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Solar Energy and Space Law†

The ever-increasing demand for energy which has been brought about by the spread of industrialization and a host of new technological and scientific discoveries and innovations has necessitated a re-assessment of available energy supplies as well as a conscious effort to find new sources of energy, especially in view of the dwindling supplies of conventional sources of fuel.

One of the possible sources of energy to which attention has been directed in recent years is solar energy. Scientists estimate that the total amount of energy reaching the Earth's surface environment from solar, geothermal, and tidal sources is about 173,000 x 10^{12} watts and that solar radiation accounts for 99.98 percent of the total. The sun's contribution to the available energy supplies of the Earth is 5,000 times greater than the energy input of all other sources combined.[1]

The large-scale utilization of solar energy not only for purposes of direct heating and cooling of homes and offices but also for purposes of electric power production may well become a necessity should other sources of energy fail to cope with the increasing demand and should the relevant technical problems be overcome. Investigations and experimentations with different uses of solar energy have been going on for some time. To mention but one example, the Australian Post Office has recently been reported to use silicon solar cells in field trials for powering Post Office telecommunication equipment in remote areas.[2]

The purpose of this presentation is to shed some light on some of the legal implications of the utilization of solar energy not so much from the point of view of conventional law but from the point of view of the law applicable to outer space.

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[1]*See* Testimony of Dr. Peter E. Glaser, *Hearing Before the U.S. Senate Comm. on Aeronautical and Space Sciences*, 93d Cong., 1st Sess. (Pt. 2, 1973).

[2]42 TELECOMMUNICATIONS J. 459 (Aug. 1975).

It is probably commonplace to assert that the legal problems which arise especially in newly emerging areas of the law are closely related to and conditioned by technological developments and innovations in a given field.[3] The utilization of solar energy which provides light and also reaches millions of people by way of sunshine is certainly not new. Mankind has been the beneficiary of this since time immemorial. Legal questions have arisen in cases where people have been deprived of light or sunshine[4] or have been exposed to an excessive amount of glare from it in their homes by the erection of nearby structures,[5] where resort owners and farmers have blamed the activities of rainmakers in their area for rain[6] or no rain and associated weather conditions.[7]

If we speak about solar energy in the form of heat this has rather eluded legal regulations for control. As an intangible substance, heat has not been the subject of larceny neither at common law nor, in general, under state statutes. However, if heat is turned into electricity we would find its unlawful appropriation to be larceny under state statutes.

Today, in some areas of the world where climatic conditions permit, the heating and cooling of homes and offices could be accomplished probably without too much difficulty on a larger scale. The turning of solar energy into electric power presents much more of a problem under today's technology. Direct conversion by the use of silicon or photovoltaic cells is still far from being economically competitive with conventional fuel[8] and conversion by steam turbine generators is also difficult because of the large area required for the setting up of the heat collection facilities (estimated at about 37 square miles for a 10 gigawatt plant).[9]

Additional difficulties are created by the fact that such collecting units would have to be set up in areas where the sun's usable energy is the greatest and least subject to weather impediments as, for instance, on mountain tops and higher elevations or desert areas around the globe. Furthermore, most of the electric

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[3]For an analysis of such interrelationship with respect to the meaning of "peaceful" versus "military" uses of nuclear energy, see Gorove, *Distinguishing "Peaceful" from "Military" Uses of Atomic Energy: Some Facts and Considerations,* 30 OHIO ST. L.J. 495 at 497ff. (1969).

[4]In Case v. Minot, 158 Mass. 577, 33 N.E. 700 (1893) the court held the landlord liable to the tenant for wrongful restriction of light and air caused by a chimney built by another tenant under express permission received from the landlord.

[5]Excessive glare caused by the reflection of the sun's rays by a nearby aluminum tank on plaintiff's premises may constitute actionable nuisance. *See* McKinney v. City of High Point, 239 N.C. 232, 79 S.E.2d 730 (1954).

[6]Slutsky v. City of New York, 97 N.Y.S. 2d 238 (Super. Ct. N.Y. Cty., 1950).

[7]Southwest Weather Research Inc. v. Jones, 160 Tex. 104, 327 S.W.2d 417 (1959); Southwest Weather Research Inc. v. Duncan, 160 Tex. 104, 327 S.W.2d 417 (1959).

[8]The conversion ratio of solar energy into electrical power is between 11% and 16%. The maximum theoretical efficiency of a silicon solar cell is about 22%. *Supra* note 1 at 36.

[9]For details, see NASA/ASEE SYSTEMS DESIGN, FINAL REPORT ON TERRESTRIAL APPLICATION OF SOLAR TECHNOLOGY AND RESEARCH, Auburn University, 1973.

power plants are currently located far away from such areas and the establishment of such plants next to the receiving areas would increase production costs and make the utilization of solar energy under present technology even less competitive with conventional fuel. The setting up of power lines from such places to areas of large-scale consumption would also add to the cost element. Conceivably, microwave transmission, if perfected, might eventually reduce this cost.

