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A PROPOSED SOLAR ZONING ORDINANCE†

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Sunlight travels through space unobstructed for 93,000,000 miles. Only during the last few hundred feet before it touches earth is it impeded by obstructions other than clouds, which cause shading. Since access to sunlight is critical to every solar energy system, the legal problems that may result from the obstruction of sunlight are great.[1]

The common law has long had the doctrine of ancient lights[2] to

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1. MILLER, THOMPSON, HAYES, MEEKER, DEAN, FRIEDRICH, TEPPER, SHAW & HEIMANN, LEGAL BARRIERS TO SOLAR HEATING AND COOLING OF BUILDINGS 1 (1977) (prepared, under contract, for the Energy Research and Development Administration by the Environmental Law Institute) [hereinafter cited as MILLER & THOMPSON] If the owner of land adjoining the collector constructs a building or plants a tall tree that shades the collector, no energy is captured. Even if no such obstruction currently exists, the possibility that it might arise in the future may deter investment in solar energy devices. Schiflett & Zuckerman, *Solar Heating and Cooling: State Municipal Legal Impediments and Incentives*, 18 NAT. RESOURCES J. 1 (1978).

2 The doctrine of ancient lights generally states that if a homeowner had light and air coming through a window for a period of twenty years his neighbor could not block that light and air. *See* Eisenstadt & Utton, *Solar Rights and Their Effect on*

protect access to natural light, but the doctrine has not survived in the United States, and in this country a property owner has no right of access to the sun.[3] This proposed solar zoning ordinance hopes to overcome legal problems that cloud the passage of solar energy across those final few feet of its journey and, thereby, allow the individual property owner to utilize this valuable resource.

While various solutions have been suggested for the solar access problem, existing common law approaches are of limited usefulness. For example, the common law of nuisance has been explored and found to be of marginal utility. Fundamentally, it is nearly impossible to define nuisance.[4] The plaintiff in a nuisance suit, to meet the burden of proof, must show irreparable damage and a greater hardship than would be caused by enjoining the defendant's activity—a standard the solar energy user probably could not satisfy.[5] Also, nuisance suits are generally limited to an award of damages, with injunctive relief available in only about half the jurisdictions.[6] While express easements offer another approach, there are a number of factors that limit their usefulness. For example, express easements are voluntary—courts cannot force their sale, they may be prohibitively expensive, enforcement may involve long, costly court proceedings, and neighbors are unlikely to go to the trouble and expense of drafting this type of legal document.[7]

Restrictive covenants have been suggested as a solution. Large-scale developments could be required to provide such agreements.[8] However, convenants have severe limitations since they offer little help to established neighborhoods, are inapplicable to much commercial and industrial land, and their enforcement involves hiring lawyers and enduring delays due to crowded court calendars.[9]

Solar Heating and Cooling, 16 NAT. RESOURCES J. 363 (1973) [hereinafter cited as *Solar Rights*]. *See also* Fontainebleu Hotel Corp. v. Forty-five Twenty-five, Inc., 114 So.2d 357 (Fla. 1959); 34 TUL. L. REV. 599 (1960).

3. *Solar Rights*, note 2 *supra*.

4. W. PROSSER, LAW OF TORTS, § 86, p. 571 (4th ed. 1971).

5. Miller, *Solar Energy and Land Use in Colorado: Legal, Institutional and Policy Perspectives*, 6 ELR 50039, 50049 (1976). *See also* Deeny & Zillman, *Legal Aspects of Solar Energy Development*, 1976 ARIZ. ST. U. L.J. 25, 39.

6. Becker, *The Common Law—an Obstacle to Solar Heating and Cooling?* 3 J. CONTEMP. L. 19 (1977).

7. MILLER & THOMPSON, note 1 *supra*.

8. P. Robbins, Building Codes, Land Use Controls, and Other Regulations to Encourage Solar Energy Use, at 9 (Oct. 2-5, 1976) (unpublished paper presented at the Consumer Conf. on Solar Energy Development, Albuquerque, N.M.).

9. MILLER & THOMPSON, *supra* note 1, at 16.

It has been suggested that water rights law provides a framework that could, by analogy, govern access to solar energy.[10] However, the analogy does not fit perfectly. Sunshine falls freely everywhere, like rainfall, but unlike water it is not confined to particular courses or drainage basins. Nonetheless, some useful concepts have been developed in water law, such as that of beneficial use, that are incorporated into this model zoning ordinance.

To avoid the various shortcomings of these legal concepts, the zoning mechanism provides an ideal approach to solar access that is also easy to administer. Zoning is a desirable and legally appropriate tool for creating solar rights. These rights must be created in such a way that they are acceptable to society, or else they may be rendered meaningless in a practical sense. Acceptability lies in minimizing any inconvenience to the neighbors of a solar collector owner, while at the same time guaranteeing the collector owner sufficient solar energy for his use.

Until now, "solar rights" is usually seen as simply the right to solar energy that would fall on one's property if the path of the sunshine were not impeded. This definition must be narrowed to gain greater social acceptability for the solar rights concept.

To gain acceptability for solar rights, the need of one party for solar energy must be balanced against any inconvenience to his neighbor.[11] This balancing is more effective when both parties act in a spirit of cooperation, and apply common sense to their mutual problem. Unfortunately, cooperation and common sense do not always characterize the relationships of the parties involved. Therefore, those limitations that should logically be imposed on solar rights should also be reflected in zoning regulations.

The first consideration has to do with the height at which the collector is located. It can be placed on the roof, on the ground, or anywhere in between. If a collector owner places his collector on the ground near his south property boundary and expects his neighbor not to shade the collector, he places an unreasonable burden on his neighbor since the collector owner could find another site on his property that could accommodate a collector but would cause less inconvenience. The right of the collector owner to sunshine should not be protected if the site selected for the collector is unreasonable.

10. White, *The Allocation of Sunlight: Solar Rights and the Prior Appropriation Doctrine*, 47 COLO. L. REV. 423 (1976).

11. *Solar Rights, supra* note 2, at 390.

The words "reasonable" and "unreasonable" often create problems when used in their legal sense. Thus, any restrictions placed upon solar rights in the name of reason must be stated specifically. This ordinance does that by using the concept of the "hypothetical wall," allowing the local governing body to determine the height of buildings and vegetation that an adjoining property owner may erect or grow.

A great revision of the legal system will soon be necessary to accommodate solar energy.[12] The most important elements in this reshaping of legal institutions must be simplicity in administration and a reasonable balancing of the interests of adjoining owners. This proposed ordinance is offered in the hope that it may contribute to accommodating solar access in a simple and reasonable manner.

HIGHLIGHTS OF PROPOSED ORDINANCE

The proposed ordinance that appears in the next section of this Article has several important features:

1) The ordinance explicitly defines a solar collector to include "passive" system, but requires that the collector be more than a mere "toy" since it must be capable of collecting at least 25,000 Btu on a clear winter solstice day. (Model Ordinance, section 2)

2) The ordinance draws on the experience of water law and uses the concept of "beneficial use." This is consistent with the theme of reasonableness, which underlies the philosophy of the entire ordinance. The ordinance protects solar collectors but does not grant an absolute "solar right." It attempts to strike a reasonable balance between the right of the adjacent owner to grow trees and vegetation and erect buildings, and the interest of the solar collector owner in having access to the sun. It does not protect a solar collector that is not beneficially used. (Model Ordinance, section 3)

3) A key element of the ordinance is its relatively simple approach. It provides that an adjacent owner can grow vegetation or erect a structure that shades his neighbor's property, but only to a limited extent. If the neighbor has a solar collector, the adjacent owner cannot grow vegetation or erect structures that cast a shadow greater than would a "hypothetical wall" located on the property line above a height determined by the local governing body. Thus, the neighbors themselves, and any governmental supervisor, can easily

12. C. Harr, Innovative Land Use Laws, 22 (1975) (proceedings of the Workshop on Solar Energy and the Law, Washington, D.C.).

determine whether a neighbor is in complicance simply by using a rod or stick of the appropriate height at the property line to ascertain where the allowable shadow would be cast.

Thus, no absolute solar right is given. An adjoining neighbor can cast shadows on his neighbor's property, but only to the reasonable limit established by the local governing body, which can be determined easily by an "eyeball" test. The ordinance allows the governing body to take into account how much energy is received at different times during the day so that, for example, if only five percent of the available solar energy was received in December prior to a certain hour in the morning, or after a certain hour in the afternoon, it may determine that it would be reasonable for a neighbor to shade the adjoining neighbor during those hours and therefore not protect the solar collector from shading during those hours.[13] (Model Ordinance, section 4)

4) The ordinance recognizes buildings or vegetation that cast shadows at the time of the effective date of the ordinance would be violative of the ordinance as nonconforming uses. (Model Ordinance, section 5)

5) The ordinance provides for the position of City Forester, thereby establishing a responsible individual for enforcing the ordinance with regard to violating vegetation. (Model Ordinance, section 6)

6) The ordinance provides for variances when the "literal application of the ordinance would result in unnecessary hardship." (Model Ordinance, section 8)

7) Exceptions are allowed where the zoning board considers that solar collectors are impractical, such as areas containing high-rise commercial buildings. (Model Ordinance, section 9)

8) The owner or possessor has the authority to sell or give his right of access to the sun to another, thus providing for transferability of rights.[14] (Model Ordinance, section 10)

13. The concept of defining a solar right in terms of the shadow cast by a hypothetical wall between certain hours of the day is part of the solar zoning ordinance adopted by the City of Los Alamos, New Mexico. LOS ALAMOS, N.M., ZONING ORDINANCE § V-c (1976).

14. Generally, a property owner cannot sell a property right that he has acquired by means of a zoning ordinance without selling the property. State legislation would be required to permit the transfer of a solar right given by a zoning ordinance. New Mexico has passed legislation permitting the transfer of a solar right. N.M. STAT. ANN. § 48-18-31 (Supp. 1977).

9) An Appendix gives technical data on shadow lengths and insolation according to the time of the day and the time of the year, and allow local governing bodies to make decisions as to the amount of permissible shading of a solar collector.

MODEL MUNICIPAL SOLAR ZONING ORDINANCE

IN PURSUANCE OF THE AUTHORITY CONFERRED BY [Chapter 300 of the Laws of New Mexico, 1965, and by Chapter 52 of the Laws of New Mexico, 1970, and by NEW MEX. CONST. art. VI, §26] FOR THE PURPOSE OF PROMOTING THE HEALTH, SAFETY AND GENERAL WELFARE OF THE INHABITANTS OF [municipality] BY CONSERVING SCARCE NATURAL RESOURCES AND ENCOURAGING THE UTILIZATION OF ALTERNATIVE ENERGY RESOURCES, [or substitute a more specific section of the state enabling act, if one is present].

