

# SOLAR CENTER INFORMATION

NCSU • Box 7401 • Raleigh, NC 27695 • 919.515.3480 • Toll Free 1.800.33.NC SUN



## Energy-Saving Landscaping for Your Passive Solar Home

Landscaping is often regarded as a finishing touch to enhance a home's appearance and increase its sales appeal. While it certainly does that, landscaping's power is far more than cosmetic. Strategic landscaping can reduce a home's energy requirements during all four seasons, by blocking out the hot summer sun, encouraging warming solar radiation in winter, deflecting cold winter winds and channeling breezes for cooling in spring, summer and fall.

To understand how landscaping can affect a home's energy use, it helps to begin with knowledge of the sun's path and how it varies throughout the year.

### The Sun's Changing Path

The sun's path varies during the course of the year from the winter solstice on December 21 to the summer solstice on June 21. At the winter solstice, sunrise occurs at an angle of 30° south of east. The sun follows a low path through the sky, reaching its maximum height of 30° above the horizon at solar noon, when it is directly south. It sets nine and a half hours after sunrise at an angle of 30° south of west.

As the year progresses, the sun takes a longer and more northerly path, moving at higher angles across the sky. At the summer solstice, sunrise occurs at 30° north of east. When the sun reaches its maximum height, again at solar noon when it is directly to the south, it is at an altitude angle of 78° above the horizon. It sets fourteen and a half hours after sunrise at an angle of 30° north of west.

Notice that in winter the sun's path is almost entirely to the south. When it is toward the east or west, it is at very low angles in the sky. In the summer, on the other hand, although the sun's path is still largely to the south, it also shines during a large portion of the day from the east and west. When the sun is to the south in summer, it is at very high angles in the sky.

An important consequence of the sun's altitude is its ability to cast shadows. When the sun is low in the sky, objects in its path cast long shadows horizontally. Horizontal overhangs

projecting from a vertical wall, however, cast short vertical shadows when the sun is low in the sky because the sun shines underneath them. Thus, in winter, while the sun is able to shine effectively into south-facing windows throughout the day, the east and west faces of a house receive little solar benefit. This is due to the fact that during the relatively brief time the sun shines from those directions, it is very low in the sky and is likely to be blocked by obstructions in the landscape.

In the summer, overhangs on south walls can exclude much of the direct sunlight because the sun shining from the south is at high angles. The east and west sides of the house face long periods of sun at low angles and have the potential for greatly increasing the home's cooling needs if some shading is not provided by the landscape.

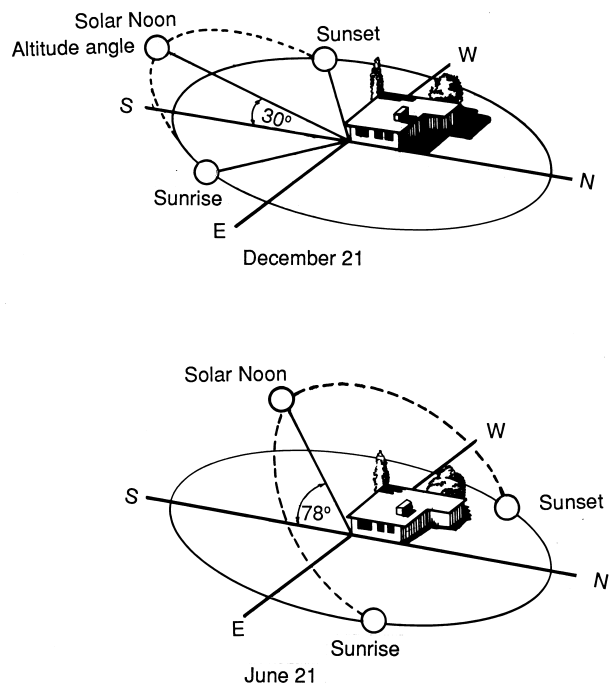


Figure 1. Winter sun is lower and more southerly than summer sun.

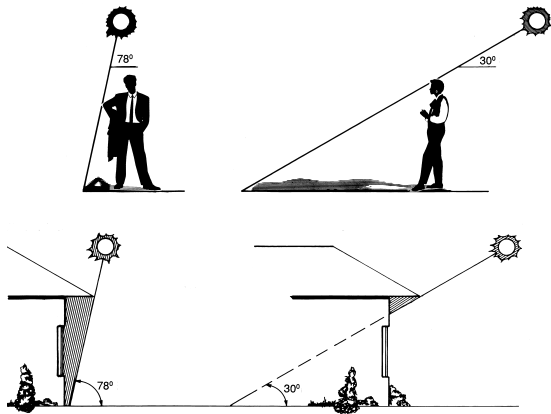


Figure 2. When the sun is at low angles, it casts long shadows horizontally and short shadows vertically. When the sun is at higher angles, horizontal shadows are short, while vertical shadows are long.

