SERVICE IN ACTION

COLORADO STATE UNIVERSITY EXTENSION SERVICE

Landscaping for energy conservation

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Quick Facts

- Through proper use of landscaping, the climate around a home can be modified to reduce heat gains in summer and heat losses in winter.
- Properly placed landscape vegetation can reduce air infiltration by reducing wind velocity in the vicinity of the home.
- Control of the temperature difference between the inner and outer surfaces of walls and ceilings through proper landscaping can reduce heat conduction.
- Vegetation around a home can regulate radiation transmission into a home as desired during different seasons of the year.
- The goal of energy-conserving landscaping is to regulate energy flows from the sun and the wind.
- Research has shown that up to 25 percent energy savings is possible for heating by using windbreaks.

Most homeowners invest in some landscaping for their home to improve its value and appearance. They should also consider the functional use of landscaping, namely as a way of reducing the amount of energy used in the home. A home is a structure designed to provide a comfortable environment for the occupants. The comfortable environment is achieved through the use of heating and air conditioning systems that use energy to maintain the comfort level.

Today, homeowners faced with rising energy costs are seeking ways to conserve energy in the home, and proper landscaping elements can make a significant difference in the amount of energy required to maintain comfort. Through proper use of trees, shrubs, vines and manmade structures, the climate around a home can be modified to reduce heat gains in summer and heat losses in winter. Reductions in energy use are brought about by protecting a home from the winter wind and shading the home from summer sunlight. Using these techniques, winter heating bills may be reduced as much as 25 percent and summer cooling bills reduced 50 percent or more.

Heat Exchange

To take full advantage of the effects of energy conserving landscapes, the ways in which a home gains or loses heat must be understood. Heat exchange in a home occurs through three major processes: air infiltration, heat conduction and transmission of radiant energy through windows.

The first process, *air infiltration,* is the passage of outside air through cracks around windows and doors or other openings in house walls or ceilings. One of the ways outside air is forced through these openings is through pressure differences caused by the force of the wind on the outside of the home. Surfaces of the home facing the wind will experience increased air pressure with increased wind velocity and air will enter the home through openings in these surfaces. Passage of air into the home will force an equal amount of interior air out of the home through openings in surfaces facing away from the wind. In winter, heat losses due to air infiltration may represent up to one-half the total heat losses on the windiest, coldest days. Properly placed landscape vegetation can reduce air infiltration by reducing wind velocity in the vicinity of the home.

The second process of heat exchange is *conduction* through materials from which the home is constructed. The amount of heat conduction through exterior surfaces is dependent on the insulating property of the building materials, thickness of material, surface area available for heat flow, and the temperature difference between the inner and outer surfaces of the home. Control of the temperature difference between the inner and outer surfaces of walls and ceilings through proper landscaping can reduce heat conduction.

The outer surface temperature is controlled mainly by the outside air temperature, the wind velocity and solar radiation. In summer, landscape vegetation can reduce the amount of

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solar radiation reaching the outer surfaces of a home and thus reduce heat conduction into the house. In the winter, solar heating of the building's exterior surfaces oriented to the sun can be beneficial in reducing the rate of heat loss by raising the outer surface temperature of walls. Blocking cold winter winds from striking the home also will reduce conductive heat loss.

The third process for heat exchange in a home is *transmission of solar radiation* through windows. Large expanses of east or west facing glass will admit undesirable solar radiation in the summer. Large expanses of south facing glass will passively solar heat a home in winter. Vegetation around a home can regulate radiation transmission into a home as desired during different seasons of the year.

The goal of landscaping for energy conservation is to regulate energy flows from the sun and the wind. Because of its abundance, the sun plays a very important role in the Colorado climate. Landscaping can regulate the amount of sun that reaches the home so that beneficial use can be made of solar radiation during the winter for solar heating, and unwanted solar radiation in the summer is blocked.

Because of the Colorado summer climate of low humidity and cool nights, proper house design and proper attention to landscaping can reduce or eliminate the need for air conditioning. Summer shade is best provided by strategically located vegetation along the sunny borders of the home. Shade should be provided for south-facing roof and wall surfaces that receive the most direct sunlight during midday when the sun is higher in the sky. Walls facing generally east or west also should be protected since these surfaces receive considerable direct sunlight in the morning and afternoon when the summer sun is low in the sky. Vegetation protecting these surfaces will intercept solar energy that would otherwise overheat the home. In addition, the shade provided by the vegetation will maintain an environment that is several degrees cooler than the temperature in the sunlight.

Providing Shade

The recommended way to provide shade is to plant deciduous trees in an arc encompassing the home on the east, southeast, south, southwest and west sides (see Figure 1). When planting shade trees, locate them with an understanding of the mature height of the trees so that they will be properly spaced and provide desired shade. Location of shade trees also depends upon the shape of the tree crown, the position of the sun, the height of the roof or walls, maintaining a desirable view from windows, aesthetic appeal in landscaping a home, and avoiding overhead wires and underground pipes. A tree that is a small twig when planted can grow into a very large tree at maturity and if the mature height and shape is not planned for in advance, the location of the tree may cause problems.

