Chapter 7
What Are the Legal Issues?

Abstract This chapter explains the extent to which Sunsats can be deployed under existing treaties and regulatory provisions at various levels of government, and the extent to which new policies and procedures must be negotiated. Issues related to export controls, assignment of orbital positions and frequencies, ownership and control of space assets, liability for damage in space and environmental protection are also addressed.

International Development Goals

The International Telecommunications Union (ITU), at its May 2005 World Telecommunication Development Conference in Hyderbad, India, set broad goals for public access to ICTs (information and communication technologies), hoping to reach more than half of the world's population by 2015.

In its 2010 midterm review of these Millennium Development Goals, the helpful role of communication satellites was prominently mentioned. "If satellites are taken into account, then practically the whole world is covered by broadcasting," the report said. "The number of households around the world with DTH dishes rose from 82 million in 2000 to 177 million in 2008" (Oberst 2010, p. 14).

In reporting on the ITU midterm review in the trade magazine *Via Satellite,* Gerry Oberst noted, "This is not the end of the story, however, because access or coverage is not the same as actually receiving broadcasting signals. In addition to low income, the current lack of broadcasting reception in developing countries arises from lack of electricity…. The ITU statistics show that about 79% of the world's households own a television set, but only 28% of households in Africa own a set. To increase that number, satellite services offer the possibility for most developing countries to ensure national broadcasting coverage. Nevertheless, there is that tricky problem of a lack of electricity" (Oberst 2010, p. 14).

When it comes to satellite coverage, whether for solar power or for communication, politics and government regulations can play a decisive role. Prominent and

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long-standing examples of political impediments are the export rules imposed by the United States on global trade in satellites and satellite-related equipment beginning in 1999. These have come to be known as the U. S. International Traffic in Arms Regulations (ITAR).

In *The Broadband Millennium*, this author writes:

> [In 1999, the] U. S. Congress wrote into a defense authorization bill language that placed limitations on satellite exports largely aimed at tightening U. S. technology transfers to China and curbing Chinese espionage in sensitive American facilities. The restrictions required detailed technology transfer control plans for any satellite or satellite technology to be sold outside U. S. jurisdiction, whether to China, Russia, Canada, or any trading partner nation.
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> With export licensing authority shifting from the Commerce Department to the U. S. Department of State, commercial satellite transactions were treated in the same manner as munitions transactions. Approvals for previously routine commercial exports and technical exchanges experienced long delays. At the time, U. S. companies were supplying 76% of the world's commercial GEO spacecraft and 88% of the LEO satellites. A Satellite Industry Association study found that by 2001 the U. S. share of the global market for communication spacecraft and parts had fallen to 45%.
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> The U. S. war on terrorism, implementation of Homeland Security measures, and the greater scrutiny given to international trade has made matters much worse for the global satellite industry. A particularly low point occurred when the U. S. National Defense Authorization Act for 2004 included "Buy American" provisions that would require the Pentagon to buy only hardware constructed with components and machine tools built in the United States" (Flournoy 2004, pp. 251–252).

By the end of his second term, President George W. Bush directed changes that would clarify regulations governing the export of civil aircraft components and streamline the U. S. export approval process. One of the first items on the agenda of newly elected President Barak Obama was to launch a review of all export control policies and procedures.

A 2009 editorial in the trade journal *Aviation Week & Space Technology* demanded, "Every facet of the export control regime must be on the table. Both the climate and the timing are ripe for major change. The Secretaries of Defense, State and Commerce all acknowledge the need for updated controls, and Congress is more aware than ever of the importance of defense exports to U.S. security and its economy" (Editorial 2009, p. 66).

Addressing the U. S. National Space Symposium in Colorado Springs in April 2011, Lei Fanpei, vice president of China Aerospace Science and Technology Corp. (CAST), spoke to the political and legal constraints hindering international cooperation in space. He made a direct appeal to the U. S. government "to lift its ban on most forms of U. S.-Chinese cooperation," saying both nations would benefit from closer government and commercial space interaction (de Selding 2011, p. 8).

Lei Fanpei was quoted as saying, "China purchased more than $1 billion in U. S.-built satellites in the 1990s before the de facto ban went into effect in 1999. Since then, the U. S. International Traffic in Arms Regulations (ITAR) have made it impossible to export most satellite components, or full satellites, to China for launch on China's now successful line of Long March rockets." He noted that "Chinese vehicles launched more than 20 U. S.-built satellites in the 1990s" (de Selding 2011, p. 8).