### Blocking Out the Hot Summer Sun

There are three principal strategies by which landscaping may be used to reduce the amount of cooling energy required by a home: 1. *directly shading the house with trees, shrubs or vines;* 2. *shading the area around the house to lower the temperature of its surroundings and* 3. *using ground covers to reduce sunlight reflected into the house and lower the surrounding ground temperatures.*

Shading the east and west sides of the house can provide the greatest cooling energy savings, since they and the roof face the greatest amount of summer sun. Since substantially more energy enters through windows than through insulated walls, give priority to shading windows over shading walls. Also, give priority to shading the west over shading the east, because heat from afternoon sunlight comes when the house has had an opportunity to build up heat all day, outdoor temperatures are at their highest and the house is most likely to be occupied.

Avoid planting trees on the south side of the house, since even a deciduous tree can block as much as 60 percent of winter sunlight, thus making passive solar heating ineffective if not impossible. Extended overhangs, fixed or movable awnings, shade screens and similar devices are more appropriate for use on the south side.

Plant to shade areas surrounding the house. Even though trees to the north can't shade the house directly, they reduce the air and ground temperatures surrounding the house and reduce the light reflected into it. Also useful is shading the compressor of your air conditioner or heat pump. This will help improve its performance as well as reducing noise and improving the home's appearance. Be careful to make sure that shrubs or falling leaves are not allowed to block air flow to the unit.

Shading the roof can also provide energy savings. However, this is a strategy that must be implemented with care. If you plan to use the roof for mounting solar collectors or photovoltaic arrays, you need to make sure that they will *not* be shaded. If you plan

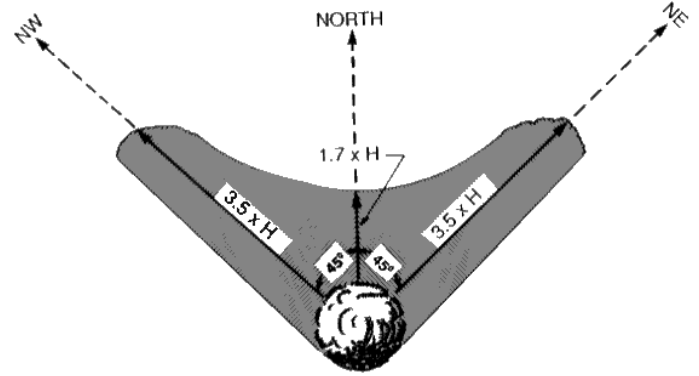


Figure 3. In winter, the low morning and evening sun casts shadows of length 3.5 x Tree Height; noon shadows are 1.7 x Tree Height.

to shade the roof, the species of tree and its distance from the wall must be chosen carefully to avoid damage to your house from roots or fallen limbs.

In general, trees should not be planted closer than 10 or 15 feet from the home's foundation. Because of this, it is usually practical only to shade portions of the roof. The type of tree that will work best will be tall, with little undergrowth and a wide canopy on top to extend over part of the roof area.

*The NC State Cooperative Extension Service provides several factsheets on North Carolina trees and plants. Visit their website at [www.ces.ncsu.edu/depts/hort/consumer/factsheets](http://www.ces.ncsu.edu/depts/hort/consumer/factsheets) or call your local Extension office to request a hard copy. Pertinent publications include **Selecting Trees** as well as information on vines and ground covers. For more information, consult a nursery or your local NC Cooperative Extension agent.*

Shrubs are often a good alternative for shading walls and windows because they grow more quickly than trees and may be planted closer to the house since their root structures are less likely to cause damage. Shrubs that grow well in North Carolina include hydrangea, azalea, holly, rhododendron, juniper and common box hedge.

