

Current Legal Issues Pertaining to Space Solar Power Systems

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Abstract

This paper discusses a range of legal issues that need to be considered in planning for a space solar power system. Because objects placed in space inherently are international, the paper primarily looks at international law that affect launching, construction, operation, property rights, the environment, communication and liability. International coordination early in the planning process is urged to more speedily make space solar powers systems a reality.

I. Introduction

A. Space Solar Power in the 21st Century

This paper describes the 21st Century outer space legal environment into which a space solar power system would fit. Underlying this paper is the assumption that non-renewable earthly sources of energy (oil, coal and natural gas) will significantly decline during the 21st Century and that an outer space solar power system (SSPS) will be established to collect solar energy in space, convert it to electricity and transmit it to Earth via microwave beams. The solar energy collecting satellites would be placed in orbit around the Earth. They would provide renewable energy to Earth.

The collecting satellites would be of extensive mass and area. Because of the great cost of uplifting such massive cargo from the Earth, it is possible that the collecting satellites would be built from the Moon from available lunar

resources. Lunar construction is particularly likely if a large number of collecting satellites are built, sufficient to provide a significant amount of electric power around the Earth.

Space solar power systems may be built in stages, possibly beginning with a demonstration project as described at the 1999 International Astronautical Congress by Professor H.H. Koelle. 1/

B. Legal Regime in Space Governing Solar Power

The existence of solar power satellites in outer space will be governed by a combination of international and national laws. On the fundamental sovereignty-in-space issue, the 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (commonly known as the 1997 Outer Space Treaty) 2/ expresses (1) that outer space is not sovereign territory (Art. II); (2) it is governed by international laws, including the U.N. Charter (Art. III); (3) states "bear international responsibility for national activities in outer space," (Art. VI); (4) states are obligated to supervise activities of their non-governmental organizations in outer space (Art. VI); (5) states retain jurisdiction over the objects that they launch into outer space (Art. VIII); and (6) ownership rights are not changed by their existence in outer space (Art. VIII), so U.S.-owned space objects remain U.S.-owned when in outer space. The 1967 Outer Space Treaty is further amplified by the 1972 Convention on International Liability for Damage Caused by Space Objects. 3/ This treaty makes the launching state liable for damage caused by space objects which it launches. 4/ The 1975 Convention on Registration of Objects Launched into Outer Space obligates states to register their space objects. 5/ States retain jurisdiction and control over their registered space objects. 6/

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SSPS operators will communicate by use of radio frequencies with solar power satellites. Use of radio frequencies are coordinated within the International Telecommunication Union (ITU) in accordance with the ITU Convention. 7/

Solar power systems are also subject to national laws to the extent that they do not conflict with international laws. Often the national laws, for example the U.S. Commercial Space Launch Act, 8/ implement international laws. It is likely that a space solar power system will have varying legal relationships with a number of different countries depending on competition requirements, local needs for electricity, national security considerations, liability and other special situations. 9/

C. International Commercial Entity.

A solar power system will be so massive that it is likely to be an international commercial entity. That entity could be international treaty organizations such the International Atomic Energy Agency or INTELSAT. 10/ It could be an international private commercial entity such as IRIDIUM. It is less likely to be an entirely state-operated service such as the U.S. Global Positioning System (GPS) although it is possible that, for national security reasons, the United States could find it necessary to build a solar power system in the same way that the U.S. spent \$11 billion to build the GPS system. GPS is a global system which is accessible all over the world. Another possible model is the European navigation and positioning system, Galileo, planned to be operated as a public-private partnership (PPP); it is intended to be operational in the year 2008. 11/ Galileo is planned to be a global service. Another solar power system operating analogy could be to the non-governmental satellite remote sensing organizations; several global remote sensing services exist, for example SPOT-IMAGE, EOSAT, and others.

