

Saving with Shade

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We all know that trees improve our lives. They make our homes look better, clean the air and make outdoor activities more pleasant.

Yet not everyone knows that trees also provide financial benefits. Properly located, they can cut a home's annual heating and cooling bill by as much as 25 percent.

If your yard has trees or if there are trees throughout the neighborhood, you're probably already enjoying their energy-saving benefits. By planting more and judiciously pruning trees that are there already, you may be able to increase the savings.

To be most effective, you need to plant the right kinds of trees in the right places. What is right for your house depends on your climate, the structure of your home and whether you use air conditioning, as well as the trees next door and those in the neighborhood.

Let's start with heat flow between the environment and your house.

Heat in, heat out

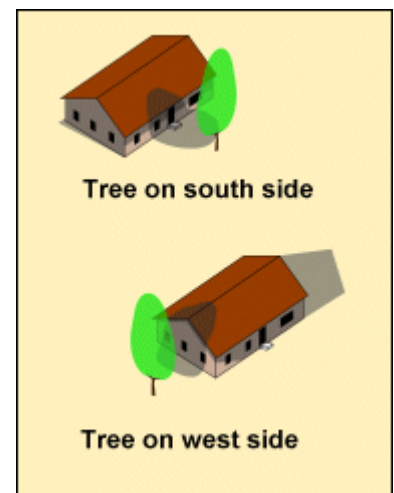
Every house is a solar home to some extent. The sun can provide much of the energy for heating even without special features such as solar panels. In fact, a recent study found that the sun provides a typical house in Madison, Wis., with a third of its winter heat-energy needs.

One way heat gets into or out of a house is by leakage of air through cracks and small pores in the building exterior or envelope - a process engineers call air infiltration. Air infiltration wastes energy in both high and low outside temperatures, but the energy loss is particularly high in cold climates.

When inside air is being heated to a comfortable temperature and the outside air is cooler, heat goes out with exiting air. The results of the Madison house, built with standard construction, are typical. One-third of the home's winter heat loss was the result of air infiltration.

Very cold outside temperatures increase the infiltration rate because the cold, dense outside air tends to seep into cracks and pores at lower levels of the house and displace warm, light inside air that tends to rise and escape at upper levels. High wind speeds have an even more pronounced effect on infiltration. So trees, which slow the wind, save heating energy.

Wind also exchanges heat with a house by convecting heat away



4 p.m. in July at the latitude of Columbus, Ohio. The tree on the west provides more benefit overall.

from outside surfaces of windows and walls when outside temperatures are cool and transferring it to the house when the weather is warm.

The convected heat first goes through the walls or windows by conduction, the movement of heat through a material in response to the temperature difference between the two sides. The value of insulation in reducing conduction is measured in units called R-values.

Convection of heat away from a wall or roof with high R-values is small. However, windows have generally low R-values. A two-thirds reduction in wind speed, which could be accomplished by trees, would reduce the heat loss by about 9 percent for double-pane windows and 13 percent for single-pane windows.

Your strategy for using trees or other landscaping may depend upon whether your house has air conditioning or a solar collector and the climate of your area.

Your climate

The best strategy for using trees to save energy depends on the amount of energy used for heating compared to the energy used by your air-conditioning system, if you have one.

Tree shade is especially important for hot climates, where the best strategy for energy-saving landscaping is to maximize shade with trees in the long warm season without concern for the fact that the trees will cause some loss of solar heat in winter.

Letting in the sun to help heat the house becomes important in the north and even in places like the Texas panhandle and higher elevations in the Southwest.

In most areas across the northern tier of states, there are warm summer days during which shade is welcome. However, windbreaks for reducing winter winds are likely to be more important, and tree arrangements should let winter sun into the house.

Only in extremely cool climates is summer shade not much needed. For most of the United States, heating needs predominate over cooling, but summer shade and access to the winter sun are both important, and reducing winds saves energy.

If you want to plant trees to reduce wind in winter, you'll want to plant to protect your home from common wind directions. For average monthly wind speeds and directions at a major weather station near you, look for tables of 'normals, means and extremes' on the Internet, or ask a local architect. The general flow of wind across the country is from west to east.

If you can't get local information, your best bet is to design your house and landscape with the assumption of west winds in winter. However, prevailing wind direction differs because of topography and bodies of water. For example, the average direction at Denver's airport is from the south in all months of the year.

The key to planting and managing trees for shading is to keep in mind the path of the sun across the sky throughout the year.

In mid-summer, the sun shines on the northeastern and eastern sides of buildings in the morning, passes high overhead near midday, then shines on the west and northwest sides in the afternoon. In mid-winter, the sun rises in the southeast, goes low across the sky and sets in the southwest.

Even locations in the north receive large amounts of solar energy on south-facing surfaces in mid-winter, and reflection from snow cover can greatly increase the sun on south walls. If you are in a cool climate and have large window areas on the south, you'll save energy by arranging trees to let in the winter sun.

The sun's high course across the sky in summer provides much radiant heat to east and west walls early and late in the day, whereas the high sun in mid-day strikes only a glancing blow to south-facing windows and walls, so that little energy is absorbed. The farther south you are, the less sun strikes your south-facing wall at noon in mid-summer. The opposite happens in mid-winter.