The government official from CAST suggested three areas of possible cooperation that would serve the interests of the two nations. These included open commercial access of each nation to the other's capabilities in satellites and launch vehicles, manned spaceflight and space science—particularly in deep space exploration—and such satellite applications as disaster monitoring and management (de Selding 2011, p. 8).

Space Law

When Kiantar Betancourt wrote "Legal Challenges Facing Solar Power Satellites" for the *Online Journal of Space Communication*, he was a third-year student at the University of Maryland School of Law, specializing in environmental and international law. He currently works at Enhesa, Inc., an international consulting group. Permission is given for the abbreviated reporting of his article below, which is available in its entirety at http://spacejournal.ohio.edu/issue16/hsu.html (Betancourt 2010, p. 2).

In his article, Betancourt describes the current system of international space law, explaining the specific ways international regulations could help to create a supportive environment for launching, maintaining and removing solar power satellites. He also offers suggestions for future improvements to this system:

> Solar power satellites automatically raise questions concerning the currently applicable international law, and which laws and processes may need to be in place to accommodate the special requirements of SunSats.
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> These questions include coordination and registration of space objects, property rights in space, rights of private parties, liability for damage, and environmental protection. The general framework to answer these questions already exists, but further development will be needed. The United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) has led the development of this legal framework. Presently there are three treaties relating to outer space significant to SBSP.

He writes that the first and most important of these is the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space (Outer Space Treaty). Second is the Convention on International Liability for Damage Caused by Space Objects (Liability Convention). Third is the Convention on Registration of Objects Launched into Outer Space (Registration Convention)" (Betancourt 2010, p. 2).

The Outer Space Treaty

According to Betancourt, the Outer Space Treaty has been accepted and ratified by over 100 countries including all current spacefaring nations. Ratified in 1967, this treaty created the fundamental base of outer space law under the idea that outer space is the common heritage of mankind. Thus, the exploration and use of outer space shall be free for exploration and use by all states. Article II states that outer space, including the Moon and other celestial bodies, is not subject to national

appropriation by any means. Even for countries that currently lack the resources to reach outer space, the right of exploration and use remains available to them as they become capable of space exploration.

Under Article VII, though a state cannot claim ownership to outer space or any celestial bodies within, a state on whose registry launches an object into outer space retains jurisdiction and control over that object. The ownership of such objects in outer space is also not affected by their presence in outer space or by their return to Earth. Thus, countries or companies that launch satellites on their state's registry retain ownership of those satellites. If no such ownership interest existed, there would be no incentive to send a satellite into space that could be appropriated by another country or private party.

Betancourt explains that the Outer Space Treaty addresses actions taken by states. It does, however, contemplate the actions of private companies in two sections. First, in Article VI, parties to the treaty agree to bear international responsibility for their national activities in outer space, whether those activities are carried out by governmental agencies or by non-governmental entities. Second, Article IX requires states and their nationals to seek international consultation in circumstance that could cause harm to other states. Though space exploration in 1968 was dominated by states, the Outer Space Treaty still contemplated private companies joining the states in space travel.

> The Outer Space Treaty contains several other key provisions. Article V of the Outer Space Treaty specifically prohibits the placement of any objects in space carrying nuclear weapons or weapons of mass destruction. Further, testing of any military weapons is strictly forbidden. An example might be an attempt to transform a solar power satellite into a death ray using microwaves or laser beams. Such an action would be in strict violation of the Outer Space Treaty.

He notes that Article XII of the Outer Space Treaty requires that any station, installation or equipment on the moon, asteroid or other celestial body must be open to inspection on a basis of reciprocity. This provision, though limited to objects on celestial bodies, allows countries to ensure that others are within the terms of the treaty. The Outer Space Treaty answers questions concerning the right of private ownership and the role of private companies in outer space (Betancourt 2010, p. 3).

The Liability Convention

"Ratified in 1972," Betancourt notes, "the Liability Convention helped clarify the liability of states and private parties for damage in space. The guidelines, under Article II, that affirmed that launching states will be absolutely liable for damage caused by their space objects on the surface of Earth and to aircraft in flight have now been approved and ratified by 91 countries including all current spacefaring nations."