Comment: All states have adopted enabling legislation that delegates some zoning power to municipalities. The ability to regulate property in pursuit of solar energy goals must be found within the existing enabling legislation or else the existing enabling legislation must be amended to provide for it. A general grant of police power by a state to its municipalities does not include the power to enact and enforce zoning ordinances.[15] Nor, probably, would the mere existence of a home-rule act authorize such power, unless specifically granted.[16]

Most of the state zoning enabling acts that authorize the power to enact and enforce zoning ordinances are slight variations on the Standard State Zoning Enabling Act promulgated by the United States Department of Commerce. If not patterned after the Standard Act, other enabling acts usually reflect the thinking behind the Standard Act.[17]

The Standard Act delineates the purposes for which zoning restrictions may be imposed. These are to:

> lessen congestion in the streets; to secure safety from fire, panic, and other dangers; to provide adequate light and air; to prevent the overcrowding of land; to avoid undue concentration of population; to facilitate the adequate provision of transportation, water, sewage, schools, parks, and other public requirements.[18]

15. R. ANDERSON, AMERICAN LAW OF ZONING, § 2.20 (2d ed. 1976).
16. *Id.*
17. DEPARTMENT OF COMMERCE, STANDARD STATE ZONING ENABLING ACT (1926); 4 R. ANDERSON, *supra* note 15, at § 30.01.
18. DEPARTMENT OF COMMERCE, STANDARD STATE ZONING ENABLING ACT § 3

Two possible purposes in the Standard Act, to provide adequate light and air;[19] and to promote the general welfare,[20] could justify zoning for solar energy objectives. Although adequate light and air is an accepted reason for zoning regulations, litigation dealing directly with adequate light and air is rare. Generally, the light and air requirement appears in a different context,[21] such as zoning regulations that specify maximum building heights,[22] setbacks,[23] and lot frontage.[24] Thus, litigation over light and air usually involves violation of height and setback requirements.[25] As stated by the court in *Taliafero v. Salyer*, "in the exercise of police power, a local government can impose restrictions on the maximum height of buildings for the purpose of securing adequate sunlight to promote public health in general."[26] While the leading twentieth century case on solar access, *Fontainebleu Hotel Corp. v. Forty-Five Twenty-Five, Inc.* did not protect sunshine falling on a swimming pool, the court commented that such protection could be provided under the zoning power.[27] Thus, at present, the validity of providing solar access by relying on the power to zone for adequate light and air is uncertain.

While further support for solar zoning may be found under the general welfare clause, this clause does not provide a statutory basis for imposing zoning restriction on everything having a tangential relationship to some public advantage.[28] On the other hand, some

(1926). New Mexico, for example, follows this language very closely, as do the zoning enabling acts of many states. N.M. STAT. ANN. § 14-20-3(14) (1968).

19. Many states specify that one of the purposes of zoning is to provide adequate light and air. *E.g.*, CONN. GEN. STAT. ANN. § 8-2 (1958); GA. CODE ANN. § 69-802 (1933); ILL. ANN. STAT. ch. 24, § 11-13-1 (Smith-Hurd 1961); MASS. GEN. LAWS ANN., ch. 40A, § 3 (1968); N.M. STAT. ANN. § 14-20-3(a)(4) (1968); N.Y. GEN. CITY LAW, art. 2A, § 20-24; TEXAS REV. CIV. STAT. art. 1011C (1963).

20. Since the zoning power falls under the police power, zoning enabling acts usually specify that zoning shall promote the general welfare. *E.g.*, COLO. REV. STAT. § 31-23-203 (Michie 1973); IDAHO CODE § 67-6502 (Supp. 1977); IND. CODE ANN. § 18-7-2-1 (Burns 1974); N.J. STAT. ANN. § 40:55-32 (West 1967); ORE. REV. STAT. § 215.055 (1975).

21. *Solar Rights, supra* note 2, at 385.

22. Ann. 8 A.L.R. 963 (1949).

23. Ann. 93 A.L.R. 2d 1223 (1964).

24. Ann. 96 A.L.R. 2d 1367 (1964).

25 *See, e.g.*, LaSalle Nat'l Bank v. City of Chicago, 5 Ill. 2d 344, 125 N.E.2d 609 (1955); City of Cleveland v. Young, 236 Miss. 632, 111 So.2d 29 (1959); San Lan Builders Inc. v. Baxendale, 28 N.J. 148, 145 A.2d 457 (1958).

26. Taliafero v. Salyer, 162 Cal. App. 2d 685, 328 P.2d 799, 802 (1958).

27. 114 So.2d 357, 360 (Fla. 1959). *See also* 34 TUL. L. REV. 599 (1960).

28. Dunham, *Flood Control via the Police Power*, 107 U. PA. L. REV. 1098, 1108 (1959).

courts have noted that, with the expanding scope of public action in this century, the interpretation of general welfare has necessarily expanded.[29] A determination that a certain purpose lies within the scope of the general welfare is necessarily made on a case-by-case basis. The decision depends on the magnitude of the public need and the sociological climate at the given time.[30]

One critical public need involves the growing energy crisis. Every American is conscious of it when the gas tank is filled or the power bill is paid. The purpose of solar zoning is to encourage the use of a non-depletable energy resource. Given this situation, solar zoning may fall within the general welfare provision.

It may be asked at this point whether it would not be better simply to amend the zoning enabling act to provide for solar energy zoning. Certainly, some litigation might be avoided. While one of the chief goals of the Standard Act is to develop a uniform interpretation among the states, conceptual changes must generally occur on a state-by-state basis. It is our opinion that changing the zoning enabling statutes to include solar access is probably the easiest way to ensure that municipalities can zone for solar access.[31]

IT IS HEREBY ORDAINED BY THE [governing body] OF THE [municipality], AS FOLLOWS:

SECTION 1. SHORT TITLE—THIS ORDINANCE MAY BE CITED AS THE "SOLAR ZONING ORDINANCE OF THE [municipality]."

SECTION 2. DEFINITIONS—AS USED IN THIS ORDINANCE:

A. "SOLAR COLLECTOR" MEANS ANY DEVICE OR COMBINATION OF DEVICES OR OTHER ELEMENTS WHICH RELIES UPON SUNSHINE AS AN ENERGY SOURCE AND IS CAPABLE OF COLLECTING NOT LESS THAN TWENTY-FIVE THOUSAND BTU's ON A CLEAR [Winter Solstice Day] FOR USE IN:
   (1) THE HEATING OR COOLING, OR BOTH, OF A BUILDING OR OTHER STRUCTURE;
   (2) THE HEATING OF WATER;
   (3) USE IN INDUSTRIAL, COMMERCIAL OR AGRICULTURAL PROCESSES; OR

29. N. WILLIAMS, JR., AMERICAN LAW OF PLANNING, § 13.03 (1974).

30. For a discussion of the considerations involved, see Mayor & Council of Wilmington v. Turk, 14 Del. Ch. 392, 129 A. 512 (1925).

31. The desirability of changing the zoning enabling acts is one example of the interplay between state and local law as it relates to solar access.

(4) THE GENERATION OF ELECTRICITY.

IN ADDITION TO SUCH USES, THE USE OF THE SOLAR COLLECTOR MAY ALSO SERVE OTHER USES, SUCH AS, BUT NOT LIMITED TO, SERVING AS PART OF A ROOF; OR SERVING AS A WINDOW OR WALL; OR OTHERWISE SERVING AS A STRUCTURAL MEMBER OF A BUILDING OR OTHER STRUCTURE.

Comment: This definition of a solar collector assures the community that only installations capable of delivering a reasonable amount of energy will be protected. Claims for collectors capable of collecting only small quantities of solar energy (solar toys) will not be protected under this Ordinance because the collector must be capable of collecting not less than 25,000 Btu[32] on some specified day. In an area where the major energy use is in cooling, it should be defined as the day on which the maximum cooling load occurs, according to data from the U.S. Weather Bureau. In areas where winter cold brings on maximum energy consumption, it is probably desirable to define it as the shortest day of the year. All of this is assuming, of course, a clear day.

The ordinance does not discriminate against simple devices, or hinder technical innovation. Passive systems are protected. A window on a southern exposure used to collect sunlight for heating purposes will qualify, provided that at least 25,000 Btu per day are collected.

B. "MOUNTAIN STANDARD TIME" MEANS TIME AT THE ONE HUNDRED FIFTH MERIDIAN WEST OF GREENWICH, ENGLAND, AND IN THE SEVENTH TIME ZONE BASED UPON IT IN NORTH AMERICA, EVEN THOUGH THE [municipality] MAY BE USING MOUNTAIN DAYLIGHT SAVINGS TIME OR ANY OTHER METHOD TO DETERMINE THE TIME OF DAY.

Comment: The description obviously will vary depending on the time zone in which the municipality is located.

32. 25,000 Btu per day is approximately the amount of heat needed to supply the daily hot water needs of two adults, assuming that each adult uses twenty gallons of 140-degree water per day. The American Society of Heating, Refrigerating and Air Conditioning Engineers recommends that the hot water requirement of an adult person is between fifteen and twenty gallons per day. A.S.H.R.A.E., HANDBOOK OF FUNDAMENTALS 507 (1972).

C. "OWNER OF REAL PROPERTY" IS A PERSON WHO HOLDS A FEE SIMPLE INTEREST IN REAL PROPERTY.

D. "POSSESSOR OF REAL PROPERTY" IS A PERSON HOLDING AN INTEREST IN REAL PROPERTY LESS THAN A FEE SIMPLE AND WHO IS ENTITLED TO TAKE IMMEDIATE POSSESSION OR HAS POSSESSION OF THE PROPERTY.

SECTION 3. BENEFICIAL USE

A. THIS ORDINANCE SHALL NOT PROTECT ANY SOLAR COLLECTOR WHICH IS NOT BENEFICIALLY USED.

B. BENEFICIAL USE MEANS THAT THE ENERGY COLLECTED BY THE SOLAR COLLECTOR IS ACTUALLY BEING USED FOR ONE OR MORE OF THE PURPOSES SET FORTH IN SECTION 2(A) OF THIS ORDINANCE OR HAS BEEN SO USED DURING THE PAST [24 months].

Comment: This section states that unused solar collectors are not protected. The term "beneficial use" comes from western water law,[33] and analogies between water law and sun rights have been proposed.[34] While some[35] feel that the analogy is inappropriate, certain water law concepts are useful.

There is no reason to protect collectors that are not being used. However, seasonal use constitutes beneficial use. For example, if solar collectors are only used seasonally, they must be protected during the season in which they are used, even though they are not used during the remainder of the year. This is accomplished by Subparagraph B, which requires that the collector have been unused for a period of time to be selected by the local government before it loses its protection.

SECTION 4. SHADING OF SOLAR COLLECTORS UNLAWFUL EXCEPT AS OTHERWISE PROVIDED BY THIS [Ordinance], IT IS UNLAWFUL FOR THE OWNER OR POSSESSOR

33. The term "beneficial use" is used by states that employ the doctrine of prior appropriation in their water law. This includes the arid western states. *See, e.g.*, NEV. REV. STAT. §§ 533.030-.035 (1973); N.M. CONST. art. vi, § 3; UTAH CODE ANN. §§ 73-1-3, 73-1-5 (1953).

34. White, *The Allocation of Sunlight, Solar Rights and the Prior Appropriation Doctrine*, 47 COLO. L. REV. 423 (1976).

35. MILLER & THOMPSON, *supra* note 1, at 26.

OF REAL PROPERTY TO ERECT A BUILDING OR OTHER STRUCTURE, OR TO ALLOW A TREE, SHRUB, OR OTHER FLORA TO CAST A SHADOW UPON A SOLAR COLLECTOR WHICH IS GREATER THAN THE SHADOW CAST BY A HYPOTHETICAL WALL [seven feet] HIGH LOCATED ALONG THE PROPERTY LINE, BETWEEN THE HOURS OF [8:00 a.m. and 4:00 p.m. during the period of the year from September 21 to March 21] OR [between the hours of 7:00 a.m. and 5:00 p.m. during the period of the year from March 22 to September 21]. ALL TIMES OF THE DAY USED IN THIS SECTION CORRESPOND TO [Mountain Standard Time].

Comment: This section defines the solar right, but is subject to modification by the other sections of the Ordinance. For example, it can be modified by a variance. It can also be modified if the owner of the collector is not making beneficial use of the solar energy. Note that it is the shading of a collector that is unlawful, *not* the shading of an area where a collector might be located. Thus, if there is no collector, there is no right to solar access.