The low winter sun shines nearly perpendicular to a south-facing wall, so that energy on the wall and through windows is greater in winter than in mid-summer.

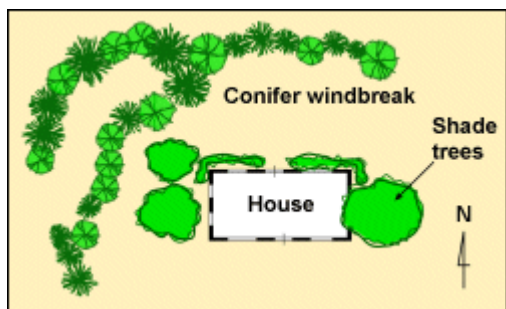
A tree south of a house may block more of the sun's energy to a south-facing wall in mid-winter than it does in summer. This is true even for deciduous trees, which lose their leaves in winter. We measured 45 percent reductions of solar energy on a south-facing wall in the shade of a single sugar-maple tree.

Now you can begin to visualize a good strategy for shading your house. If you have west-facing walls with windows, the first priority in all but the coldest climates is usually for trees on the west. They will block sun on the house in the summer afternoons when temperatures are commonly highest.

Trees on the south provide little benefit unless they are tall-growing deciduous trees close to the house, where they will shade the roof in summer. If a tree close to the south side of a house has a main central trunk, you can prune lower branches to allow winter sun to reach south-facing windows.

To increase sun on the house in winter in cooler climates, you can use 'solar friendly' trees - deciduous trees that leaf out late and lose leaves early, and that have large leaves but sparse branch structure.

Varieties of green ash (*Fraxinus pennsylvanica*) and white ash (*F. americana*) are solar-friendly trees that thrive in much of the country. Chinese pistache (*Pistacia chinensis*) is a solar-friendly tree commonly grown in California, but it does well across most of the south also.



A site plan showing the best places for windbreaks and shade trees in much of the U.S.

Redirecting the Wind

If your house is exposed to high winds because it is on a large lot in a neighborhood with few trees, or if it's in an open, rural area, it may be a good candidate for windbreak trees. Our computer simulations suggest that windbreaks for saving heating energy are worth considering for most areas of the United States except the very deep south.

With windbreaks on the north and west of a simple single-story house, the simulations predicted annual heating and cooling energy savings that ranged from 14 percent in Wichita Falls, Tex., to 19 percent in Minot, N.D., compared

to houses that were fully exposed to the wind.

For a single home, a row or two of dense conifers, planted close together within a row, can provide good wind protection. In most parts of the United States, the first location to consider for a windbreak is on the west side of the house; the second place is usually the north. This can vary with the prevailing wind directions.

Because they block winter sun, windbreaks close to the south side of the house may not be very beneficial; they may even waste some energy if you have a large area of windows facing south. In selecting trees for windbreaks, choose varieties that will be dense and relatively fast-growing. A windbreak is most effective after it gets at least as tall as the house. Plant trees close together within a row; six or eight feet apart is not too close for most species and too far apart for some of the very narrow trees, like most varieties of arborvitae. For small yards, hemlocks can be easily pruned on the sides to keep the row narrow, but don't prune between trees in the row.

Some species would make excellent windbreaks except on very exposed sites where windbreaks are most needed. Douglas fir (*Pseudotsuga menziesii*) is one of these, though it makes a rapidly growing, attractive, dense visual screen in moderately cool and moist climates, such as throughout the Northeast. Austrian pine (*Pinus nigra*) tolerates exposure well and is usually moderately fast-growing and dense. Norway spruce (*Picea abies*) is fast growing, moderately dense and easily established. Colorado spruce (*Picea pungens*) is slower growing, but may be the densest of all windbreak trees, and it adapts well over large parts of the country.

Windbreaks require a relatively large number of trees. The cost of planting will usually not pay for the energy saving benefits unless trees are planted when small.

Well-planted and -watered small trees will often adapt quickly and catch up to trees that were planted at larger sizes. Most garden shops and nurseries supply trees that do well in your area.

Trees in the neighborhood

Trees along your street and in other people's yards contribute to the climate around your house. For example, if you live in a neighborhood with many large trees, you already have a windbreak.

One of our studies found that all the trees working together in typical neighborhoods of single-family homes greatly reduced wind speeds. In a new Pennsylvania development with no trees, wind speeds amounted to 78 percent of speeds in a large open area. Yet, in neighborhoods where most of the original trees were retained when houses were built and in older neighborhoods with many large trees, wind speeds averaged only 34 percent of speeds in the open, even in winter when many of the trees had lost their leaves.

The vegetation in a neighborhood can also reduce air temperatures. For example, in continuous measurements during one August in Atlanta, we found that the temperatures in a residential neighborhood with 29 percent of the area covered by trees or grass averaged nearly 1 F degree cooler than an area with only 17 percent vegetation cover. The temperatures in an area with more vegetation were sometimes 3.5 F degrees cooler than in the lower vegetation area.

Tree management is not a substitute for good, energy-efficient house construction and maintenance, but it can contribute to comfort in winter and summer and reduce unnecessary heating and cooling bills in the process.

This article has been posted in its entirety from the Smart HomeOwner November/December 2001 issue.