The space solar power system may become subject to the kind of international operating guiding principles (supported by the United States and all other countries) adopted by the UNITED NATIONS General Assembly regarding remote sensing. 12/ The UNGA Resolution mandated respect for sovereignty of

individual states (for example when beaming into a sovereign state by microwave), international cooperation with other states, technical assistance for developing countries, environmental protection, non-discriminatory access to the electrical solar power system (on reasonable cost terms); and right of consultations among states regarding disagreements. The UNGA resolution stressed the operating states' international responsibility for their remote sensing activities. Similar international operating principles were developed in the International Civil Aviation Organization (ICAO) for Global Navigation Satellite Systems. 13/ These kinds of principles are becoming standard for outer space services. They have worked well for the commercial remote sensing industry. There is a strong possibility that such international operating guiding principles also will be established for international commercial solar power systems.

II. SSPS Oversight Responsibility

A. Launch license

Launches of Government-owned space objects do not require a launch license in the United States or other states. However, a private launch of SSPS space objects requires a U.S. launch license under the U.S. Commercial Space Launch Act for launches in the United States and for U.S. citizens to launch abroad (unless the foreign country agrees to assume jurisdiction over the launch). 14/ The launch license is issued by the U.S. Department of Transportation, Federal Aviation Administration. Launches may lift off from existing governmental launch sites or from private launch sites and will be monitored by the Department of Transportation. Launches are also subject to regulation by the individual (fifty) states within the United States. 15/ SSPS launches from the moon by U.S. citizens could be considered a foreign launch requiring a U.S. launch license. 16/

B. Construction of SPS satellites

Construction of solar power satellites from the Moon would be governed by the 1967 Treaty on Principles Governing the Activities of States

in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies.

17/ Construction from the moon is legally possible, however, appropriation of land on the moon by claim of sovereignty, by use or by occupation and by any other means, is not legal (Art. II). Production of solar power satellites from the moon by non-governmental entities "shall require authorization and continuing supervision by the appropriate State Party to the Treaty." 18/ Consequently, construction of solar power satellites on the moon by United States citizens would be subject to U.S. oversight pursuant to Article 6 of the Outer Space Treaty. U.S. treaty obligations could be satisfied by a construction license analogous to a launch license described above.

C. Operation of Solar Power Satellites in Space

Operating solar energy collecting satellites in space would be legally possible. Functioning of the satellites would be governed by the 1967 Outer Space Treaty. 19/ In consequence of the treaty, Article II, the space occupied by a solar power satellite could not become a permanent appropriation. However, that would not preclude a solar power satellite from collecting solar power on a continuing basis as long as it does not interfere with other uses of space. It would not be in the interest of an operator to place a solar power satellite where it would conflict with other uses of space because that could limit the use of the satellite itself. 20/

III. SSPS Property Rights in Space

Legal rights in property in outer space were fairly uncomplicated when most space activities were performed by governments. However, commercial space activities are increasingly performed by private entrepreneurs whose activities are based on commercial demand for their services. Ownership and financing of private enterprises is much more intricate than that of public enterprises. Legally, the issue of solar power satellite ownership is left to national law because the 1967 Outer Space Convention, Article VIII, states that: 21/

Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of

their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the Earth.

The 1975 Convention on Registration of Objects Launched into Outer Space, Article II, requires that: 22/

When a space object is launched into Earth orbit or beyond, the launching State shall register the space object by means of an entry in an appropriate registry which it shall maintain. Each launching state shall inform the Secretary-General of the United Nations of the establishment of such a registry.

In addition to state registration, the Registration Convention, Article IV, requires registration of vital statistics in a United Nations registry concerning each space object launched. Only one country may register a space object; thus an international cooperative SSPS (analogous to INTELSAT) or a privately owned international cooperation would have to select one country to register its space objects. However, analogous to the international space station, the several countries participating in an SSPS enterprise could arrange jurisdictional issues among themselves. The Registration Convention does not require space objects to be marked with serial numbers or similar identification signs; however Article V requires that if a space object has been so marked then the markings shall also be transmitted to the United Nations registry.