The time of day that the solar right exists changes as the season changes. The longer summer days mean the solar right starts earlier in the morning and extends later in the afternoon. This may be particularly significant in areas where the greatest demand for solar energy is for solar powered air conditioning systems. If, however, the climate is such that solar systems are used for space heating and domestic hot water, lengthening the duration of the solar right during summer is inappropriate since the solar system will be used only to heat domestic hot water during that season.

At least one proposed solar zoning ordinance defines the solar right in terms of azimuth and altitude angles.[36] The scheme utilized in this section comes from the solar zoning ordinance presently in use by the City of Los Alamos, New Mexico.[37] It has the advantage of being simple to administer and enforce.[38] An enforcement official needs only a rod of the designated height, whose shadow he can ob-

36. MILLER & THOMPSON, *supra* note 1, at 55.

37. LOS ALAMOS, N.M. ZONING ORDINANCE § V-c (1976).

38. While the proposed method is simpler to administer, it is not without problems. Site inspections will still be required in many cases. For new construction, it may be necessary to ensure that any proposed construction meet the requirements of the Ordinance before a building permit is issued. It is probably possible to computerize the Ordinance requirements for an easy determination of whether the requirements are met before a building permit is issued.

serve, in order to determine whether or not an obstruction is in violation of the Ordinance. Transits or other angle measuring instruments are not required. In addition, the extent of the solar right is readily understandable to the neighbors.

Selection of the times of day during which the solar right exists, and the height of the hypothetical wall used in defining the solar right, present some problems. Obviously, the collector owner is denied some of the solar energy available at the beginning and end of the day, in order to reduce the inconvenience to his neighbor. This concept has been discussed and analyzed, and it was found that the amount of solar energy impinging on a solar collector shortly after sunrise and shortly before sunset was small compared to the inconvenience caused to neighbors.[39] Thus, the solar right should not extend from sunrise to sunset.

It will be the task of the local government to determine both the hours during which the solar right exists and the height of the hypothetical wall. In order to aid the local government in making this decision, a mathematical analysis was made of the amount of solar energy that a collector owner would lose for various times and heights that might be selected. The results of that analysis are given in the Appendix.

SECTION 5. PRIOR NONCONFORMING USES

A. OWNERS OR POSSESSORS OF REAL PROPERTY ON WHICH A BUILDING OR OTHER STRUCTURE EXISTED AT THE TIME THIS ORDINANCE BECAME EFFECTIVE [or on which trees, shrubs or other flora were growing at the time this Ordinance became effective] AND WHICH DID CAST A SHADOW DURING THE DESIGNATED HOURS GREATER THAN THAT ALLOWED BY SECTION 4, AT THE TIME OF THE INSTALLATION OF A SOLAR COLLECTOR, SHALL NOT BE SUBJECT TO THE PROVISIONS OF SECTION 4 EXCEPT FOR MEETING THE LIMITATIONS ON PRIOR NONCONFORMING USES AS SPECIFIED IN SUBSECTION B OF THIS SECTION.

B. A PRIOR NONCONFORMING USE [for a building or other structure] SHALL NOT BE EXCEPTED FROM THE PROVISIONS OF THIS ORDINANCE AFTER IT IS DESTROYED TO THE EXTENT THAT ITS FAIR MARKET

39. *Solar Rights, supra* note 2, at 402.

VALUE IS REDUCED BY AT LEAST [fifty per cent (50%)]. [A prior nonconforming use for flora shall not be excepted from the provisions of this Ordinance after it is certified by the City Forester to be dead. (The City Forester is defined in Section 5)]. THIS SUBSECTION SHALL NOT BE CONSTRUED TO LIMIT OTHER MEANS OF TERMINATING THE EXEMPTION FOR NONCONFORMING USES THAT HAVE BEEN OR MAY BE DEVELOPED THROUGH CASE LAW.

C. [Use if no prior nonconforming uses granted for flora.] THE OWNER OR USER OF THE SOLAR COLLECTOR SHALL BEAR THE COST OF INITIAL REMOVAL OF ALL UNLAWFUL FLORA. ALL REMOVAL OF FLORA SHALL BE DONE PURSUANT TO SECTION 6.

Comment: This Section provides for prior nonconforming uses and establishes their limits.

The Standard Act[40] does not have a provision for nonconforming uses. Nevertheless, almost all zoning ordinances make some provision to continue uses that lawfully preexist the adoption of a zoning ordinance.[41]

The original belief behind permitting nonconforming uses was that over time they would naturally abate. In practice, this has not been the case. Certain judicial doctrines have developed to speed abatement. For example, a nonconforming use cannot be expanded or changed.[42] Thus, a person operating a business which is a nonconforming use must move if he desires to expand. Most states have long recognized abandonment as terminating a nonconforming use.[43] Similarly, a nonconforming use can be terminated if it becomes a nuisance.[44]

40. DEPARTMENT OF COMMERCE, STANDARD STATE ZONING ENABLING ACT, (1926).

41. D. HAGMAN, URBAN PLANNING AND LAND DEVELOPMENT CONTROL LAW § 105 (1971).

42. *Id.* at § 81. *See* Holiday Management Co. v. City of Santa Fe, 83 N.M. 95, 488 P.2d 730 (1971).

43. City of Las Cruces v. Neff, 65 N.M. 414, 338 P.2d 731 (1959).

44. D. HAGMAN, *supra* note 41, at § 89. *See also Solar Rights, supra* note 2, at 392. Their discussion includes the concept of amortization of a nonconforming use, and indicates that the duration of the amortization of a nonconforming use may depend upon the value of a solar right. This will probably present difficulties for appraisers.

The decision to "grandfather" prior nonconforming uses for flora is optional. It could also be optional to "grandfather" any prior nonconforming uses. However, a zoning ordinance that operates to deprive an owner of land of the *entire* use value of his property is unconstitutional as being a deprivation of property without due process of law.[45] It should be noted, however, that a zoning ordinance is not unconstitutional simply because it denies to a landowner the highest and best use of his land or because it reduces the value of his land, provided the ordinance bears a reasonable relation to the public health, safety, morals or general welfare.[46]

Even in the absence of a grandfather clause, courts can declare the zoning ordinance unconstitutional as applied,[47] giving relief to the plaintiff landowner without undercutting the entire zoning scheme. Such a remedy is analogous to a variance and has a similar destructive potential if not sympathetically applied.

If the option is taken not to allow flora as a prior nonconforming use, one issue that arises is whether the cutting of trees or shrubbery would be a valid exercise of the police power, thus not requiring compensation to the tree owner, or whether it would be an exercise of eminent domain requiring compensation. In *Miller v. Schoene*,[48] the Supreme Court held that it was an exercise of the police power rather than eminent domain to cut diseased cedar trees in order to save an apple crop affected by the disease. Nevertheless, the state in this case paid to cut the trees. In a solar zoning scheme, it seems only fair for the owner of the solar collector to bear the initial cost of removal of violating flora since he will derive the benefits. Optional Subsection C covers this contingency.

SECTION 6. CITY FORESTER

A. THERE IS HEREBY ESTABLISHED THE OFFICE OF CITY FORESTER.[49]

45. R. ANDERSON, *supra* note 15, at § 3.26. *See* Pennsylvania Coal Co. v. Mahon, 260 U.S. 393 (1922); F. BOSSELMAN, D. CALLIES & J. BANTA, THE TAKING ISSUE (1973).

46. *See* Village of Euclid v. Ambler Realty Co., 272 U.S. 365 (1926); F. BOSSELMAN & D. CALLIES, THE QUIET REVOLUTION IN LAND USE CONTROL, (1971). For a discussion of the constitutional limits of the zoning power, as applied to solar zoning, see *Solar Rights, supra* note 2, at 379.

47. Nectow v. City of Cambridge, 277 U.S. 183 (1928).

48. 276 U.S. 272 (1928).

49. The title "City Forester" and his duties and authority are fashioned after the model zoning ordinance included in WILSON, JONES, MORTON & LYNCH, SANTA CLARA, CALIFORNIA, COMMUNITY CENTER COMMERCIAL SOLAR DEMONSTRATION,

B. THE CITY FORESTER SHALL HAVE THE AUTHORITY AND IT SHALL BE HIS DUTY TO TRIM OR REMOVE ANY FLORA, WHICH BY ITS LOCATION OR NATURE OF ITS GROWTH, IS IN VIOLATION OF THIS SOLAR ZONING ORDINANCE.

C. THE CITY FORESTER, UPON COMPLAINT FROM ANY OWNER OR USER OF A SOLAR COLLECTOR, SHALL DETERMINE WHETHER THE COMPLAINT IS A VIOLATION OF THIS SOLAR ZONING ORDINANCE. UPON CERTIFICATION OF THE CITY FORESTER THAT A VIOLATION OF THIS ORDINANCE EXISTS, THE CITY FORESTER SHALL CAUSE TO BE REMOVED THAT PORTION OF ANY FLORA IN VIOLATION OF THIS ORDINANCE, PURSUANT TO SUBSECTION D OF THIS SECTION.

D. (a) WHEN IT IS CERTIFIED THAT PURSUANT TO THIS ORDINANCE FLORA MUST BE REMOVED, THE CITY FORESTER SHALL SERVE A WRITTEN ORDER TO CORRECT THE INTERFERING CONDITION UPON THE OWNER OR POSSESSOR OF THE PROPERTY UPON WHICH THE INTERFERING CONDITION LIES.

(b) THE ORDER SHALL BE SERVED IN ONE OF THE FOLLOWING WAYS IN ORDER OF PREFERENCE:

(1) BY MAKING PERSONAL DELIVERY OF THE ORDER TO THE OWNER OR POSSESSOR OF THE PROPERTY;

(2) BY LEAVING THE ORDER WITH SOME PERSON OF SUITABLE AGE AND DISCRETION UPON THE PREMISES;

(3) BY AFFIXING A COPY OF THE ORDER TO THE DOOR AT THE ENTRANCE OF THE PREMISES IN VIOLATION;

(4) BY MAILING A COPY OF THE ORDER TO THE LAST KNOWN ADDRESS OF THE OWN-

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LEGAL ALTERNATIVES, IMPLICATIONS AND FINANCING OF SOLAR HEATING AND COOLING BY A MUNICIPAL CORPORATION (1976). Whether a municipality would assign enforcement of this ordinance to a new enforcement official or would add this to the existing enforcement duties of its personnel would be a decision for the municipality.

ER OF THE PREMISES, BY CERTIFIED MAIL WITH RETURN RECEIPT;

(5) BY PUBLISHING A COPY OF THE ORDER IN A LOCAL NEWSPAPER OF GENERAL CIRCULATION ONCE A WEEK FOR THREE SUCCESSIVE WEEKS.

(c) THE ORDER REQUIRED HEREIN SHALL SET FORTH A TIME LIMIT FOR COMPLIANCE, DEPENDENT UPON THE NATURE AND DEGREE OF INTERFERENCE CREATED BY THE VIOLATION.