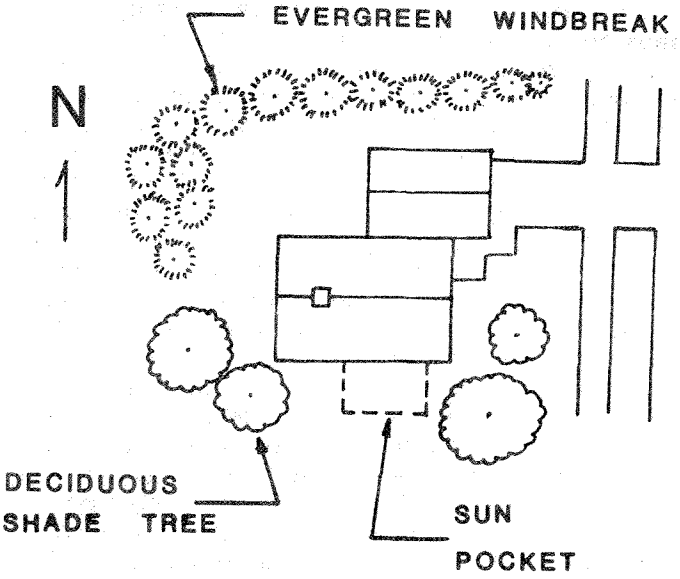

Figure 1: Suggested locations for windbreak, shade trees and sun pocket.

Securing shade for south-facing roof surfaces in the summer generally depends on having overhanging tree crowns. Trees that do not overhang the roof will not cast much shade on the roof during midday in summer due to the high position of the sun in the sky. Thus, shade trees should be planted as close to the home as practical. For this location, choose a species that is not susceptible to breakage. Leaves in gutters are an undesirable consequence of large deciduous trees near the home but most people can cope with this nuisance. Prompt removal of diseased or damaged trees or limbs also is necessary to avoid damage to the home from falling debris.

Tree planting arrangements that provide shade in summer may be detrimental in the winter if solar heating of the home is interrupted. Leafless deciduous trees in winter may reduce the amount of sunlight reaching the home by more than one-third. However, since the sun in winter is typically less than 45° above the horizon, what shading of the home does occur will be largely by tree trunks. For this reason, only trees necessary for summer shade should be maintained along the southerly edge of the home, and the lower trunk should be pruned to allow maximum solar heating of walls and roof in winter (see Figure 2). As few as two or three large deciduous trees with well developed crowns may suffice.

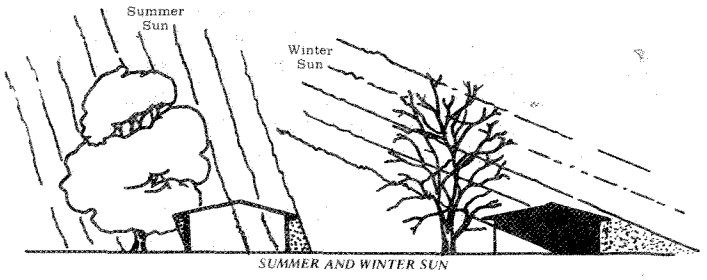

Figure 2: Effect of deciduous trees in summer and winter.

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If the home has a solar water heating device that needs solar radiation in summer as well as winter, provision should be made that no shade is thrown on the collectors between 9 a.m. and 3 p.m. (standard time) at any time of the year. Thus, a gap should be left in the tree canopy to allow the sun to shine on the collectors during those hours. Since growth of a shade tree is a long-term undertaking, fast growing trees can be intermixed among the slower growing more desirable trees to provide a quicker shade. As the slower growing trees begin to mature, the fast growing trees can be removed.

House walls facing either an easterly or westerly direction can be shaded with clumps of vegetation or attached structures. Deciduous or evergreen shrubs or small trees that reach a height great enough to shade the wall may be used. Evergreens may be preferred on the west side to provide summer shade and winter wind protection for the wall.

Vines may be grown directly on masonry walls but should be grown on a trellis if protecting a wooden wall. East or west walls can be provided with immediate shade by constructing a slatted wooden overhead structure attached to the home to provide shade and free circulation of air. Such a structure can be constructed using 1 x 2-inch (2.5 x 5-centimeter) strips of treated pine, redwood or cedar spaced one inch (2.5 cm) apart and attached to the framework. Training vines to grow over the structure will create an arbor (see Figure 3).

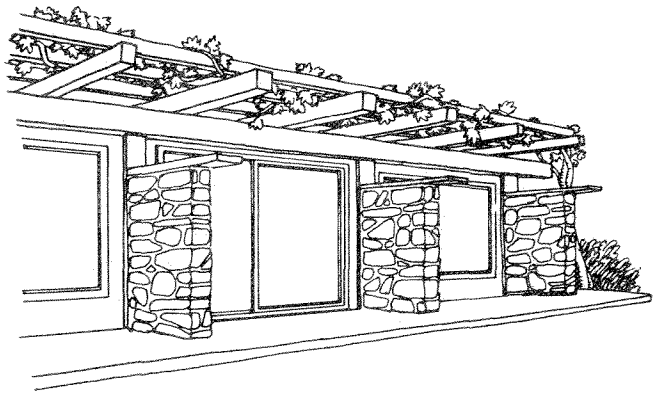

Figure 3: Use of an arbor to reduce solar radiation effects.

