EFFECTS OF TREE SHADE ON HOME COOLING REQUIREMENTS

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Abstract. This study was implemented to provide more information on the effects of shade trees on summer cooling energy reduction. A sample of 113 homes of similar setting and design in College Station, Texas was used. Electrical data reduced to kilowatt hours per square foot of living area were used as the dependent variable. Shade proved to be the most significant of several variables observed in reducing electrical energy usage.

A perennial problem in much of the country is the amount and cost of electric energy needed for cooling homes. We believe that trees play a role in reducing this energy need. There has been little quantitative evidence to support this role. The recent work of Parker (1983) showed that trees reduced cooling energy needs by more than 50 percent during warm summer days. This study was performed in Florida with buildings. Youngberg (1983) demonstrated a role of deciduous trees in winter solar heating of buildings. A project with trailer homes (Laechelt and Williams 1974) demonstrated appreciable savings of cooling energy when these mobile units were shaded by moving them into treed areas.

The object of this study was to determine the effect of tree shade on homes in a setting of native and planted trees. The ultimate benefit of the study would be to demonstrate to the public how man can use trees for home energy conservation. Because tree resources are renewable, they can become a permanent part of any energy program designed to reduce use and cost.

Two questions were addressed: Is there a significant difference in the energy required to cool a house during the summer months protected by a tree canopy versus one unprotected? What canopy configuration provides the most effective role for such energy savings? An inherent problem in a study dealing with numerous homes is the variability of home design and lifestyles. This can be reduced by using a large sample of homes of similar size and design built about the same time. A canvas of College Station, Texas in the spring of 1980 produced a suitable area. A fifteen- to twenty-year-old development met the above requirements and the homes were similarly oriented in relation to the meridian axis. Many of the homes were shaded by the remains of a post oak savannah supplemented by planted species. Mature post oaks measured 50 to 60 feet in height.

Shade was evaluated by a system which rated each home on shaded roofs. For a cooling season, June through September, the heights of trees needed to produce certain amounts of shade based on hourly solar positions on the twenty-first day of each month was measured. The shade score for each home was determined by how much of the roof perimeter and wall space was shaded (Figure 1). Shade-class 1 homes were those on which a 15-foot depth of shade (or

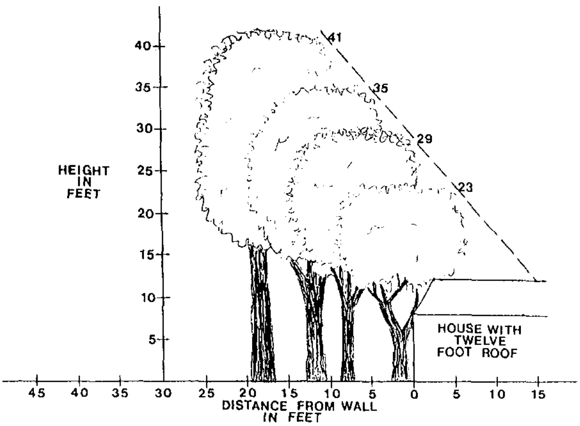

Figure 1. Required shade for a twelve foot high roof on May 21 at 3 p.m. for a fifteen foot shadow length.

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greater) was on the roof at 3 p.m. on July 21. Figure 1 demonstrates the needed tree heights at various distance from a 12-foot roof house in order to achieve a 15-foot shadow. The technique followed the solar azimuth and altitude formulae of Griffiths (1976). Figure 2 demonstrates tree heights and azimuths to achieve optimum roof shading. Electrical data were obtained from the City of College Station electrical department. These data in kilowatt hours were converted to a value per square foot to correct for the varying sizes of living (cooled) area. Records for the cooling seasons of 1977, 1978, and 1979 were used.

Table 1 displays the results of the study. Electrical data for each home in the sample were used as a dependent variable in a statistical analysis software system (SAS). In each of the tree study years there was a significant difference at the 0.01% level between shade-classes 1 and 4. Observations on wall and roof color revealed that homes with light colored roofs and walls used significantly less kwh than those with dark colored roofs. A SAS General Linear Model Procedure computed the following F values: shade 45.06, wall color 20.10, roof color 5.81. Thus, shade from trees proved to be the most highly significant variable.