(d) A PERSON TO WHOM AN ORDER HEREUNDER IS DIRECTED SHALL HAVE THE RIGHT, WITHIN ONE WEEK FROM THE SERVICE OF SUCH ORDER, TO APPEAL TO THE [zoning authority], WHO SHALL REVIEW SUCH ORDER AND FILE ITS DECISION THEREON WITHIN [30 days]. UNLESS THE ORDER IS REVOKED OR MODIFIED IT SHALL REMAIN IN FULL FORCE AND EFFECT AND BE OBEYED BY THE PERSON TO WHOM DIRECTED. NO PERSON TO WHOM AN ORDER IS DIRECTED SHALL FAIL TO COMPLY WITH SUCH ORDER WITHIN THE TIME PERIOD SPECIFIED IN THE ORDER.[50]

E. THE OWNER OF FLORA WHICH IS FOUND TO BE IN VIOLATION OF THIS ORDINANCE AT THE TIME THAT A COLLECTOR IS FIRST USED BENEFICIALLY SHALL HAVE THE INITIAL OPPORTUNITY TO REMOVE THE VIOLATING FLORA. IN THE EVENT THAT THE OWNER OF THE VIOLATING FLORA FAILS TO REMEDY THAT CONDITION WITHIN [30 days], THE CITY FORESTER SHALL CAUSE THE CONDITION TO BE REMEDIED. THE CITY FORESTER SHALL THEN SUBMIT A BILL TO THE COLLECTOR OWNER FOR THE COST OF REMEDYING THE CON-

50. The appeal can be either to an administrative authority or to a judicial authority. If the first appeal is to an administrative authority, the right to judicial appeal exists. Whether the initial appeal should be administrative or judicial is a local decision that will depend upon the relative work loads of the zoning authority and the judicial authority.

DITION, AND THE BILL SHALL BE PAID BY THE COLLECTOR OWNER WITHIN [30 days].

F. WITH THE EXCEPTION OF THE SITUATION DESCRIBED IN SUBPARAGRAPH E OF THIS SECTION, IT SHALL BE THE RESPONSIBILITY OF THE OWNER OF REAL PROPERTY, OR THE POSSESSOR OF REAL PROPERTY IF THE OWNER IS NOT IN POSSESSION, TO MAINTAIN ALL FLORA IN SUCH A CONDITION THAT THE FLORA DOES NOT VIOLATE THIS ORDINANCE. THIS RESPONSIBILITY EXTENDS TO FLORA WHICH HAS BEEN REMOVED OR TRIMMED UNDER THE CONDITIONS SPECIFIED IN SUBPARAGRAPH E OF THIS SECTION.

(1) WHEN AN OWNER OF REAL PROPERTY OR POSSESSOR OF REAL PROPERTY, UPON WHOM AN ORDER TO CORRECT AN INTERFERING CONDITION HAS BEEN SERVED IN ACCORDANCE WITH SUBPARAGRAPH D OF THIS SECTION, SHALL FAIL TO COMPLY WITHIN THE SPECIFIED TIME, THE CITY FORESTER SHALL REMEDY THE CONDITION AND SEND A BILL FOR THE COST THEREOF TO THE PERSON TO WHOM THE ORDER IS DIRECTED. THAT PERSON SHALL PAY THE BILL.

Comment: This Section specifies the procedure for enforcing the Ordinance in the case of violating flora. A responsible individual is named, his authority is defined, and the appeal procedure established.

Subparagraphs E and F are applicable only if the Ordinance does not grant a prior non-conforming use to flora in existence at the time the solar collector was installed.

There are at least two reasons for requiring that the solar collector owner pay for removing flora in violation of the Ordinance. First, basic fairness indicates that the person who derives the benefit should bear the cost. Second, if the collector owner must bear the cost of removing flora that violates the Ordinance when his collector is first installed, he will be inclined to select a collector site that is not shaded. This is consistent with the requirement of reasonableness,[51]

51. The requirement of reasonableness, in its simplest terms, merely states that neighbors should accommodate each other in matters of solar rights. *Solar Rights, supra* note 2, at 390.

and does not burden administrators or courts with determining what is reasonable.

After the violating flora has been removed initially, maintaining the flora in a condition that does not violate the Ordinance is part of the normal yard maintenance that a homeowner performs. It is therefore logical to place this burden on the owner or user of the flora, eliminating the need for the City Forester to periodically trim such flora and charge the cost of trimming to the collector owner.

G. IT SHALL BE THE RESPONSIBILITY OF THE OWNER OF REAL PROPERTY, OR THE POSSESSOR OF REAL PROPERTY IF THE OWNER IS NOT IN POSSESSION, TO MAINTAIN ALL FLORA IN SUCH A CONDITION THAT SAID FLORA DOES NOT VIOLATE THIS ORDINANCE.

(1) WHEN AN OWNER OF REAL PROPERTY OR POSSESSOR OF REAL PROPERTY, UPON WHOM AN ORDER TO CORRECT AN INTERFERING CONDITION HAS BEEN SERVED IN ACCORDANCE WITH SUBPARAGRAPH D OF THIS SECTION, SHALL FAIL TO COMPLY WITHIN THE SPECIFIED TIME, THE CITY FORESTER SHALL REMEDY THE CONDITION AND SEND A BILL FOR THE COST THEREOF TO THE PERSON TO WHOM THE ORDER IS DIRECTED. THAT PERSON SHALL PAY THE BILL.

Comment: This Section covers the case in which flora in existence at the time the collector is installed is "grandfathered." The language here corresponds to Subparagraph F, and Subparagraph E would be deleted.

SECTION 7. PENALTIES

A. NO PERSON SHALL BE PENALIZED FOR VIOLATING THE PROVISIONS OF THIS ORDINANCE UNTIL HE HAS BEEN INFORMED OF SUCH A VIOLATION IN ACCORDANCE WITH SUBPARAGRAPH D OF SECTION 6 OF THIS ORDINANCE. AFTER BEING SO INFORMED, VIOLATION OF THE PROVISIONS OF THIS ORDINANCE SHALL BE PUNISHED BY A MAXIMUM FINE OF [$300], OR BY IMPRISONMENT FOR A MAXIMUM OF [90 days], OR BOTH. EACH DAY THE VIOLATION PERSISTS SHALL BE CONSIDERED A

SEPARATE VIOLATION SUBJECT TO AN ADDITIONAL PENALTY.

B. IN ADDITION TO ANY ACTION TAKEN UNDER SUBSECTION A OF THIS SECTION, THE [zoning authority or governing body] MAY ENFORCE THIS ORDINANCE IN ANY MANNER PROVIDED BY LAW, INCLUDING INJUNCTIVE RELIEF.

C. NOTHING IN THIS SECTION SHALL BE CONSTRUED TO PROHIBIT A PRIVATE PARTY FROM PURSUING OTHER REMEDIES IN LAW OR EQUITY.

Comment: The laws of many states permit the enforcement of zoning ordinances in the same way as other municipal ordinances are enforced.[52] Thus, violations of a zoning ordinance can be redressed by either civil or criminal means. Typically, however, criminal sanctions play a small role in zoning enforcement.

Zoning administration is generally aimed at prevention rather than punishment. While prevention is accomplished through requirements for building or other permits, such preventive procedures will be peculiarly ineffective with solar zoning. Whereas a zoning administrator can look at proposed building plans and determine if they conform to zoning ordinances, only an on-site inspection will reveal which solar collectors need to be protected.

Additionally, criminal sanctions for violation of a solar zoning ordinance present unique problems. Typically, with any other zoning ordinance, the violator has reason to be put on notice that what he is about to do may involve an infraction of the zoning laws. For example, the reasonable person about to construct a new building or an addition thereto or open a particular business will generally inquire whether any zoning ordinance is of concern. At a minimum, the violator is *doing something* that constitutes a violation. This zoning ordinance creates a violation when a person's trees grow to a height that shades his neighbor's collector. There may be constitutional problems

52. For example, N.M. STAT. ANN. § 14-20-8(A) (1953) authorizes the enforcement of any zoning ordinance in the same manner as any other municipal ordinance. N.M. STAT. ANN. § 14-16-1(C) provides for fines not to exceed $300, or imprisonment not to exceed 90 days, or both, for violation of municipal ordinances. Section 14-20-8(B) also gives municipalities power to enforce zoning ordinances by instituting any appropriate action or proceedings to (1) prevent any unlawful erection, construction, reconstruction, alteration, repair, conversion, maintenance or use; (2) restrain, correct or abate the violation; (3) prevent the occupancy of such building, structure or land; or (4) prevent any illegal act, conduct, business or use in or about the premises. *Id.* § 14-20-8(B).

with such a sanction.[53] For this reason, Subparagraph A requires that the offender be put on notice before he is subject to any sanctions.

There may also be a problem with purporting to make each day a separate violation. Some courts have held that an enabling act authorizing some maximum amount which municipalities can fine imposes an absolute maximum on a "single violation," no matter how long continued.[54]

If this Ordinance is included as part of a comprehensive zoning scheme, a separate penalty section may not be needed.

SECTION 8. VARIANCES

ANY PERSON DESIRING TO ERECT ANY STRUCTURE, OR INCREASE THE HEIGHT OF ANY STRUCTURE, OR PERMIT THE GROWTH OF ANY TREE OR OTHER FLORA, OR OTHERWISE USE HIS PROPERTY, NOT IN ACCORDANCE WITH THIS ORDINANCE, MAY APPLY FOR A VARIANCE. A VARIANCE SHALL BE ALLOWED IN ALL CASES WHERE LITERAL APPLICATION OR ENFORCEMENT OF THIS ORDINANCE WOULD RESULT IN UNNECESSARY HARDSHIP.

Comment: This Section sets forth a type of relief from the potential oppressiveness of the zoning ordinance. There are basically two avenues of relief from zoning ordinances: (1) legislative, *i.e.*, a change in the text of the ordinance or an amendment to the zoning map; and (2) administrative, *i.e.*, a variance or special use permit granted by the zoning board of adjustment, or analogous administrative authority.

There is probably little need for such a special provision. Section 7 of the Standard Act[55] provides for a board of adjustment which:

> may, in appropriate cases and subject to appropriate conditions and safeguards, make special exceptions to the terms of the ordinance in harmony with its general purpose and intent and in accordance with general or specific rules therein contained.

Under the Standard Act, the board of adjustment can grant three types of relief: (1) in Subsection 1 it is given authority to reverse or modify the decision of an administrative officer; (2) in Subsection 2 it may grant a special exception, frequently referred to in other enabling acts as a conditional or special use permit; and (3) in Subsection 3 it may grant a variance.

53. *E.g.*, Robinson v. California, 370 U.S. 660 (1962).

54. *E.g.*, Mill Neck v. Fronsdal, 39 App. Div. 2d 549, 332 N.Y.S.2d 53 (1972).

55. DEPARTMENT OF COMMERCE, STANDARD STATE ZONING ENABLING ACT, (1926). *See, e.g.*, N.M. STAT. ANN. § 14-20-6(C) (1953).

A variance is fundamentally different from a special exception. A special exception is a permitted use if the requisite conditions are met (see comment under Section 9 of this solar zoning ordinance). A variance, on the other hand, is a use permitted only by sufferance and certain conditions must exist before it is granted. The enabling legislation (Section 7 of the Standard Act) specifies some of the criteria. The variance must "not be contrary to the public interest," and literal application of the ordinance must "result in unnecessary hardship" such that "substantial injustice" will be done and the "spirit of the ordinance" shall be observed. Case law has added to the requirements. A survey of the case law in the seven states in which over fifty per cent of the variance cases arise, found the following criteria generally required, although there were considerable differences between states.[56]

1. In most states there is a presumption against granting of variances, *i.e.*, they should be granted only in very clear-cut cases.
2. A case is suitable for a variance only when the hardship arises from the circumstances unique to the particular plot rather than general to the neighborhood.
3. If, as a result of the zoning regulations, it is impossible to develop a lot for conforming use, then a variance is appropriate. However, if a conforming use could be reasonably developed a variance is inappropriate and should be denied by the board or (if granted) overruled by the courts. More specificially, the test is whether a developer can expect a reasonable return from a conforming use, or alternatively make some reasonable use of his land.
4. Assuming that a reasonable return is guaranteed, there is no right to obtain a variance in order to get a higher rate of return. If a developer presses his case on this point, the board should reject the request for a variance; if the board grants one, the neighbors can have it declared invalid.
5. The negative criterion—the proposed use should not be harmful to the surrounding area.
6. If hardship is self-created, this cannot serve as a foundation for a valid variance. The cases have split on whether purchasing the lot with knowledge of the zoning regulations would result in self-created hardship.
7. Often, practical difficulty is a separate concept from unnecessary hardship. In one group of states, particularly New

56. R. ANDERSON, *supra* note 15, at § 131.01.

> York, practical difficulty is a less stringent concept, and is sufficient alone to justify an area variance—while unnecessary hardship is the appropriate criterion for a use variance.