The SSPS property of non-governmental organizations and of private enterprises is likely to be financed by financial institutions which will require security in the launched space objects in the same way that a car is financed by a bank subject to a bank lien or mortgage in the car itself. Most financing of space objects takes place in the United States under the Uniform Commercial Code (UCC). 23/ The UCC is not Federal legislation. It is state legislation made virtually uniform in all the fifty states. UCC section 9-103 regulates the perfection of security interests. UCC Section 9-304 provides for registration of security interests in the state registries. The purpose of such registration is that "a good faith search would reveal the

presence of the secured creditor's claim." 24/ Registration leads to establishment of priorities among holders of security interest. 25/ An international registry of all space assets may be established by a UNIDROIT convention on security interests. 26/

IV. Environmental Laws and Regulations

International law regulation of space objects in outer space is very limited. The 1967 Outer Space Treaty, Article IX, merely provides that states shall avoid harmful contamination of space and of the Earth's environment. Art. VI of the Treaty requires states to exercise oversight over their commercial enterprises; within that oversight function the U.S. Commercial Space Launch Office considers the possible environmental impact of proposed commercial launches of space solar power satellites. The National Environmental Policy Act (NEPA) requires the preparation of an Environmental Impact Statement (EIS) for major federal actions which have potential adverse impact on the environment. 27/ NEPA applies in U.S. territory. While there is no case law directly holding that NEPA applies in outer space, the Federal Court of Appeals expressed in the case of the Environmental Defense Fund v. Massey, 986 F. 2d 528 (D.C. Cir. 1993), that the National Environmental Policy Act applies to Antarctica. By analogy NEPA would also apply to outer space. 28/ The environmental laws of the state in which a launch takes place would apply to launches in that state.

V. Communication Law Issues

Space solar power satellites would be controlled by use of radio frequencies. The satellites in orbit need constant monitoring and corrective intervention in order to remain in place. Radio contact with the satellite needs to be free of radio interference from the many other satellites in orbit and free from physical interference (collision) with other satellites and debris. Location of a solar power satellite without prior consideration of these two factors could seriously threaten economic investment in SSPS. For that purpose the solar power satellites need to be placed at a distance from other satellites sufficient to avoid both radio interference and

physical interference (collisions). Because of recent technological progress it is possible to place satellites more closely together; but they need extensive coordination in order to fulfill their purpose in space. The International Telecommunication Union (ITU) is the major international forum for coordinating the use of radio frequencies and slots by the many member nations of the ITU. 29/ Most important in this coordination process is the ITU Radio Communication Service (RCS) registration of radio frequencies and slots so that the users may know existing uses of radio frequencies and the slots currently used. With this knowledge, solar power satellite operators can begin to plan to avoid radio frequencies and slots in current use and look for openings. Furthermore, they can begin to negotiate with existing users to make adjustments in order to make room for solar power satellites.

Solar power satellites placed in orbit will be affected by the International Telecommunication Treaty which states that the geostationary orbit and radio frequencies are scarce resources which must be used efficiently and economically so that countries may have equitable access, taking the special needs of developing countries into account. 30/

Because ITU was established by international treaty, only governments can claim their rights in ITU under that treaty. Private SSPS operators have to ask their governments to act for them in ITU. Most government action is in the form of ITU conferences called World Administrative Radio Conferences (WARCs) which meet frequently to discuss current issues. The Department of State represents the United States in international negotiations; however, the State Department consults extensively with all potential users in presenting U.S. views in ITU. Other governments do likewise.

Decision-making in ITU would tend to be favorable to SSPS establishment, considering that all the countries of the world would be in need of electric energy. However, the SSPS operator would have to convince them that SSPS power is in their interest. Countries voting in ITU may tend to be more favorably disposed if they not only were to receive solar energy but if they or their citizens also were to have a share in the SSPS business. 31/

The U.S. Federal Communications Commission (FCC) 32/ regulates uses of radio frequencies in the United States under the Federal Communication Act. The FCC acts more in a regulatory than in a coordinating role and in this respect differs from ITU. However, the FCC's regulatory policy is consistent with U.S. international policy in ITU and with domestic policy favoring deregulation.