It might become technologically feasible sometime in the future to set up appropriate units in outer space for the purposes of collecting the sun's energy and relaying it back to the Earth.[10] The advantages of such devices would include the avoidance of the day-night cycle and cloudy weather conditions with the result that solar energy would be available nearly 24 hours for every day use.[11]

A satellite solar power station (SSPS) could be placed into a synchronous orbit above the Earth's Equator so that its solar collectors would always face the sun, while its transmitting antenna would direct a microwave beam to a receiving antenna on Earth. The microwave beam would permit all-weather transmission making full use of the nearly 24-hour availability of solar energy.[12]

In all situations where solar energy is used in some manner in outer space, questions may arise with the respect to the applicability of the provisions of the Outer Space Treaty of 1967[13] as well as of other international treaties and agreements relating to man's activities in outer space.

One of the first questions which comes to mind in connection with the use of solar energy is the question of whether such energy can freely be used at all. This question may arise in situations where the solar energy is directly used in connection with man's activities in outer space such as for light or power generation within a spacecraft or on a celestial body or elsewhere in outer space and in situations where the solar energy would just be collected or converted in outer space and then redirected to earth for eventual use. In either case, the question arises whether or not there are any stipulations in the currently existing outer space agreements which would limit the utilization of solar energy.

Even a glance at the provisions of the Outer Space Treaty seems to indicate that they would be applicable to man's activities in outer space which relate to

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[10]The current funding for the satellite power systems program is used to investigate the economic, environmental and operational aspects of the space-based collection, conversion and relay of solar energy concepts. *See* US.SENATE COMM. ON AERONAUTICAL AND SPACE SCIENCES, HR.REP. 4700, 94th Cong. 1st Sess., 86 (1975).

[11]*Supra* note 1 at 36.

[12]*Id.* at 35-36.

[13]Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, Jan. 27, 1967 [1967] 3 U.S.T. 2410, T.I.A.S. No. 6347 (hereinafter referred to as Outer Space Treaty).

solar energy. The cardinal principle of freedom of exploration and use of outer space which is spelled out in Article I of the Outer Space Treaty[14] would certainly apply to such activities.[15] Also other stipulations, including those pertaining to international law,[16] the United Nations Charter,[17] restrictions on the military uses of outer space,[18] international responsibility of states,[19] would appear to be clearly applicable. On the other hand, the prohibition of national appropriation of outer space[20] would not apply to the spatial utilization of solar energy inasmuch as solar energy constitutes an inexhaustible source of energy and any prohibition of its use would be against reason and common sense.[21]

Of particular interest may be questions pertaining to loss of life, injury or damage caused by the utilization of solar energy and changes in the environment brought about by the utilization of such energy. With respect to the former, the Liability Convention of 1972[22] would be applicable to damages arising out of the utilization of solar energy insofar as such damages were occasioned directly by the use of such energy.[23] If, for instance, it ever became technically feasible to concentrate solar energy in certain cases of the Earth and thereby cause fires, scorch the Earth, or cause floods, such damage would seem to fall within the scope of the Liability Convention.[24]

With respect to environmental changes which may be brought about by the large-scale utilization of solar energy Article IX of the Outer Space Treaty would be applicable. It may be recalled that this article requires that the states refrain from introducing extraterrestrial matter which would bring about adverse changes in the environment of the Earth.[25]

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[14]Outer Space Treaty,Art. I, ¶¶ 1 and 2.

[15]*See* Gorove, *Freedom of Exploration and Use in the Outer Space Treaty: A Textual Analysis and Interpretation,* 1 DENVER J. INT'L L. AND POL. 93 at 99 (1971).

[16]*Id.* Arts. I (para. 2) and III.

[17]*Id.* Art. III.

[18]*Id.* Art. IV.

[19]*Id.* Art. VI.

[20]*Id.* Art. II.

[21]*See* Gorove, *Interpreting Article II of the Outer Space Treaty,* 37 FORDHAM L. REV. 349 at 350 (1969).

[22]*Cf.* Art. I of the Convention on International Liability for Damage Caused by Space Objects, done at Washington, London, and Moscow, March 29, 1972; entered into force for the United States October 9, 1973, T.I.A.S. No. 7762.

[23]Injury or damage caused by the utilization of some form of advanced energy (and also of solar energy) would appear to be covered by Article I(a) of the Liability Convention which defines damage as "loss of life, personal injury or other impairment of health" and "loss of or damage to property." *See* Gorove, *Some Comments on the Convention on International Liability for Damage Caused by Space Objects,* Proc. 16th Colloquium on the Law of Outer Space 253 at 255 (1973).

[24]An example of potential environmental change involved the idea of turning Arctic climates into temperate ones through the use of space mirrors by concentrating the sun's energy in certain areas of the world. *See* Gorove, *Pollution and Outer Space: A Legal Analysis and Appraisal,* 5 N.Y.U.J. INT'L L. AND POL. 3 at 57 (1972).

[25]For details, see *id.*

The foregoing brief review of some of the legal implications of solar energy under the current international legal rules applicable to outer space seems to indicate that the utilization of such energy must take place within the generally prescribed parameters of space law. However, if the technical problems associated with the production of competitive electric power from solar energy are resolved, international agreements may well be necessary to deal with whatever problems the allocation of cost and power will present at the time of then-existing technology.