The criteria for obtaining a variance should be rigorous. In fact, the variance is probably more often misused than any other type of administrative relief.[57]

The application of existing variance law to solar zoning should not present any particularly unique problems.

SECTION 9. EXCEPTIONS

THE [zoning board] SHALL, FROM TIME TO TIME, SPECIFY WHICH AREAS OF [the municipality], IF ANY, ARE TO BE EXCEPTED FROM THE OPERATION OF THIS ORDINANCE. AN EXCEPTION SHALL BE BASED ON THE EXISTENCE OF HIGH RISE COMMERCIAL BUILDINGS IN A CONCENTRATED AREA SUCH THAT IT APPEARS TO THE [zoning board], PURSUANT TO EXPERT ADVICE, THAT SOLAR COLLECTORS ARE UNFEASIBLE OR IMPRACTICAL IN THE EXCEPTED AREA FOR THE NEAR FUTURE. AFTER SUCH SPECIFICATION IS MADE, IT SHALL BE PRESENTED TO [the governing body] FOR RATIFICATION OR FURTHER INSTRUCTIONS.

Comment: Section 7 of the Standard Act, as noted above, authorizes the board of adjustment to make special exceptions to the zoning ordinance. Under this type of authority, the board of adjustment can only make special exceptions in conformity with the requirements of a given ordinance. Thus, this section is vital to a solar zoning ordinance because it sets forth criteria that the board of adjustment must apply in granting special exceptions.

The principal requirement of such an ordinance is that there be sufficient standards to guide administrative discretion. The above section should provide sufficient criteria. The underlying assumptions are basically engineering in nature rather than legal.

SECTION 10. GIFT OR SALE OF SOLAR RIGHTS

ANY PROPERTY OWNER OR POSSESSOR MAY GIVE OR SELL HIS RIGHT TO ACCESS TO SUNLIGHT PROTECTED BY THIS ORDINANCE. A POSSESSOR OF REAL PROPERTY MAY ONLY GIVE OR SELL HIS RIGHT TO SUNLIGHT FOR THE DURATION OF HIS POSSESSORY ESTATE. A PROPERTY OWNER MAY GIVE OR SELL HIS RIGHT TO SUN-

57. D. HAGMAN, *supra* note 41, at 6.

LIGHT PERMANENTLY OR FOR ANY LESSER TIME. SUCH A GIFT OR SALE, WHETHER BY OWNER OR POSSESSOR, SHALL BE RECORDED WITH THE [city clerk].

Comment: A recent New Mexico law[58] permits the transfer of solar rights. A state statute is required to accomplish this. Transferability introduces a flexibility that cannot be readily obtained otherwise. If a person wishes to erect a building that shades his neighbor's collector, he can purchase the neighbor's solar right.

58. N.M. STAT. ANN. § 48-18-31 (1977).

APPENDIX

The information presented in this Appendix is intended as an aid for those zoning officials in determining during which times of the day a solar right should exist, and how high an obstruction should be permitted for purposes of Section 4 of the Ordinance. Much of the information is presented in graph form. The general principle used throughout the graphs, with the exception of Figure 1, was to illustrate what percentage of the total available solar energy would be lost to a collector owner when any particular hours of the day were selected for defining the solar right. Some communities may desire to give the maximum benefit to the solar collector owner, while others may tend to favor the neighbor who is being inconvenienced.

The data from which the curves were plotted came from a computer program written as part of this project. One of the factors that influences the exact shape of the graphs is the latitude of the collector. For this project, calculations were made for three latitudes, but including data for all three latitudes here would only further complicate an already complicated presentation; therefore only the data for thirty-five degrees North latitude is presented here.[59]

A number of different types of solar collectors are treated in this study. These are passive systems, flat plate collectors, sun-tracking collectors, and concentrating collectors that do not track the sun.

Section 4 of the Ordinance defines the solar right in terms of the shadow cast by a hypothetical wall along the property boundary. The height of the wall is to be determined by the officials adopting the zoning ordinance. Figure 1 will aid in deciding what the height of the hypothetical wall should be.[60] This diagram shows the length of the shadow cast *north* by an object one foot high. For a solar right to be effective, it must protect the region to the south of the collector from obstructions. Assume that an obstruction is located on the south property boundary of a collector owner. If the obstacle is to shade the collector, that shading will come from a shadow cast to the north by the obstacle.

59. Information concerning other latitudes may be obtained from the authors.

60. Those communities favoring the collector owner will use a low wall height, while those tending to favor the collector owner's neighbor will use a high wall (or obstruction) height. It should be noted that these heights apply to flora as well as walls.

Shadow lengths for three different days of the year are given in the figures. These days are June 21 (the summer solstice), March 21 (the spring equinox), and December 21 (the winter solstice). The curve for the autumn equinox, which occurs on September 21, is the same as the curve for March 21. The shape of the curves can be readily explained. On December 21, the sun rises in the southeast. As soon as the sun appears above the horizon, an obstruction begins to cast a very long shadow to the northwest. The curve in Figure 1 shows how far *north* that shadow extends. As the day goes on and the sun rises higher, the shadow length decreases, therefore the length of the shadow cast to the north also decreases. Note that we only indicate how far north the shadow goes, not the total length of the shadow. On March 21, the sun rises due east. Thus, the shadow cast by an object at sunrise is due west of the object, and the shadow does not go in a northerly direction at all. Thus, at sunup on March 21, the shadow length to the north is zero. As the sun climbs higher in the sky, it moves to the south and west. As the sun moves southerly, an object will cast a shadow northward. The curve for June 21 is confusing unless one remembers that the sun rises in the northeast in the summer. A shadow cast by an object on a summer morning will lie towards the southwest, and therefore there is no shadow to the north. The curve shows that, at about 8:30 a.m., the sun begins to move to the south of the object and the resulting shadow is cast to the north.

Figure 1 gives data only from sunrise until noon. The part of the curves from noon to sunset are the same as the curves from sunup to noon, that is, the curves for the afternoon are mirror images of the morning curves. For example, the length of the shadow cast north at 4:00 p.m. on March 21 is exactly the same as the length of the shadow cast north at 8:00 a.m. on the same day.

If one wishes to use Figure 1 to determine the length of a shadow cast by an eight foot wall, find the shadow cast by a one foot wall and multiply that length by eight. Simply follow the same procedure for any height desired.

The manner in which the shadow length affects solar rights is worthy of some discussion. The first thing shadow length tells is how far from the southern lot line a collector must be in order not to be shaded *if it is placed at ground level.* Active collectors are not generally placed on the ground, but are usually located on rooftops. If a collector is located ten feet above the ground, a ten foot obstacle will not shade it at all even if the obstacle is located next to the collector. As an example, Figure 1 shows that a one foot high obstacle will cast

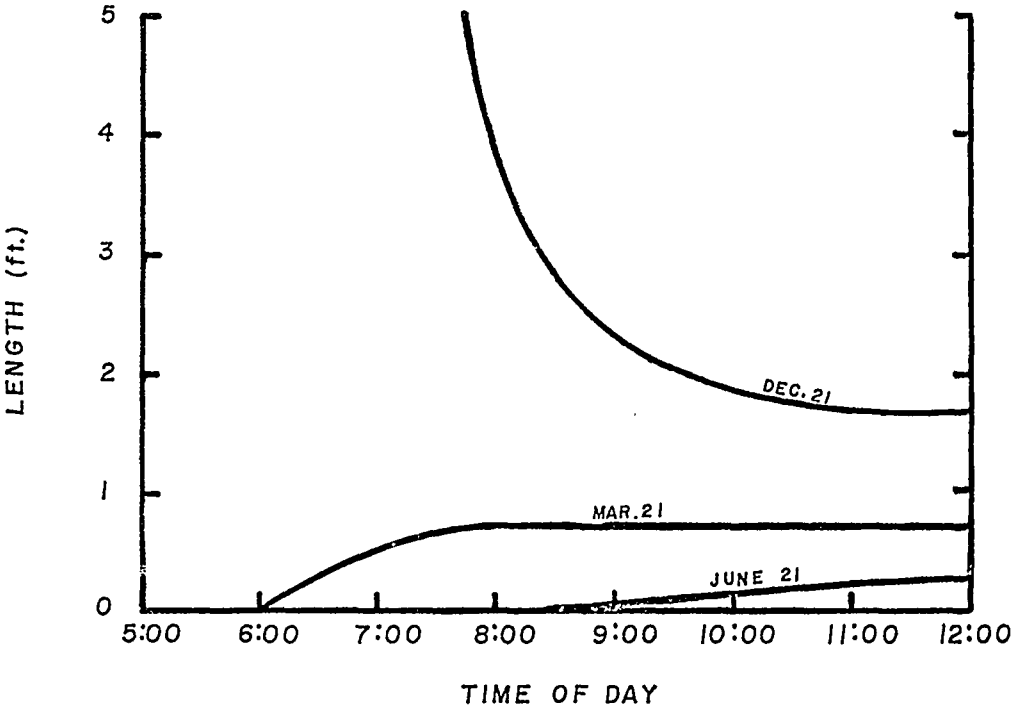

FIGURE 1. *Length of a shadow cast north of a one foot high object, at 35° N. Lat.*

a north shadow two feet long on December 21 at 9:30 a.m. (or 2:30 p.m.). A fifteen foot obstacle would thus cast a shadow thirty feet long on the ground. If a house were located twenty-five feet from the southern lot line, the shadow would cover the twenty-five foot area between the house and the lot line, and would then extend two and a half feet up the south wall of the house. To arrive at this number, the shadow cast by twelve and a half feet of wall will be used to shade twenty-five feet of the ground. The remaining two and a half feet of the wall will shade two and a half feet of the south facing house wall. The two and a half foot shadow on the house wall would have no effect on solar collectors for an active system placed on the roof. If, however, the south wall of the house was part of a passive system, the lower two and a half feet of that passive collector would be shaded. Thus, from the point of view of the height of the hypothetical wall in Section 4 of the Ordinance, passive systems cause a more difficult situation than do active systems utilizing rooftop collectors. The

problem can be readily resolved by simply not protecting passive systems. While this might ease the decisionmaking chore, not protecting passive solar systems would be a serious mistake. Passive solar is generally more cost effective than active solar, and cost effectiveness is the name of the game in solar energy.[61] Solar energy's most difficult competitor presently is fossil fuel, and the better cost effective solar systems will compete soonest with fossil fuels. Thus, not protecting passive systems will delay attainment of cost competitive solar energy. Unfortunately, passive systems complicate the job of zoning officials concerned with solar zoning.

Perhaps the easiest way to estimate the height of the hypothetical wall would be to consider the setback requirements presently specified in existing zoning ordinances. From these, one can determine how high an obstacle can be before its shadow reaches a building at a specific time of the day on a particular day of the year. If passive systems are considered, as they must be, such systems would be used for heating only and not for cooling. For such a case, the shadow length should be determined for December 21 and the Ordinance written in terms of those results. Local officials may decide that the lower two or three feet of a south facing passive system should not be protected, but that the higher glass area warrants protection. The height of the hypothetical wall could then be determined from a combination of the setback requirements and the part of the south-facing wall that is not to be protected.