He notes that countries have to create their own laws regulating private companies to protect themselves in the case that a company causes damage. If such regulations are not created, it could discourage a country from allowing a private company to go

to space for fear of international liability. For example the United States passed the Commercial Space Launch Act of 2004 granting the Federal Aviation Administration the authority to regulate commercial space flights with the interest of promoting private space development while shielding itself from liability. Prior to launching an object into space, a private company has to apply for a license from the FAA. The CSLA requires all license applicants to demonstrate financial responsibility through liability insurance or independent means. The U. S. requires evidence of insurance to compensate another party for damages or itself for losses stemming from an activity carried out under the license. If the damage exceeds $500 million, the United States will cover the remainder up to $1.5 billion but only 'to the extent provided in an appropriation [bill].' Thus, anything over $1.5 billion would need to be covered by the company. If not enough money is allocated in an appropriations bill the company will be liable for all damages" (Betancourt 2010, p. 4).

Japan has taken a similar approach, he writes, but its law seems friendlier to private companies. "As in the United States, private companies have to secure liability insurance for an amount determined by the government. Unlike the United States, the government average liability insurance requirement is around $200 million. More importantly, the Japanese government will cover any amount over the liability insurance without limit." He points out that, even though Japan protects itself from potential liability, its approach makes it easier for private companies to enter into space.

As for solar power satellites, Betancourt recommends that countries continue to develop laws encouraging commercial space companies, which can help reduce development costs while bringing fresh ideas to the marketplace. Countries could provide further incentive to develop SBSP applications by lowering or eliminating a company's liability in exchange for the company's help (Betancourt 2010, p. 5).

Betancourt recommends that the United Nations and member states work together to clarify more precisely the meaning of "fault" so that countries and companies can more easily predict their potential liability. Thus, the international contingent should continue to develop the framework used to determine liability for damages, possibly to include requiring countries to clean up or retrieve broken or decommissioned satellites—or face strict liability for the damages they cause—and improving dispute mechanisms between countries and penalty assessment on those refusing to pay proper judgments. Penalties for refusal to pay for damages could help ensure damage award compliance, motivating countries and companies to promote safe practices, while lowering the risk of catastrophic losses (Betancourt 2010, p. 6).

The Registration Convention

In his article, Betancourt describes the creation of the Registration Convention and its importance to the evolution of the Sunsat industry:

> As more satellites entered orbits around Earth, the United Nations and its members recognized the necessity of registering all space objects in a single registry to help prevent accidental collisions in space. Ratified in 1974 by 53 countries, including all current spacefaring

> nations, the Registration Convention, under Article II, requires all countries to create and maintain a registry of all objects they or their nationals have launched into space. Article IV then requires countries to give this information to the United Nations, including the objects' orbital parameters, from which the United Nations builds its global registry. Countries can then consult with the registry to ensure future satellites will not interfere with current ones. Private companies seeking to send up a satellite are expected to consult with their country registries to ensure the vehicle is noted domestically and that that information is submitted to the United Nations.

Betancourt notes that as more satellites are sent into space a simple registry may not be sufficient. The international regime will likely need to develop a mechanism for space traffic control with the ability to track satellites in orbit and the authority to assign orbital slots equitably, while establishing transit corridors for new satellites to safely reach orbit. Without such, space travel could become more dangerous. An increase in the frequency of collisions could also add to the costs and threaten the security of solar power satellites (Betancourt 2010, p. 7) (Fig. 7.1).

Space Debris

Based on his research, Betancourt concludes that space debris is the largest environmental problem for the SPS industry. He explains, "There are over 19,000 pieces of trackable debris in Earth orbit; the number of un-trackable pieces is much higher. Collisions with even small [pieces of] orbital debris can cause catastrophic damage."

The global community has taken steps to deal with this growing problem, he says. The Inter-agency Space Debris Coordination Committee (IADC) is an international organization made up of all major spacefaring countries, responsible for proposing solutions and researching problems posed by space debris. It has created guidelines to help minimize debris-creating events and avoid debris-caused hazards. The guidelines are not binding; however, states can use these guidelines to formulate their own mitigation standards. The United States also has its own standards to control space debris, and these standards offer initial guidance, but further improvements will be needed to fully address this problem. He writes:

> The Orbital Debris Mitigation Standard Practices (Standard Practices) of the U. S. government incorporates guidelines offered by the IADC while adding its own provisions. Like the IADC guidelines, the Standard Practices seek to avoid releasing debris during normal operations, especially debris larger than 5 mm that will remain in orbit over 25 years. The Standard Practices also offer guidelines for post mission disposal of space structures including:
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> - Atmospheric reentry: for objects in LEO, where atmospheric drag should limit the lifetime of the object to no longer than 25 years;
> - Maneuvering the device to a storage orbit: structures would be moved or have the capability of moving themselves to different "storage" orbital levels; or
> - Direct retrieval: retrieving and removing the structure from orbit after completion of its mission (Betancourt 2010, p. 9).

