C.F.R. § 101.31(b) grants applicants for new point-to-point microwave radio stations, or modifications of existing stations, authority to operate during the pending period of a licensing application if certain conditions are met. Thus, it seems that the FCC would also be responsible for the regulation of the SBSP microwave beam, and the granting of any necessary licenses.

The power beam itself could create several regulatory issues. Even though the low intensity of the beams (which will spread out to an area of one square mile or more by the time they reach the Earth's surface) means that they are not a health risk to humans, they could nevertheless affect, for example, the migratory pathways of birds. Is that an issue for state departments of natural resources, or some federal agency? And what effect, if any, will the beams have on airplane traffic? Will no-fly zones be created over rectennas? Or simply some kind of warning signal for aircraft approaching the space over a rectenna? As for air traffic, probably such questions will have to be determined, at least in the first instance, by the Federal Aviation Administration (FAA). Once again, though, issues of primacy assert themselves: which predominates - the convenience of airlines in selecting air traffic routes, or the interests of power companies in shortening the pathway (and thereby minimizing power losses) for power beams coming from space? And who should decide that?

As mentioned, an alternative method for transferring power from SBSP collector satellites to ground stations is with high-intensity laser beams, especially for smaller systems (because microwave power transfer systems do not scale down well). In that case, more serious safety issues could arise, including liability for property damage or even personal injury by diverted laser beams. Since low intensity microwave beams pose no health threats, personal injury liability is not a consideration; but the same cannot be said about high-intensity laser beams.

Other legal issues are more common to space launches, such as liability for a botched launch. Article VII of the Space Treaty holds each State Party to the Treaty, or each State Party from whose territory an object is launched, internationally liable for damages in air space or outer space. This treaty was later supplemented by the Space Liability Convention, which provides that "a launching State is absolutely liable to pay compensation for damage caused by its space object on the surface of the earth or to aircraft in flight," where fault is established.

Thus, even if a launch is purely private, the respective government will be held liable for damages. The U.S. government took this into account by creating liability insurance requirements. In the case of SBSP satellites, however, many dozens of launches may be required to put all of the components of an SBSP system into orbit, so the failure to successfully launch one or more modules may

have the unusual consequence of putting the entire project off schedule. Thus, the damage questions may be more complicated than typical launch failures.

Next Steps

The exciting possibilities that the SBSP opens up for the planet's energy system will, it seems certain, be accompanied by novel and challenging legal issues.

With the extraordinary financial stakes revolving around the legal issues discussed above, there should be considerable pressure to resolve these issues before SBSP systems go into production. Such resolutions could occur as the result of negotiated treaty modifications, legislative initiatives, or court challenges to restrictions that could interfere with the development of SBSP systems.

Since SBSP systems are likely to be developed by private companies in much of the world (Japan's recent contracts for the development of an SBSP system through its government space agency JAXA may be an exception), many of the key legal issues necessary to the successful development of SBSP in the United States will be fought out in public arenas: the courts, state legislatures, and the U.S. Congress.

ACKNOWLEDGEMENTS

Mr. Wallach wishes to acknowledge the research contribution of Brandi Weekley to this article.

REFERENCES

1. Mark Chediak, Bloomberg News, PG&E Seeks Approval of Contract to Get Solar Power From Space (Apr. 13, 2009), http://www.bloomberg.com/apps/news?pid=new sarchive&sid=asv9DqExVzc4.
2. Renewable Portfolio Standards Fact Sheet, United States Environmental Protection Agency, http://www.epa.gov/chp/state-policy/renewable fs.html (last visited December 18, 2009).
3. See *id*.
4. Ohio: Alternative Energy Resource Standard, Database of State Incentives for Renewables & Efficiency (DSIRE), http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=OH14R&re=1&ee=1 (last visited Dec. 18, 2009).
5. North Carolina: Renewable Energy and Energy Efficiency Portfolio Standard, Database of State Incentives for Renewables & Efficiency (DSIRE), http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NC09R&re=1&ee=1 (last visited Dec. 18, 2009).
6. New Mexico: Renewables Portfolio Standard, Database of State Incentives for Renewables & Efficiency (DSIRE), http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NM05R&re=1&ee=1 (last visited Dec. 18, 2009).
7. Cal. Pub. Util. Code § 399.15(b)(1).
8. California Energy Commission, Building a "Margin of Safety" Into Renewable Energy Procurements: A Review of Experience with Contract Failure (Jan. 2006), available at http://www.energy.ca.gov/2006publications/CEC-300-2006-004/CEC-300-2006- 004.PDF.

9. Brian Beck, The Next, Small, Step for Mankind: Fixing the Inadequacies of the International Space Law Treaty Regime to Accommodate the Modern Space Flight Industry, 19 Alb. L.J. Sci. & Tech. at *26 (2009).
10. See, e.g., Adrian Copiz, Scarcity in Space: The International Regulation of Satellites,10 CommLaw Conspectus 207 (2001-2002).
11. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, 18 U.S.T. 2410, T.I.A.S. 6347, 61 U.N.T.S. 205 (1967) (hereinafter Space Treaty).
12. See, e.g., Milton L. Smith, Space WARC 1985: The Quest for Equitable Access, 3 B.U. Int'l L.J. 229, 232 (1985), and Copiz, supra note 10, at 220.
13. Space Treaty, art. II.
14. Beck, supra note 9 at *4.
15. Space Treaty, art. VII.
16. Convention on International Liability for Damage Caused by Space Objects, 24 U.S.T. 2389, T.I.A.S. No. 7762, 961 U.N.T.S. 187 (1972).
17. Id. art. II.