Vines may be trained to climb string, wire, trellis or arbor structures to provide localized shade in the summer. Deciduous vines to consider in North Carolina include clematis, grapes, honeysuckle, pole beans, sweet potato and wisteria. Evergreen vines, which should be used only in situations where winter sunlight is not needed, include Carolina jasmine, confederate jasmine, euonymus and ivy. Be sure that there is adequate space between shrubs or vines and the house to allow air flow and help prevent mold or mildew formation on the wall. Vines grow quickly; make sure that they stay on their string or trellis structure and do not move onto the house in order to avoid damage to the siding.

Ground covers can significantly reduce the temperatures surrounding the house and reduce the amount of sunlight reflected into windows. The temperature above a healthy lawn can be more than 10° cooler than that above a concrete or asphalt surface. Even lower ground temperatures may be achieved with ground covers that have irregular surfaces such as longer grasses, vines or shrubbery (although it is unlikely that your neighbors will consider this an acceptable excuse for not mowing your grass). Ground covers that grow well in this area include vinca, ivy, candytuft, low-growing juniper, winter creeper, liriope and ajuga.

### Encouraging Warming Solar Radiation in Winter

While the opportunities to reduce summer cooling energy consumption offered by shading are quite valuable, care should be taken to see that the landscaping strategies used to minimize cooling energy use don't adversely affect the potential for solar heating. Fortunately, since the sun's path is mainly in the southern sky in winter, this will affect only the southern portion of the home's landscaping. The area that needs to be left unshaded is known as the solar access zone.

For solar systems to work effectively, they need to be unshaded between 9 a.m. and 3 p.m., solar time. The sun's angles at these times define the boundaries of the solar access zone. At North Carolina's latitudes, this means that the wedge-shaped area extending from 45° east of south to 45° west of south of the home's solar collection surfaces (south windows, collector panels or photovoltaic arrays) needs to be kept free of obstructions. See Figure 4.

Unfortunately, there is not a simple number which defines how far southward the solar access zone needs to extend. Whether or not a tree (or other obstruction) extends into the solar access zone and causes shading depends upon two properties: *the height of the tree and its distance from the solar collection surfaces*.

Because the sun's position changes throughout the day, so too do the length and orientation of the shadows it casts. Figure 3 shows the shadow pattern for a tree during the prime solar collection hours of 9 a.m. to 3 p.m. This pattern is accurate only for a flat lot; for sloped lots, the geometry is slightly more complex. To access a **Sunchart**, which graphs the position and altitude of the sun at all hours of the day throughout the year and may be used to calculate shading on sloped lots, please refer to the NC Solar Center's free factsheet, **Siting of Active Solar Collectors and Photovoltaic Modules**, (SC 112).

Because the sun is at low altitudes in the brief times it shines from the east or west in winter, there is little benefit in leaving the east or west sides of the house unshaded for solar gain; the overall energy needs of the house are better met by making sure these sides are shaded during the summer. However, high branching deciduous trees make a good choice for the east side since they can both shade in summer and admit some winter solar gain.

### Deflecting Cold Winter Winds

Landscaping can also benefit your house in winter by decreasing infiltration, which can account for as much as 30 percent of a home's heat loss. Since higher wind speeds mean higher infiltration rates, planting windbreaks to reduce the wind speeds approaching the house can lower its energy needs.

Locate the windbreak on the windward side of the house (the direction from which the wind blows) in a way that it does not interfere with solar access. In the North Carolina mountains, prevailing winds come from the northwest year-round. For most of the central part of the state, prevailing winds come from the southwest from November to mid-August. On the coast, winter winds tend to come from the north and northwest. Wind direction is a very localized phenomenon, however, affected by such things as hills, buildings and lakes. **It is important to check the wind directions for yourself rather than assuming that they are the same as for the rest of the region.**

Use evergreen trees and shrubs for windbreaks on the windward side. (This includes the west side for most of the state). If sunlight or a view is important, a combination of deciduous trees and shrubs may be used, but this will be less effective.

The windbreak needs to be at least as tall as the house it is to shield and should be located at a distance of one to three times its height away from the house. Thus, the farther away it is from the house, the taller and wider it must be. If you plan to use full-size trees, you may want to plant a temporary row of faster-growing shrubs to provide some protection while the trees mature.

The windbreak should be dense, allowing 25 to 60 percent of the air to flow through, rather than solid, because solid windbreaks create turbulence behind them. The density of the windbreak should be maintained from the ground up without major gaps. A mixture of various shrubs and trees can help prevent these gaps. It is also a good idea to mix species within the windbreak to avoid the possibility of losing the entire windbreak to a disease which affects one species.