VI. Legal Liability

Liability would be a major consideration of the SSPS operators and users. SSPS Operators could be exposed to damage claims in many different ways. The 1972 Convention on International Liability for Damage caused by Space Objects would not govern most damage claims because that convention is interpreted to apply to actual collisions with other satellites, aircraft in flight or with the Earth's surface. 33/ It is unlikely that many damage claims would arise under the Convention, except for possible collisions with debris. However, it is possible that any international agreement regarding SSPS should fashion a liability regime for the particular damages that are likely to be caused by SSPS. 34/

A. Negligent Construction of Satellites

Negligent manufacture of a solar power satellite may cause it to fail with resultant damages. The manufacturer's liability depends on who the users are. If the user is a private company then the manufacturer may be held strictly liable for faulty products. 35/ If the U.S. government contracts for the manufacture of the solar power satellite then the manufacturer may come under the umbrella of governmental immunity. 36/ The manufacturer may be able to claim that not only were the Government's acts discretionary under the U.S. Federal Torts Claims Act, 37/ but the manufacturer's acts were discretionary because the manufacturer was a government contractor; if the solar power satellite were built to government specification it may be unfair to hold the manufacturer liable for the government's faulty design. This is an even better defense if the manufacturer warned the government of potential defective design, but the government insisted on manufacture in conformity with specifications. 38/

B. Negligent Operation of Satellites

Solar power satellites in orbit would be under control and direction of ground control. Liability of the ground controller depends on whether ground control is operated privately or by the government. If it is private then the ground controller could be liable for torts on a regular negligence theory. 39/ However, if the ground control is the U.S. Government then the government is entitled to governmental immunity unless the Federal Tort Claims Act permits liability. 40/ Under the FTCA the federal government may be held liable for negligent acts which are not discretionary, similar to air traffic control activities. However, the negligent acts must have happened in the United States. Negligence by the U.S. Government in other countries is not entitled to a waiver of Governmental immunity. 41/ Negligent transfer of power to the surface of the earth resulting in personal injury, for example to passengers on an airplane or on the earth's surface, would be governed by the same laws.

VII. Military Issues

Use of solar power systems in outer space for peaceful purposes is permitted. However, SSPS could be used in outer space for military purposes, in particular for military activities requiring very great concentration of electrical power. Use of SSPS for military uses in outer space is circumscribed by the 1967 Outer Space Treaty, as follows: 42/

States Parties to the Treaty undertake not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner. The Moon and other celestial bodies shall be used by all States Parties to the Treaty exclusively for peaceful purposes.

Consequently, use of SSPS for the use of weapons of mass destruction is not permitted. Furthermore, 1958 U.S. legislation established policy dedicating outer space activities to

peaceful uses for all mankind's benefit. 43/

VIII. 1979 Moon Treaty

This paper does not extensively discuss the 1979 Agreement Governing the Activities of States on the Moon and other Celestial Bodies, because that treaty has not been ratified by most spacefaring countries. 44/ The 1979 Moon Treaty, Article 8 (2), clarifies that states may land their space objects on the moon and may launch them from the moon. Article 11 provides that participating states have the right to use the moon, including its resources, (and other celestial bodies as well), but the moon may not become the property of states or individuals. The parties to the treaty agree to establish a future international regime on exploitation of the moon and its natural resources. However, this regime has not yet been negotiated, thus placing the treaty in limbo. Most spacefaring nations, including the United States, Russia, England, France and Germany, do not intend to ratify the treaty in its present form. Nevertheless the treaty is in force, having been ratified by the required number of states. The States Parties could use the treaty in its present form to regulate SSPS resources. They could also use it to object to uncoordinated outer space exploitation by non-member states. When will the unfinished business regarding international agreement to govern uses of the moon's resources be resolved? Perhaps this unfinished business will be influenced by decisions of nations on seabed resources, including the concept of common heritage of mankind in the seabed.