Discussion

Although the large variation between homes and occupants was difficult to accept, the analysis of data revealed a positive effect of tree shade on energy reduction. As shown in Table 1, the effects of shade appear less in 1978. In 1978, College Station experienced an extremely hot and dry summer in which the higher air temperatures may have negated the cooling effect of the shade. In 1979, there was a serious defoliation of post oaks in the spring by cankerworms. Young live oaks were observed to have severely shortened twig elongation and leaf density throughout the grow-

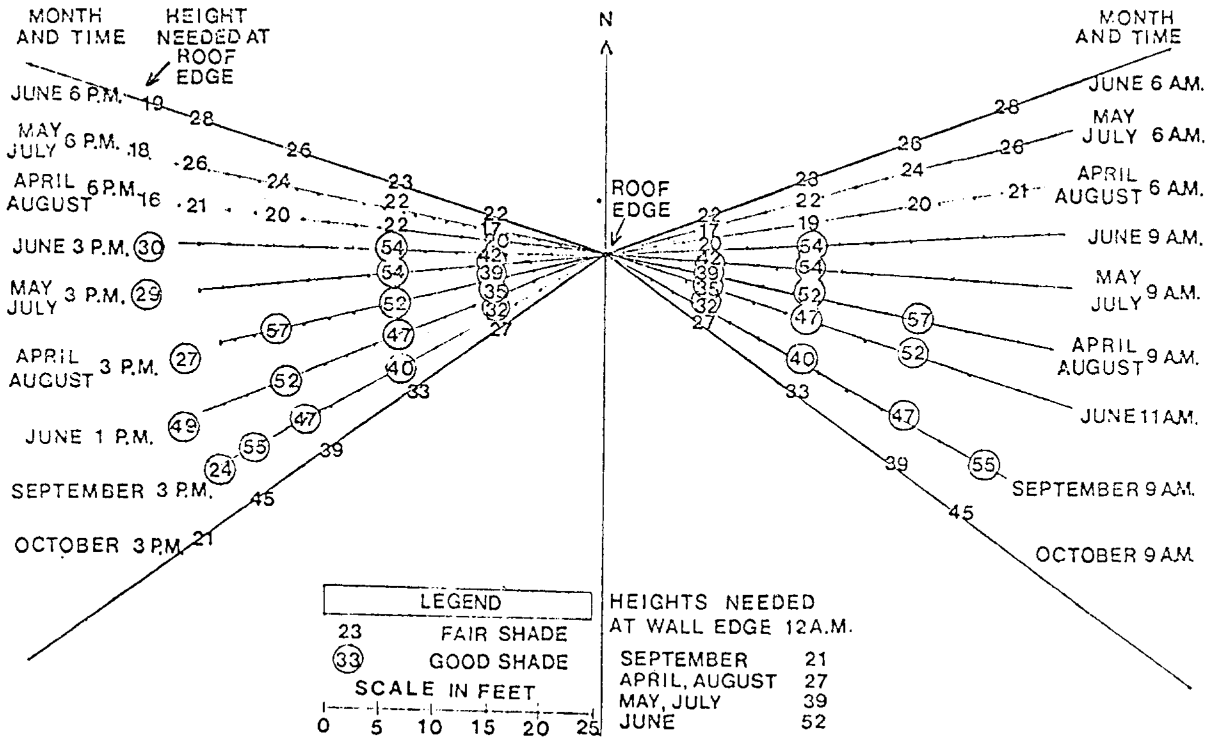

Figure 2. Diagram of tree heights needed for shading at different azimuths for a twelve foot roof.

Table 1. June through September average kilowatt hour electrical usage per square foot of air conditioned area for four shade classes in a selected residential neighborhood in College Station, Texas.

Year	*Shade Class*	*N*	*Mean June-Sept. monthly usage*	*Mean winter monthly usage*	*Mean June-Sept. temp.*
1977	1	8	4.244	.390	
(18% increase of	2	17	4.374	.385	82.8
class 4 over	3	33	5.221	.423	
class 1.)	4	35	5.019	.378	
1978	1	7	4.550	.403	
(10.94% increase	2	17	4.563	.388	84.4
of class 4 over	3	33	5.288	.428	
class 1.)	4	37	5.048	.380	
1979	1	5	3.114	.378	
(27.01% increase	2	20	3.900	.390	79.5
of class 4 over	3	35	4.168	.416	
class 1.)	4	35	3.958	.379	

Shade class 1 is most shaded as defined and shade class 4 is a treeless category.

ing season. Many trees had difficulty leafing out completely. Also a growing awareness of energy conservation was apparent. Absolute energy usage in 1979 was the lowest of the three years. These factors may explain the lack of significant difference in shade-classes in that year except for shade-class 1.

We believe that this study adequately demonstrates the value of shade trees in the home landscape in reducing cooling energy costs, and illustrates that optimum position for trees in relation to a home setting.

Literature Cited

Griffiths, J.F. 1976. Climate and the environment. Westview Press. Boulder, Colo. 148 p.

Laechelt, and Williams. 1974. Value of tree shade to homeowners. Alabama For. Comm. Bull. 2450.

Parker, John H. 1983. *Landscaping to reduce the energy used in cooling buildings.* J. For. 81(2): 82-84, 105.

Youngberg, Robert J. 1983. *Shading effects of deciduous trees.* J. Arboric. 9(11): 295-297.

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