### Channeling Breezes for Cooling

Landscaping may also be used to help cool your home by leaving an open channel between trees or hedges in the direction of summer winds to direct the breezes on and into the house. Unfortunately, prevailing winds tend to come from the same direction in both summer and winter throughout much of the state, making this a difficult strategy to implement without disrupting the higher priority practice of providing a winter windbreak.

In the mountains, prevailing winds come year-round from the northwest; in the piedmont, winds come from the southwest except for mid-August through October, when they come from the northeast. Only on the coast do winds change seasonally;

winter winds tend to come from the north and northwest; summer winds from the south and southwest. Thus, it may be advantageous to leave an open channel to the northeast of houses in the piedmont region. The open solar access zone should help funnel breezes around homes on the coast. Again, it's important to check local wind conditions to see if they vary from the standard wind directions of the region.

Channeling summer breezes for cooling is worthwhile only if your household tends to use natural cooling practices (using open windows and fans). If allergies or personal preference cause you to normally leave your windows shut, there is no advantage in directing breezes onto your mechanically air conditioned house.

### Some Practical Considerations

When planning your landscaping, start with the existing trees on the site rather than cutting and planting new ones, since it will take some time before newly-planted trees reach their mature height. If there is some question about whether or not a tree should be removed, leave it in for a full year and examine how it affects your house's energy performance before deciding. Mature, healthy trees are difficult to replace.

If you're building a new house, discuss with the contractor which trees you wish left intact. You may want to set up terms for compensation if they are damaged. Erect a barricade around the driplines of trees you wish to save, because a red flag on the trunk will do nothing to stop pick-up trucks from backing into them. Inform the contractor that this dripline barricade area is not a place to throw trash during construction, because scrap lumber thrown against the trunk, or paint and solvent cans left dripping near the roots, can be fatal to the tree.

Plant hardy varieties which are native to the area, since they will be more resistant to disease and require less food or water once they are established. Beware of trees with water-seeking root systems, such as willows; they may disrupt water or sewer pipes.

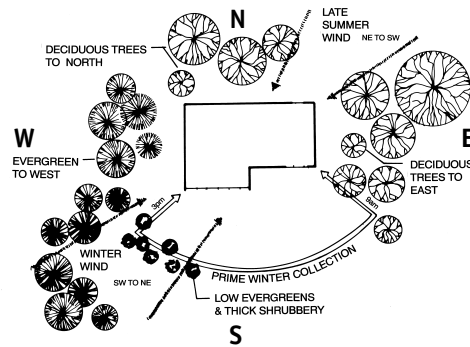


Figure 4. An energy-saving site plan for **central** North Carolina.

### What If My House Isn't Passive Solar?

A passive solar house is one which is designed with the majority of its glass area on the south face to collect heat in the winter. If your house has little south glass area, and you do not plan a solar addition at a later date, your house could benefit by following the general landscaping guidelines outlined here with the exception of maintaining a clear solar access zone. A house which is not designed to benefit from solar heating would benefit from having deciduous trees planted to the south. If you are considering mounting active solar collectors or photovoltaic arrays on the south roof, however, the roof needs to retain solar access.

### A Checklist for Energy-Saving Landscaping

- Shade the east and west faces of the house, giving top priority to the west side, and giving priority to shading windows over shading walls.
- Avoid shading of surfaces to be used for solar collection.
- Shade the area surrounding the house.
- Cover bare ground with lawns or other ground covers rather than paving where possible.
- Plant to provide a channel for summer breezes, if natural ventilation is used, and if it doesn't conflict with planting for a windbreak.

*Written by Lib Reid, Solar Engineering Specialist, North Carolina Solar Center. Revised in 2001 by Dona Stankus, Solar Extension Specialist, North Carolina Solar Center.*



North Carolina Solar Center  
Box 7401, NCSU, Raleigh, NC 27695.7401  
Phone: 919.515.3480 Toll Free: 1.800.33.NC SUN  
Fax: 919.515.5778 E-mail: ncsun@ncsu.edu  
Web: www.ncsc.ncsu.edu



State Energy Office, NC Department of Administration  
1830A Tillery Place, Raleigh, NC 27604  
Phone: 919.733.2230 Toll Free: 1.800.662.7131  
Fax: 919.733.2953 Web: www.energync.net

The NC Solar Center is sponsored by the State Energy Office, NC Department of Administration, and the US Department of Energy, with State Energy Conservation Program funds, in cooperation with North Carolina State University.