The 1979 Moon Treaty is a reminder that outer space resources are different from domestic resources because outer space resources are not in sovereign territory. These space resources are held in common by all the states in the world, but these resources may be used by individual states. The treaty illustrates that exploitation of outer space resources, including solar power collecting systems in space, require international coordination and cooperation for their very existence. It also illustrates the difficulty of arranging international agreement on use of outer space resources when virtually

all the States have to be in agreement on such a project

IX. Conclusion

This paper surveys a range of legal issues that need to be considered in planning a space solar power system. The survey contains a basic checklist, but is far from exhaustive. Its focus is on international legal issues because the solar power satellites will be placed in an international environment. It stresses that it is in the interest of an SSPS operator to seek extensive international coordination and cooperation regarding the project. Conflicts with other uses of space would limit the utility of the SSPS project and make it difficult to finance. Proper legal planning will smooth the way. 45/

FOOTNOTES

1. See Koelle, *An Experiment Program for Space Solar Power Development Compatible with Human Moon and Mars Development*, Peter Glaser lecture at the 50th International Astronautical Congress, Amsterdam, 1999. See Glaser, Davidson, Scigi, *Solar Power Satellites: A Space Energy System for Earth*, at 641 (Wiley, 1997). Note interview with Arthur C. Clark, in *New York Times* (Science Section), Oct. 26, 1999, at D4, that "the next decade is perhaps one of the most crucial in human history....There are so many things coming to a head simultaneously: The population. The environment. The energy crunch."
2. 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies, 18 UST 2410; 610 UNTS 205 (hereinafter the 1967 Outer Space Treaty). The 1967 Outer Space Treaty is so widely applicable that most of it, including the sovereignty principle, has become customary international law applicable everywhere, even to states that are not parties to the treaty.
3. 1992 Convention on the International Liability for Damage Caused by Space Objects, 23 UST 2389. 961 UNTS 187.
4. See discussion at Section VI *infra*.

5. 1975 Convention on Registration of Objects Launched into Outer Space, 28 UST 695; 1023 UNTS 15 (hereinafter referred to as the Registration Convention).

6. *Id.* Article II permits states to enter into further agreements on jurisdiction and control.

7. Convention on the International Telecommunication Union: Final Acts.

8. Commercial Space Launch Act, 49 USC 70101, *et seq.*

9. Galloway, in Glaser, Davidson, Scigi, *supra* n. 1, at 436.

10. Statute of the International Atomic Energy Agency, 1956, 8 UST 1093. Agreement Relating to the International Telecommunications Satellite Organization (INTELSAT), 23 UST 3813. Almost all states are members of these two treaty organizations. INTELSAT has established a successful international commercial enterprise using telecommunication satellites. INTELSAT consists of an assembly of states, a meeting of telecommunication operators, who provide capital based on their INTELSAT use, a board of governors; INTELSAT is headed by a secretary general. INTELSAT owns the space segment whereas telecommunications companies tend to own the ground facilities. For discussion of INTELSAT as a model for an international commercial SSPS enterprise, see Galloway, in Glaser, Davidson and Scigi, *supra* n. 1, at 431. Dr. Galloway also considers the International Atomic Energy Agency (IAEA) as a possible model stating that IAEA is an interesting model because its operating purpose includes the production of electrical energy. Furthermore, the IAEA is dedicated to peaceful purposes of energy. Dr. Galloway concludes that space solar power systems "can look to the International Atomic Energy Agency for ideas about the management of hazardous materials and situations, and to INTELSAT operations for successful patterns devised for other requirements for effective management." However, INTELSAT is changing. The U.S. Congress recently has pressed for privatization of INTELSAT thus indicating preference for one or more private operating enterprises such as IRIDIUM and ICO.

11. European Commission, Galileo, Involving Europe in a New Generation of Satellite Navigation Services, 9 February, 1999.

12. U.N. Principles Relating to Remote Sensing of the Earth from Outer Space, International Instruments of the United Nations, at 305.