The remaining graphs presented in this Appendix all relate to choosing the times of the day during which a solar right is effective. No distinction is made as to whether the collectors are roof mounted, ground mounted, or passive. Those considerations affect only the permissible shadow lengths.

The amount of solar insolation (solar energy) available to a horizontal surface is shown in Figure 2. This graph will be discussed in some detail, since all of the remaining graphs are somewhat similar. The graph shows how the available solar energy varies with the time of day. As in the case of the previous curves, data is only given until noon since the curves for the afternoon are the same as those for the morning (they are symmetric about noon). The same three days are plotted here as were plotted in the previous figure. The total amount of solar energy available to one square foot of a horizontal surface is

61. Ben-David, Schultze, Balcomb, Katson, Noll, Roach & Thayer, *Near Term Prospects for Solar Energy: An Economic Analysis*, 17 NAT. RESOURCES J. 169 (1977).

given. For example, on June 21 the total solar radiation striking one square foot of horizontal area is shown as 2,853 Btu per day. This is *not* the amount of energy collected by a square foot of collector since a solar collector does not collect all of the available solar energy. For our purposes, however, we need not be concerned with the effect of collector efficiency.

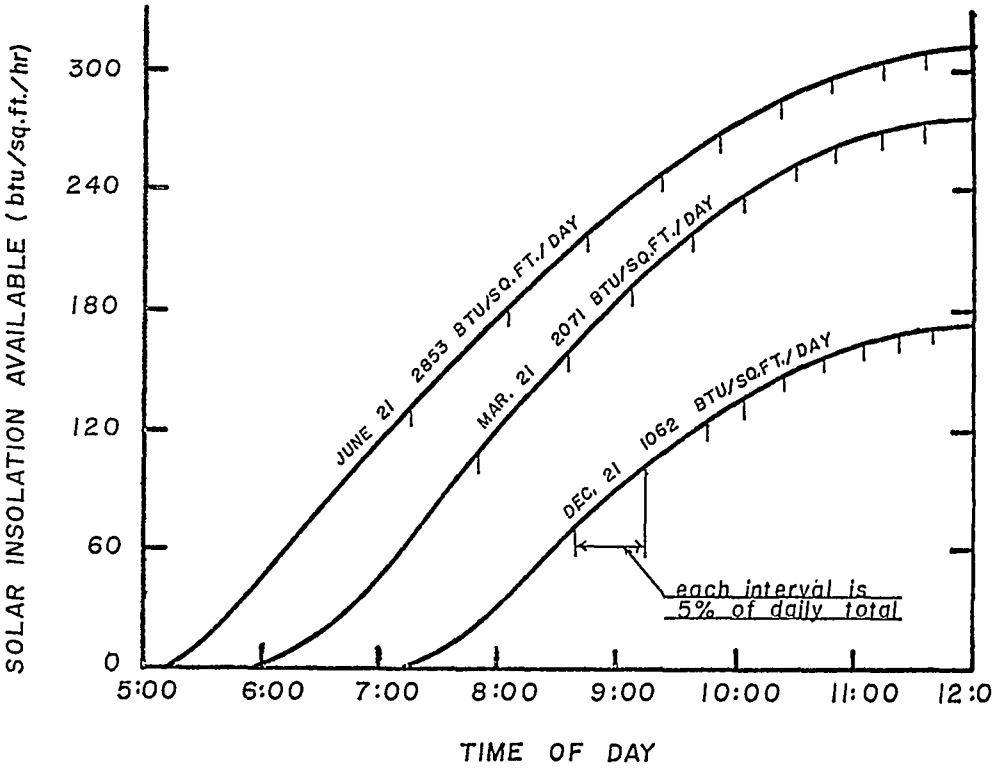

FIGURE 2. *Instantaneous insolation available to a horizontal surface at 35° N. Lat. Applicable to flat plate collectors or passive systems.*

As we would expect, the curves indicate that the amount of solar energy striking a horizontal surface is very small in the early morning and reaches a maximum at noon. These curves are for surfaces that remain horizontal during the day, that is, they do not turn as the sun

moves. Generally, data from such fixed surfaces is applicable to both passive systems and flat plate collectors.

Of particular relevance to the present work are the small vertical lines that extend down from the curves. The distance between adjacent lines represents the time required for five percent of the total available daily solar energy to strike the surface. As an example of this, consider the curve for March 21. A one foot surface would receive 2,071 Btu during the day. Sunrise occurs at 6 a.m., and the first vertical line appears a little before 8 a.m. Thus, it takes almost two hours for five percent of the total daily solar energy to strike the collector. Towards the middle of the day, however, the situation changes. A vertical line appears at about 11 a.m. and another appears at about 11:30. Between these times of the day, five percent of the total daily energy arrives in about a half an hour.

Now consider what happens if the solar right is determined to exist between 8 a.m. and 4 p.m. On June 21, the graph shows that about ten percent (2 spaces of five percent each) of the solar energy arrives at the surface between 5 a.m. and 8 a.m. Similarly, another ten percent would arrive between 4 p.m. and 7 p.m. Thus, if these times were used in the Ordinance, a collector owner having a horizontal collector (passive or flat plate) would be deprived of twenty percent of the total solar energy that arrived at his collector. If the same procedure is followed for March 21, the collector owner would lose about fourteen percent of the energy, and on December 21 only about four percent of the available solar energy would be lost to the collector owner. The information discussed in this paragraph is summarized in Table I below.

TABLE I

Date	*Hours during which solar right exists*	*% loss of available solar energy*
June 21	8:00 a.m. to 4:00 p.m.	20%
March 21	8:00 a.m. to 4:00 p.m.	14%
Dec. 21	8:00 a.m. to 4:00 p.m.	4%

The question arises as to how the information in Table I is used in determining when the solar right should exist. If an active solar system is designed for heating domestic hot water and for home heating, it will supply only domestic hot water during the summer. This means that, for summer operation, the collector owner has a much larger collector area than necessary, but is using his collectors fully during the winter. Generally, the coldest day of the year occurs in early January. For example, January 4 is, statistically speaking, the

coldest day in Albuquerque, New Mexico.[62] If the solar right exists from 8 a.m. to 4 p.m., a collector owner will only lose about four percent of the available energy when his heating load is highest. If the heating period extends from September 21 to March 21, he will lose fourteen percent towards the beginning and end of the heating season, but the heating load is lower during this period. Over the entire heating season, he will lose approximately nine percent of the total available solar energy. This may be acceptable in some communities and not in others, depending upon how the citizens view solar heating. That the collector owner would lose twenty percent of the available energy on June 21 is insignificant since he can't use it anyway. He needs only enough solar energy to heat domestic hot water, and this is a small amount compared to the energy required for home heating.

The situation changes if the solar system is used for domestic hot water, heating, and air conditioning. In this arrangement the collector area required is generally greatest for air conditioning, therefore the collector owner needs as much solar energy as he can get during the cooling season. For this reason Section 4 of the Ordinance specifies two different time periods during which the solar right exists: one for the heating season and one for the cooling season. Table II illustrates a possible use of the two-time-period-type of ordinance. Data used to prepare this table come from Figure 2.

TABLE II

Date	*Hours during which solar right exists*	*% loss of available solar energy*
Sept. 21	*8:00 a.m. to 4:00 p.m.*	*14%*
Dec. 21	*8:00 a.m. to 4:00 p.m.*	*4%*
March 21	*8:00 a.m. to 4:00 p.m.*	*14%*
March 22	*7:00 a.m. to 5:00 p.m.*	*3%*
June 21	*7:00 a.m. to 5:00 p.m.*	*8%*
Sept. 20	*7:00 a.m. to 5:00 p.m.*	*3%*

If the zoning officials so choose, the problem can be further complicated by using different hours for each quarter of the year.

A few words should be said about the present status of solar air conditioning. The cost of air conditioning a structure using solar energy is presently quite a bit higher than the cost of heating the structure with solar. As a result, solar air conditioning is less cost competitive with fossil fuel or electricity than is solar heating, and it

62. This information comes from the Albuquerque, New Mexico office of the United States Weather Bureau.

will take a longer time for solar air conditioning to become commonplace. Although several solar air conditioning installations are currently in operation,[63] most of these are government funded. Those areas whose climates do not require much air conditioning may not want to complicate an ordinance by including two different time periods for solar access. Those areas where air conditioning loads are greater than heating loads may not wish to protect solar access for air conditioning, especially since it is not as currently feasible as solar heating.

The times of day used in Tables I and II are not suggestions from the writers, but rather are only used as examples. The authors strongly feel that the hours selected for any particular ordinance represent a tradeoff between the rights of a collector owner and the traditional rights of his neighbor. Such a tradeoff can best be made at the local level where there is an awareness of both the physical and political climates.

The situation depicted in Figure 2 was that of a horizontal surface.

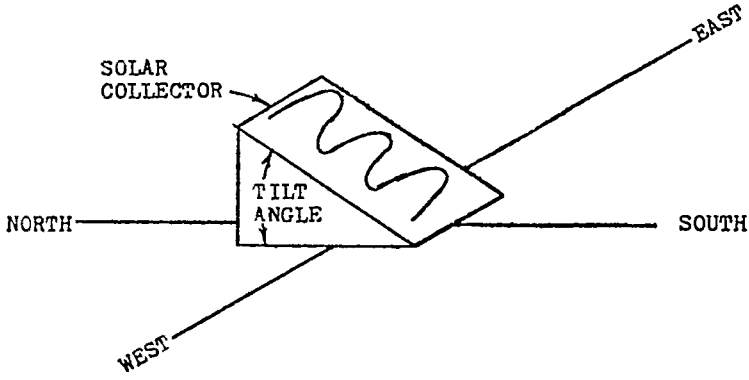

Figure 3. Definition of the tilt angle for a flat plate collector.

63. Among the solar air conditioning projects presently in operation or anticipated, one exists on the Community Recreation Center at Santa Clara, Calif., one has been completed but is not yet in operation at the U.S. Border Patrol Sector Headquarters in Marfa, Texas, and one will be installed on buildings at the Armed Forces Test Range in Yuma, Arizona.

While flat plate collectors are usually tilted to the south, passive collectors are often vertical. For this reason, figures have been prepared to show the solar energy available to a tilted flat surface. Figure 3 defines the tilt angle.

Figure 4 treats the case of a flat surface having a tilt angle of thirty degrees. All tilt angles used assume that the tilt of the collector is towards the south, as in Figure 3. The data presented in Figure 4 is the same as that given in Figure 2, except that the collector has been tilted by thirty degrees. Two significant differences are evident between Figures 2 and 4. First, the June 21 and March 21 curves cross each other in Figure 5. This is due entirely to the tilt of the collector.