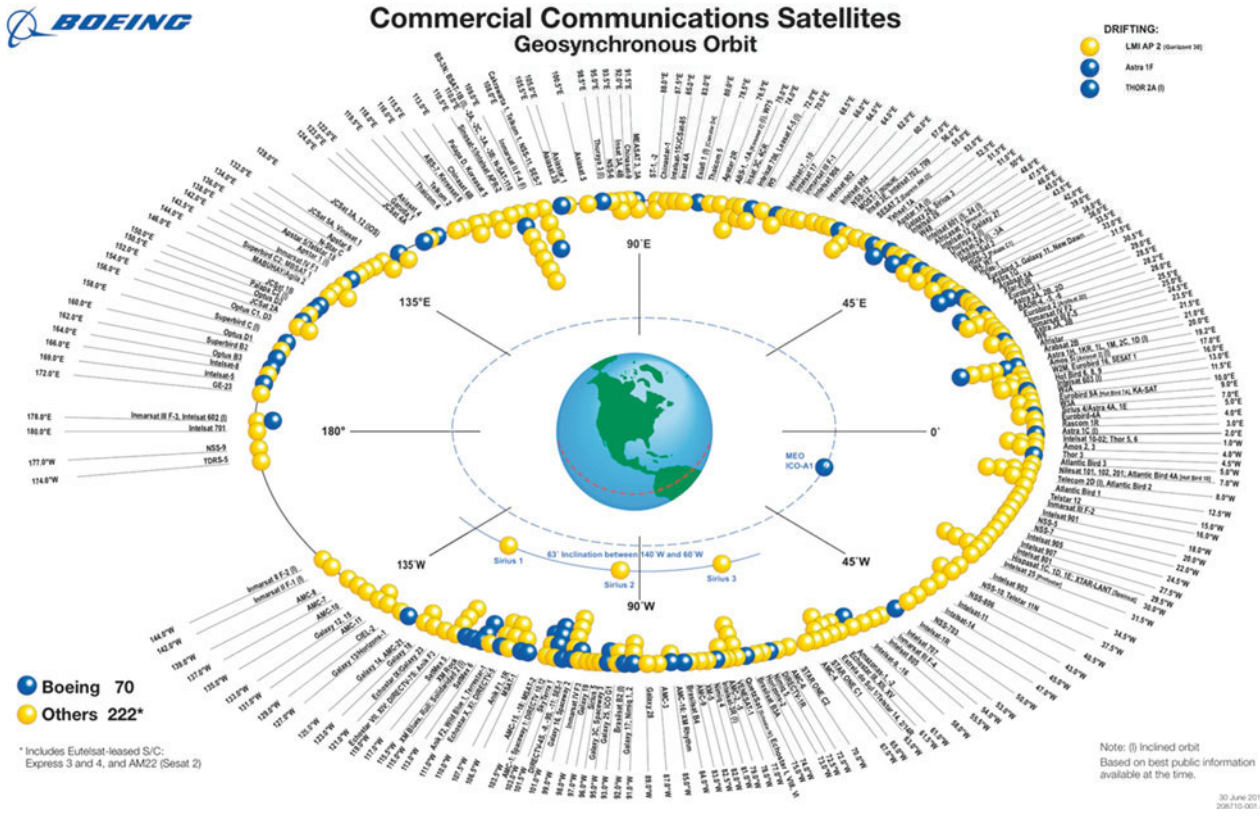

Fig. 7.1 Pictured are the commercial communication satellites within the 360° geosynchronous equatorial orbit that is 36,000 km above Earth. GEO is prime real estate in space since objects placed in this location move in sync with the turn of Earth (Boeing 2011)

Microwave Radiation

Betancourt's research led him to conclude that public health and safety issues with microwave use have been examined extensively. "Microwaves used in space solar power have no ionizing effect, and there is no danger of cancer or genetic alterations due to microwave radiation. The potential danger of microwaves, like energy from the Sun and from artificially light sources, relates directly to the energy's density in a given area. The design of SBSP systems calls for power densities well within safe limits at the planet's surface.

He explains, "For example, the average power density of the Sun's rays is about 100 mw/cm^2 while the design maximum of satellite solar power systems is 25 mw/cm^2 on the planet's surface." Even high-flying birds would still remain well within safe limits, he says, "though scientists should still plan further safety studies, a necessary precaution for technology on this scale" (Betancourt 2010, p. 10).