13. ICAO Doc. C-CW/11026. Galloway, in Glaser, Davidson, and Scigi, *supra* n. 1, at 434, established the following policy guidance for SSPS institutional planning: (1) Space activities should be for peaceful purposes for the benefit of all mankind, (2) relations with the United Nations are essential even if an international space institution operates outside the UN structure; (3) conditions that might lead to military hostilities must be avoided; (4) international cooperation should be encouraged as the most effective method for achieving friendly relations among nations; (5) the environments of Earth, air, and outer space must not be endangered; (6) harmful interference with space activities is prohibited; (7) management must be based on equitable representation and sharing; and (8) benefits from space activities must be extended to less economically developed areas of the world.

14. *Supra* n. 8

15. *Id.*

16. Such launch would be subject to U.S. supervision under the 1967 Outer Space Treaty, *supra* n. 2. See discussion in Frankle and Steptoe, Legal Consideration Affecting Commercial Space Launches From International Territory, 42nd Coll. on the Law of Outer Space (1999).

17. *Id.*

18. *Id.* at Article VI. See discussion in Frankle and Steptoe, *supra* n. 16.

19. *Supra* n. 2.

20. See discussion in Section V below.

21. *Supra* n. 2.

22. *Supra* n. 5.

23. The Portable UCC, American Bar Association, 1992. See discussion, Larsen & Heilbock, UNIDROIT Project on Security Interests: How the Project Affects Space Objects, Vol. 64, *Journal of Air Law and Commerce*, No. 3 (1999).
24. White and Summers, *Uniform Commercial Code*, 797 (1972)
25. UCC *supra* n. 23, Sec 9-312(5).
26. *Supra* n. 23.
27. National Environmental Policy Act (NEPA), 42 U.S.C. 4321.
28. See excellent discussion in Purvis, *The long Arm of the Law: Extraterritorial Application of U.S. Environmental Legislation to Human Activity in Outer Space*. Vol. 6, *Georgetown Int. Env. Law Journal* 455, (1994). See Florida Coalition for Peace and Justice v. Bush, No. 89-2682-OG, 1990 U.S. Dist. LEXIS 13345, regarding sufficiency of Environmental Impact Statement for launch of the Galileo spacecraft. Prof. von der Dunk, in *Proceedings of the Project 2001 - Workshop on Legal Issues of Privatizing Space Activities*, 1999, Vienna, indicated the need for stronger international environmental controls for outer space activities.
29. *Supra* n. 7.
30. *Id.* ITU Constitution, Art 44. See Francis Lyall, discussion of the International Telecommunication Union in *Proceedings of the Workshop on Space Law in the Twenty-first Century*, at 71, UNISPACE III, July 1999.
31. *Id.*
32. Federal Communication Act, 47 U.S.C. 151 *et seq.*
33. 1972 Convention on the International Liability for Damage Caused by Space Objects, *supra* n. 3. See discussion, Spradling, *The International Liability Ramifications of the U.S. Navstar Global Positioning System*, vol. 33, *Colloquium on the Law of Outer Space* (1990).
34. Galloway, in Glaser, Davidson, Csigi, *supra* n. 1, at 436.
35. Boyle v. United Technologies Corp. 487 U.S. 500 (1988)
36. *Id.*
37. *Id.* Federal Torts Claims Act, 28 U.S.C. 2671 *et seq.*
38. Boyle, *supra* n. 35.
39. Prosser, *Law of Torts*, 146 (1964).
40. *Supra* n. 37.
41. Smith v. United States, 507 U.S. 193, held that Antarctica is a foreign country to which the FTCA does not apply. Outer Space would be analogous to Antarctica.
42. *Supra* n. 2, Article IV.
43. National Aeronautics and Space Act of 1958, 72 Stat. 42; see Galloway, in Glaser, Davidson, Scige *supra* n. 1, at 425.
44. 1979 Agreement Governing the Activities of States on the Moon and other Celestial Bodies, (1979 Moon Treaty) *International Instruments of the United Nations*, 299 (1997).
45. Dr. Galloway suggests a multidisciplinary planning group, including law, see Galloway in Glaser, Davidson, Scige, *supra* n. 1, at 438.