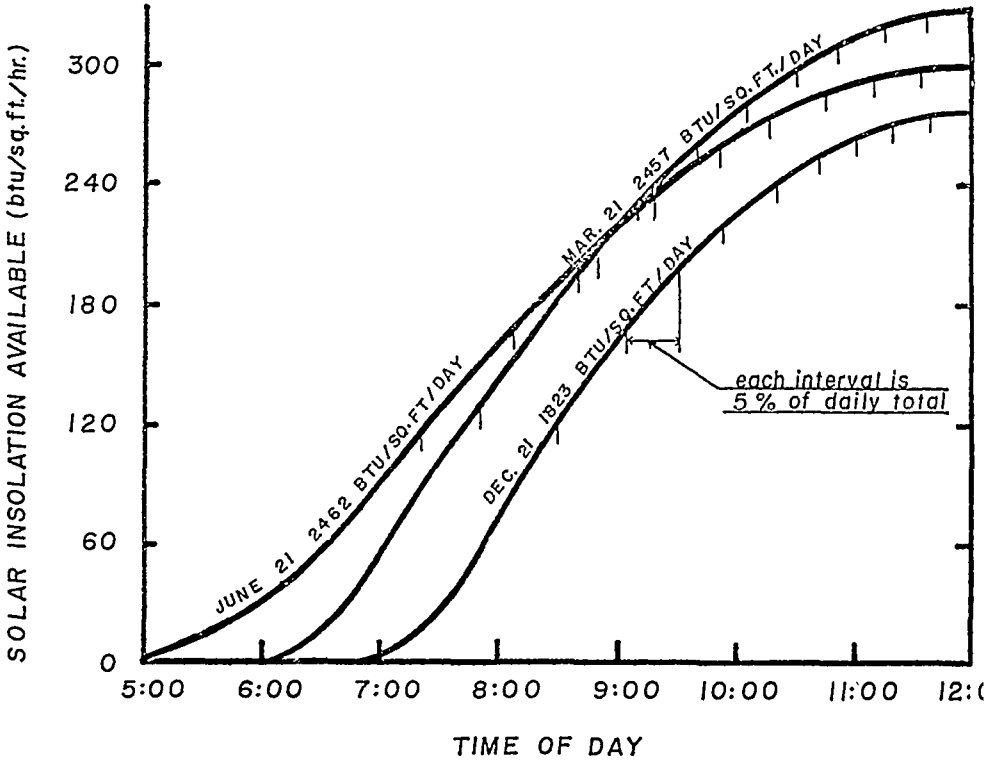

FIGURE 4. Instantaneous insolation available to south facing surface tilted up 30°, at 35° N. Lat. Application to flat plate collectors or a passive system.

64. Graphs diagramming information concerning tilt angles of 45° and 65° are available from the authors.

The second significant difference is that the total amount of solar energy available on June 21 has been reduced from 2,853 Btu for the horizontal surface to 2,462 Btu for the surface tilted at thirty degrees. At the same time, the solar energy available on March 21 and December 21 has increased, with the increase for December 21 being almost eighty percent. Thus, the tilted surface is superior for the heating season while the lesser tilt is better for the air conditioning season and summer swimming pool heating. Note that the small vertical lines that indicate the five percent intervals have changed position, and this affects the optimal hours during which solar access should be protected by the Ordinance. It is unfortunate that tilt angles complicate the situation, but they must be considered.[64]

What tilt angle should be used for determining the hours of the day that solar access should be protected? The answer, to a large ex-

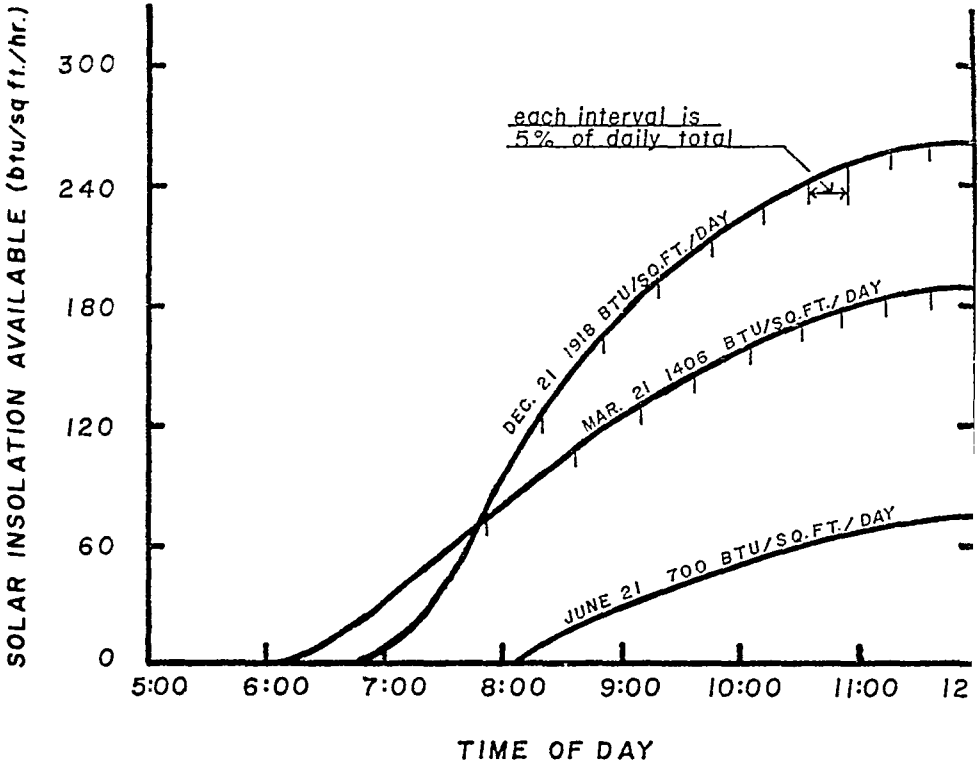

FIGURE 5. *Instantaneous insolation available to a vertical south facing surface at 35° N. Lat. Applicable to flat plate collectors or passives.*

tent, depends upon local conditions. Most flat plate collectors will have tilt angles somewhere between thirty and sixty degrees when used for heating. Areas with flat-roofed buildings will not have many solar installations having tilt angles greater than forty-five degrees, but the situation might be different in areas having many steeply pitched roofs. The authors do not have a universal answer, but hopefully the zoning officials will be able to determine the proper angle for their own areas. One suggestion would be to work out Tables I and II for two or three different tilt angles and determine whether or not a significant difference exists that would affect access to solar energy.

Figure 5 treats the case of a vertical collector (ninety degree tilt), and warrants further discussion because of its applicability to passive systems. Typically, a passive system relies heavily on the solar energy striking a vertical, southfacing wall. The amount of available solar energy on this type of surface is high in the winter and low in the summer, which fits the requirements of a solar heating system. For purposes of providing solar access for passive systems, Figure 5 is probably the most useful graph, however others must be considered for an active system. Where the collector is mounted vertically on a southfacing wall, while such systems are not typical, they do have aesthetic advantages since the collector becomes part of the wall structure.[65]

Tracking collectors are solar collectors that rotate during the day to follow the sun. These collectors usually concentrate the sun's rays. Figure 6 is a diagram of a tracking, concentrating collector.

The sheet of material with a curved shape shown in the figure acts as a reflector, and reflects the sun's rays to the tube passing through the collector. This causes the fluid that flows through the tubes to be heated. Since this type of collector *concentrates* the sun's rays on the tube, it is capable of heating a fluid to a higher temperature than can generally be achieved by a flat plate collector. These collectors are usually tilted towards the south, the same as the flat plates. In addition, the reflector rotates about the tube during the day, thereby following the motion of the sun from east to west. In this manner, the collector is always oriented toward the sun and therefore has more solar energy available to it than does a flat plate or passive collector.

65. Graphs diagramming information concerning east and west facing walls are available from the authors.

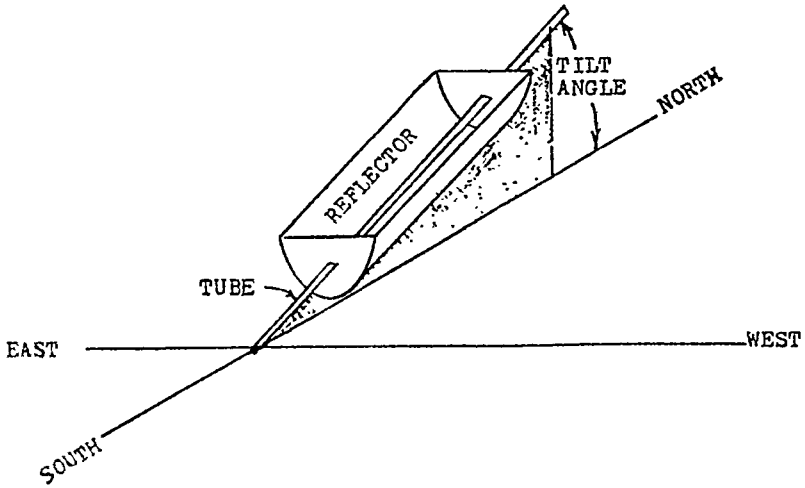

Figure 6. Definition of the tilt angle for a tracking, concentrating collector.

The tracking concentrator has the disadvantage of greater complexity and more moving parts than flat plate or passive collectors.

While tracking concentrators are not as common as flat plate or passive collectors for home use, there are a number of installations that do use them for heating and cooling. They are particularly applicable for solar air conditioning.[66] Solar air conditioning requires higher temperatures than solar heating, and the concentrating trackers are capable of reaching the required temperatures more readily than are flat plates.

A forward-looking solar zoning ordinance should consider tracking concentrators as well as flat plates and passive collectors, especially if the area for which the ordinance is written experiences high air conditioning loads. Because the tracking concentrator orients itself toward the sun, it has more solar energy available to it in the early morning and late afternoon than does a flat plate or passive

66. Of the three solar air conditioning projects listed at note 2 *supra*, two utilized concentrating tracking collectors. The third, the Santa Clara installation, uses flat plates with double glazing and a selective surface coating, both of which increase the cost of the collector.

collector. This further complicates the problem of determining those hours solar access should be made available to a collector owner by Section 4 of the Ordinance. This effect can be seen by comparing Figure 7 with Figure 2. Both of these consider collectors with a zero tilt angle, however Figure 7 includes the effect of tracking. Two significant differences stand out. First, the tracking concentrator has more solar energy available to it during the course of a day. For example, on June 21 the flat plate has 2,853 Btu available to a square foot of surface over the course of a day. The tracking concentrator has 3,518 Btu available. Second, the tracking concentrator has more energy available early and late, thereby complicating the problem of solar access. For example, on June 21 the flat plate receives five per-

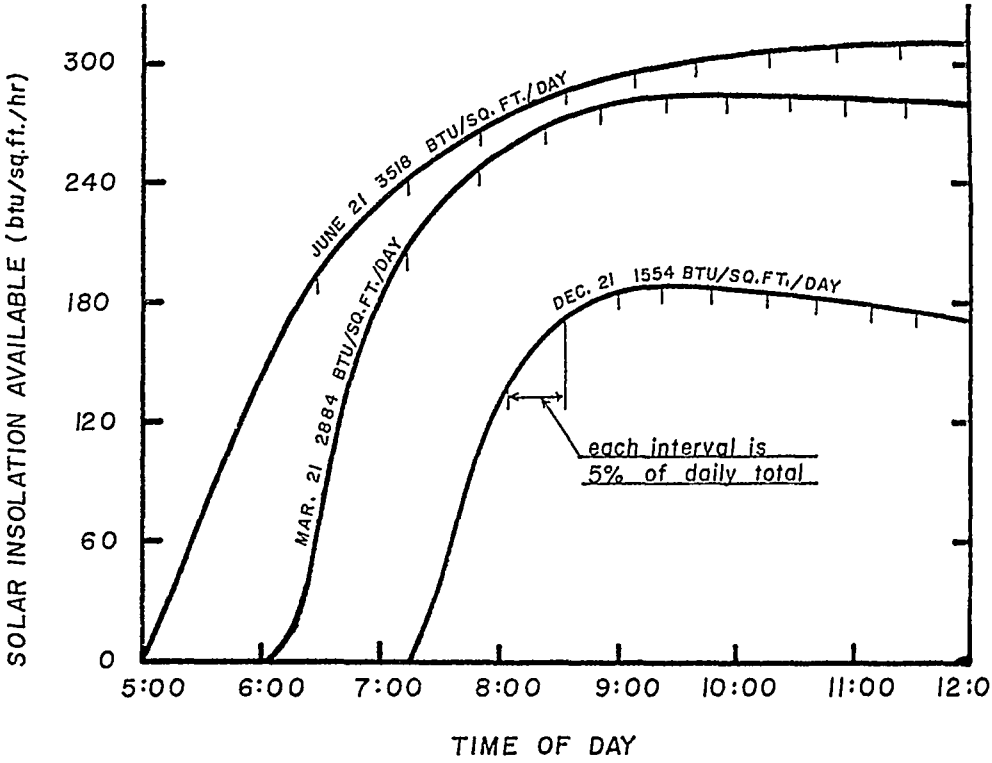

FIGURE 7. *Instantaneous insolation available to a surface tracking the sun about a horizontal north — south axis at 35° N. Lat. Applicable to tracking collector.*

cent of the daily total available solar energy between the hours of 5 a.m. and about 7:15 a.m. The tracking concentrator receives its first five percent between 5 a.m. and about 6:15 a.m. The tracking concentrator thus may deserve solar access protection earlier and later in the day than a flat plate or passive system. If tracking concentrators are to be protected, the burden on the neighbors of a solar collector owner will be greater than if only flat plates and passive systems are protected.