Wind Protection

The other important climatic element to be controlled by landscaping is the wind. Research conducted on the Great Plains has shown that up to 25 percent energy savings is possible for heating by using windbreaks. An evergreen windbreak planting, properly placed, can divert cold winds away from the home. The windbreak should be located upwind from the home in the direction of the prevailing winter wind. In Colorado, this generally means protecting the north and west side of the home (see Figure 1).

The windbreak should be located upwind from the home a distance depending on the tree height. The optimum distance for reducing wind velocity is about one to three times tree height, however reasonable protection is afforded out to a distance of six times tree height. Windbreaks can cause drifting of snow, which can be a nuisance if a driveway is located between the trees and the home. Where possible, the rows of trees should extend 50 feet (15 meters) beyond the ends of the area being protected. However, limited lot size often necessitates reducing both the distance from the home and the length of the windbreak.

Design and composition of the windbreak depend upon the space available on the property and upon the species and size of planting stock that can be obtained. Where space is limited, a single row of evergreens is adequate. However, up to five rows consisting of several evergreen species is much more effective. Spacing in one-, two- and three-row windbreaks should be six feet (1.8 m) between trees. The mature shape of the tree should be considered when developing a landscaping plan for a windbreak.

Most windbreaks also can serve several other purposes: visual screening can be provided when the trees become five to six feet (1.5 to 1.8 m) in height; a well-planned and properly maintained windbreak is aesthetically pleasing; birds and mammals are attracted to trees for protection and food.

Evergreens planted close to the home can further reduce effects of wind. Foundation plantings of spreading evergreens, if allowed to develop into a thick hedge immediately in front of the north and west wall of the house, will provide an additional insulating effect due to the trapped dead airspace created (see Figure 4). If an entry is exposed to wind, an evergreen planting to shelter the entry will be effective.

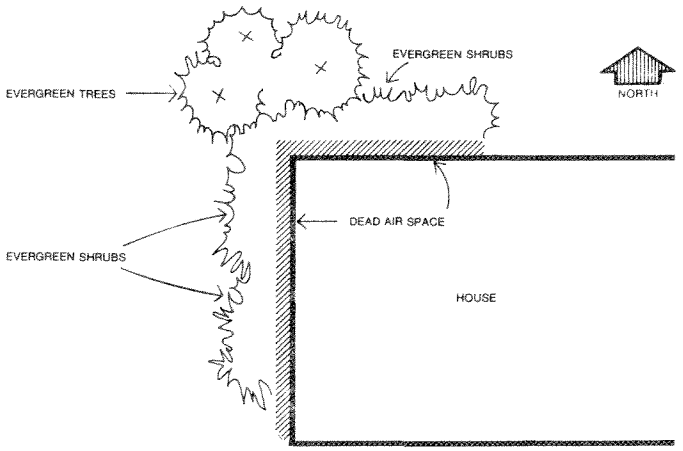

Figure 4: Use of foundation plantings.

A windbreak takes time to become established and effective. An immediate step that can be taken to cause relief from the effects of wind is the construction of a fence. A windbreak fence with an open weave pattern (i.e. basket weave) creates a larger protected downwind area than a solid fence. A solid fence provides a greater degree of shelter immediately behind the fence.

Planning the Landscape

Using the information above, sketch your house and site to scale allowing ¼ inch (6 millimeters) for each foot (.3 m). Identify north, south, east and west. Mark location of doors, windows and other glass areas. Measure the height of the house. Next observe how the sun and wind affect the site. Observe the wind during a winter storm, and note the patterns made by drifting snow as an indicator of the direction of the winter winds. Add windbreaks to your plan to block this wind flow.

Observe the sun during different seasons of the year. Notice how the sun strikes the house between 9 a.m. and 3 p.m. in the winter. A south-facing solar heating device (including a window) receives the majority of solar radiation between these hours during the winter months. Notice also how the sun strikes the house during the summer months particularly in early morning and late afternoon so that appropriate shading can be provided. At any time during the summer, the sun is not desired and should be blocked (the exception being the use of a solar water heater mentioned earlier).

Add shade trees to your plan to maximize summer shading and winter solar heating. Choose specific trees for your plan with an understanding of their mature height so as to determine their proper location for maximum effectiveness. Choose vines and shrubs in a similar fashion. Add manmade structures as appropriate for immediate effectiveness.

Use the elements of fences, windbreak plantings and shade trees to provide for creation of a sun pocket on the south side of your home where outside activities can take place during our sunny, cool, but comfortable winter days (see Figure 1). A sun pocket would make an excellent location for a patio or greenhouse addition.

To determine the best species of tree, shrub or vine to be planted for your particular conditions and to meet the requirements of shade or wind protection, consult your local county extension office for recommendations.