Other Regulatory Issues

Mark I. Wallach is a partner with Calfee, Halter & Griswold, LLP, where he serves as co-chair of the litigation group of more than 40 attorneys. A member of the National Space Society and the Space Frontier Foundation and an active advocate for space-based solar power, he contributed to the October 2007 *Report on Space Based Solar Power* issued by the National Space Security Office. In 2009, Mr. Wallach became a member of the Advisory Board of the for-profit Space Energy Group. He authored an article on legal issues in the winter 2010 *Online Journal of Space Communication.* Included below is a summary of several important matters he addresses that are likely to affect solar power satellite system implementation.

GEO Slot Rights

According to Wallach, a major, yet still largely undeveloped, legal question is who owns the right to the "slot" located at the geosynchronous orbit above a particular rectenna. He notes that "The highly prized equatorial orbit at approximately 36,000 km above mean sea level has the unique characteristic of appearing to maintain the same position relative to Earth's surface, since the object in that orbit has an orbital period matching Earth's rotational 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'" (Wallach 2010, p. 2).

Who owns—or who controls—the "air rights" in GEO orbit? Wallach cites the not-so-hypothetical example of 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? Wallach points out that, 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 ITU and the nations' regulatory agencies to adjudicate such questions.

He explains that "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 its "Master Register" (Wallach 2010, p. 3)

Wallach notes that Article II of the Space Treaty assures 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" (Wallach 2010, pp. 4–6).

Power Beaming

Wallach cites another legal issue that relates to the operation of SBSP systems. That is, "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 commission: 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 (Wallach 2010, p. 6).

Wallach foresees the power beam itself raising regulatory questions. 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 Earth's surface—ensures that they are not a health risk to humans, these beams could nevertheless affect, for example, the migratory pathways of birds. Is that an issue for state departments of natural resources, or some federal agency? He continues:

> 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).

He notes that 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 (Wallach 2010, pp. 7–10).

Renewable Energy Targets

"Perhaps the first issue raised by SBSP power contracts will be whether those contracts can be used to satisfy regulatory targets for renewable energy," Wallach says, and he goes on to note that, for conventional renewable sources, this question may be answered by the specifics of state regulatory requirements. But 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.

He notes that in California, for instance, public opinion holds that the PG&E/Solaren contract, approved by the California Public Utilities Commission in 2009, is useful whether or not it could be performed. "The law appears to be fairly stringent; that is, Section 399.15 of the California Public Utilities Code requires that the

specified purchase levels be procured from eligible renewable energy resources" (Wallach 2010, p. 6).

Wallach consulted a report published by the California Energy Commission that discussed the risks of signed renewable energy contracts failing to meet the timelines in the contracts and found "this risk of contract failure could cause individual load-serving entities, or entire states, to fall short of their renewable energy targets." The report suggested that companies should anticipate a contract failure rate of 20–30%. This led 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 (Wallach 2010, p. 7).

The Role of Government

Feng Hsu, vice president for systems engineering and risk management at the Space Energy Group, is of the opinion that a model similar to the one used in successfully launching and commercializing communications satellites will be a viable approach for solar power satellite implementation.

As a former NASA scientist, serving as a senior advisor to the Aerospace Technology Working Group and a co-founder of the Space Development Steering Committee, Dr. Hsu has been an advocate for space-based solar power for a long time. In thinking about "the roadmap ahead," he believes that hope for a viable solar power satellite system lies in the collaborative efforts of private, entrepreneurial space businesses and venture capital investment, undertaken as a global-scale commercial enterprise.

He writes that "For SPS to be successful, we need an organized consortium consisting of private businesses, venture capitalists from major international partners, along with government support of R&D and technology demonstrations by industrial nations. We need this concerted effort to bring down associated risks in safety, reliability and technology maturity." He also says he is convinced that government policy and regulatory support will be crucial to success, as will the funding of R & D and related technology demonstrations, "but quite frankly, as a former employee of one of the great space agencies of the world, I am pessimistic about getting the necessary government support for any SBSP project" (Hsu 2010, p. 6).

Concluding Thoughts

Some of the legal and policy issues identified by Betancourt, Wallach and Hsu are unique to Sunsats and could require special attention, adjudication and perhaps some law-making. But their research and experience suggests that the preponderance of current regulatory concerns about solar power satellites have been anticipated in law and in regulation.

Doing the legal research and anticipating regulatory roadblocks are important and necessary steps to establishing the SPS industry. But even more important is realizing that those companies, those utilities, those nations aspiring to be in the business of providing energy from space are lucky to have a mature and profitable comsat industry at hand showing them the way, and that solar power satellites and communications satellites are natural allies. The author concludes: the one is the natural business extension of the other.

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