Figure 8 considers a tracking, concentrating collector with a thirty degree tilt angle. The situation that occurs as the tilt angle increases for tracking concentrators is the same as the result when the tilt angles of flat plates and passive collectors were increased, and the reader is referred to that discussion appearing earlier in this Appendix. There is one point concerning these curves that requires brief

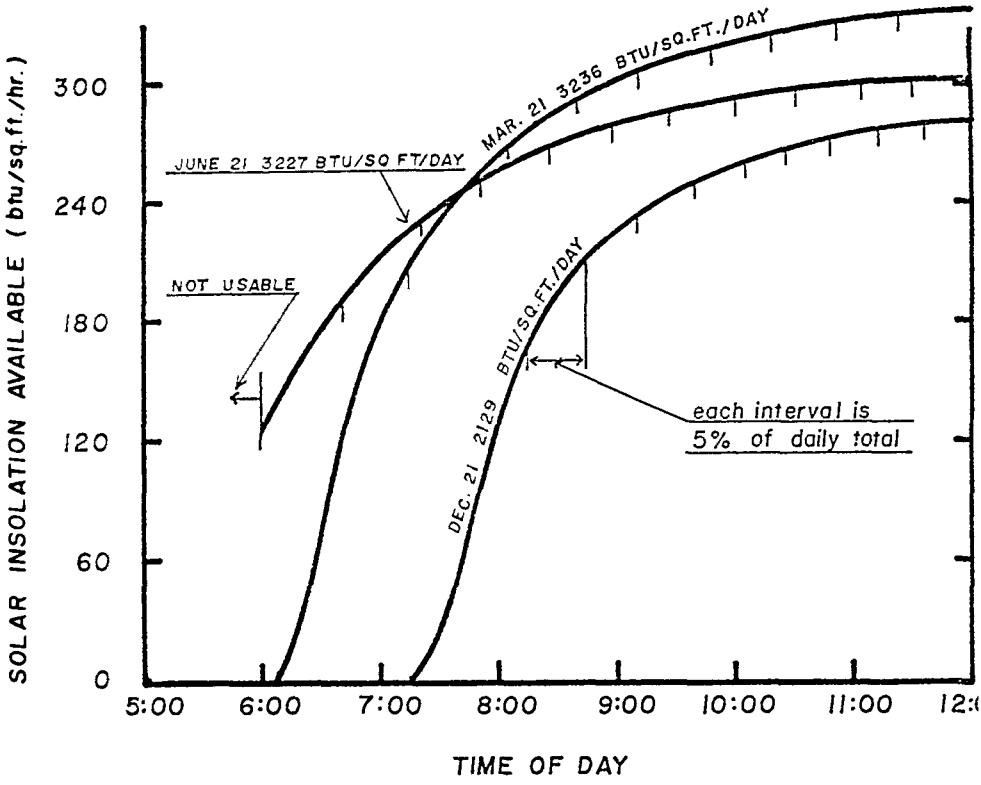

FIGURE 8. *Instantaneous insolation available to a surface tracking the sun about a north — south axis tilted up 30° toward south at 35° N. Lat. Applicable to tracking collectors.*

discussion. Figure 8 has a region labeled "not usable" on the June 21 curve. The solar energy is not usable because it strikes the underside of the collector. Recall that the sun rises in the northeast in the summer, for the latitudes being considered. When the sun is near the horizon and to the north of the collector, the sun's rays strike the underside of the reflector (see Figure 6) and are not reflected to the tube. Therefore this solar energy is not collected by the collector.[67]

OTHER COLLECTOR TYPES

There are two other collector types that should be considered. Although neither is presently in common use they may become so in the future.

The first is a concentrating tracking collector mounted horizontally in the east-west direction. This type of mounting is advantageous for large, heavy collectors that are difficult to mount with a tilt angle. At present, this arrangement is used on a large system developed by Sandia Laboratories.[68] That system is capable of providing electricity, heating and cooling for an entire neighborhood. These large collectors generally deliver a fluid having a temperature in the neighborhood of 400 degrees F, and are of more interest for industrial processes than for heating and cooling of buildings that contain their own solar collectors. It would appear that, while the industrial use of solar energy is certainly an important field, problems of solar access associated with industrial use are not as serious as those connected with the heating and cooling of buildings. For this reason, zoning for solar access should be based upon the heating and cooling of buildings, at least for the near future. Figure 9 presents data for the type of collector just described.

A second type of collector shows signs of entering the solar market. This collector does not track the sun but does concentrate the sun's rays. This collector is also mounted on an east-west axis, and the reflector tilt angle (in the north-south direction) is changed monthly or quarterly by the collector owner. From the point of view of solar zoning, this collector type does not deviate significantly from

67. Graphs diagramming information concerning tracking concentrators tilted at angles of 45° and 60° are available from the authors.

68. This system is called the "Total Solar Energy System," and has been developed by Sandia Laboratories. Several reports are available, and the reader can receive copies of these by requesting them from Sandia Laboratories, Albuquerque, New Mexico.

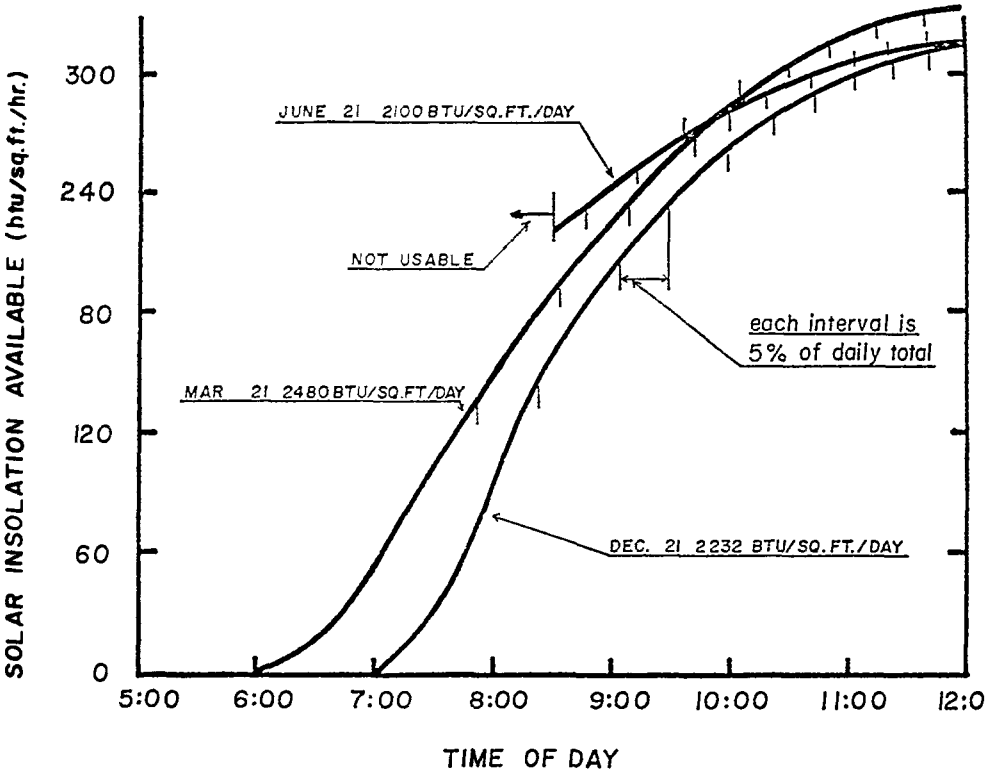

FIGURE 9. *Instantaneous insolation available to a surface tracking the sun about an east — west axis, 35° N. Lat. Applicable to tracking collectors.*

the flat plate or passive collector. As seen in Figure 10, the shape of the curve is similar to the flat plate curves. This collector does not require the same protection of solar access in the early morning or late afternoon as does the tracking concentrator.

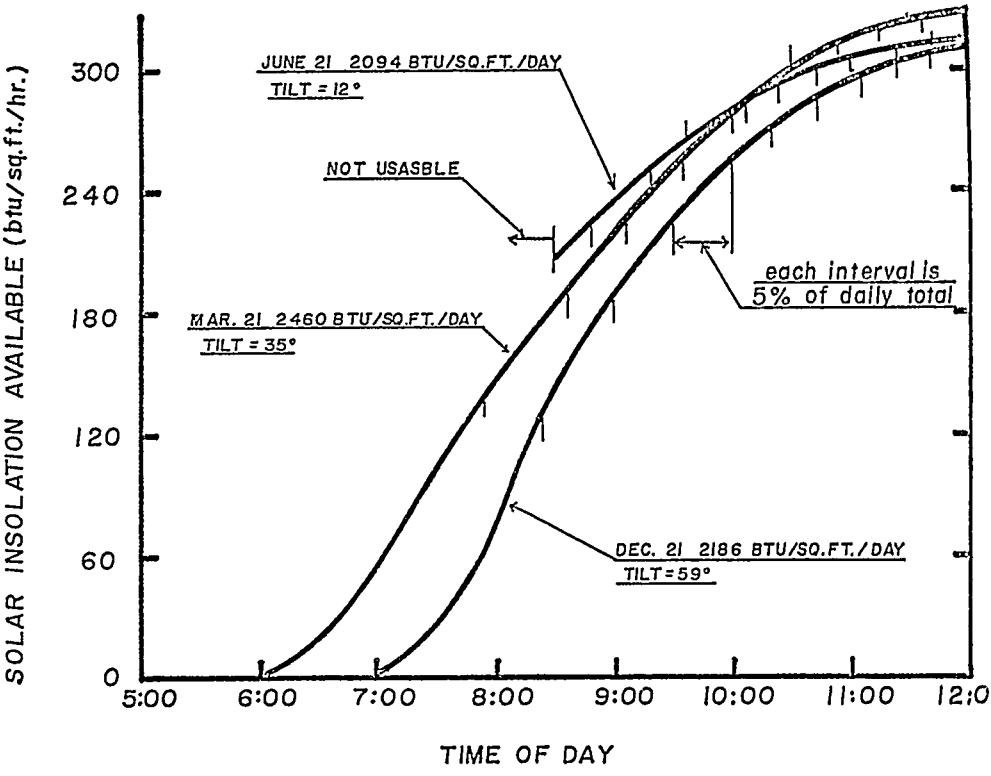

FIGURE 10. *Instantaneous insolation available to a south facing surface at a tilt =(90°-noon altitude angle), at 35° N. Lat. Applicable to non-tracking concentrating collectors.*

NOTES