Landscaping for Energy Conservation

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Planting trees and shrubs around your home will help to reduce heating and cooling costs. How much it reduces costs depends on your choice of plants and where you locate them.

Trees and shrubs also reduce noise and air pollution and make your home more attractive and valuable. Therefore, money spent on landscaping your home is a good investment.

First, do a site analysis of your grounds. Are there nearby hills? Are you on a slope? If so, what is the degree of slope? Is there a two story house nearby or is your house two stories? Which direction does your house face? It is vital to effective plant placement for energy conservation. For instance, if your house sits diagonally to north, summer sun will shine on all four walls and winter winds will blast the house more directly.

Do a wind study. Where do the average winter and summer winds hit your house? Use 4- to 5-foot tall stakes with bright banners on 10-foot centers in a grid pattern or at strategic points around your home. Generally, our winds are northwest in winter and southwest in summer, but they can be diverted by terrain and neighboring houses near your site. The average wind speed in Oklahoma is 12 mph. Gradual slopes can increase wind speed by 20 percent while steeper slopes create turbulence, therefore increasing costs or discomfort through air infiltration.

Note where buried pipes, cables, and sewers are as well as overhead wires that might limit your choice of trees. Have a soil analysis done to determine the best fertilizers to use to ensure plant growth.

Draw your house to scale and record all these facts on the plan. You'll also need a protractor, compass, and straight edge. An adjustable triangle would also be helpful. See Table 1 and record the angle of the sun in June and December for your location. Then use the protractor to draw those angles as indicated in Figure 1.

Our "period of concern" in the winter is between 9:00 a.m. and 3:00 p.m. Other than this period of time the sun is so low on the horizon that there is very little sunlight on the east or west walls. In Figure 1, notice the difference between the angles of the sun at 3:00 p.m. in December, March, and June. Then notice the angles at 9:00 a.m., noon, and 3:00 p.m. on June 21. The angle is more nearly directly above. Heating of east/west and south walls is intense in summer. If we lived in a cold climate we would not want anything to grow in the path of the winter sun, and we want to be aware of the December 21 angle if we have a solar collector on the roof or a solar wall. There is a 40 degree difference in the sun's angle from June to December in Oklahoma, not only in height above the earth, but also on the horizon.

Whether to shade the south side or not depends on the number of days we heat or cool. For instance, Guymon heats for 5,000 winter degree days (hrs.) while Idabel only heats for 2,500. However, Idabel cools 1,850 degree days or hours and Guymon cools only 1,000 during an average year. On the other hand southwest Oklahoma has about 3,650 winter degree days or about 152 days per year when heating is needed.

The sun always reaches its highest point at noon, refer to Figure 2, part A.

Table 1. Minimum-Maximum Sun Angles In Oklahoma.

Northern border 37˚ N Latitude	
Dec.	22-29.22˚ Angle
June	22-76.5˚ Angle
Stillwater-36˚-9' N Latitude	
Dec.	22-30.5˚ Angle
June	22-77˚ Angle
Oklahoma City-35.5˚ N Latitude (I-40)	
Dec.	22-30.7˚ Angle
June	22-78˚
Southern border-34˚ N Latitude	
Dec.	22-32.2˚ Angle
June	22-79.4˚ Angle

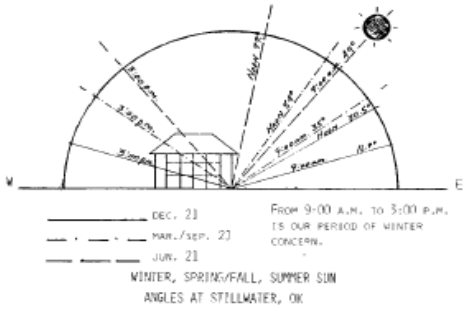


Figure 1. Winter, spring, summer, and fall sun angles at Stillwater, OK.

Anything taller than 20 feet will impede winter sunlight on a south residential wall. Measure where a 20-foot perpendicular line intersects the December 21, noon angle. At Stillwater this is 34 feet south of the house on a level grade. Thus if we don't want any blockage of the sun's penetration at a 30.5 degree angle we cannot plant a tree that grows more than 20 feet tall closer than 34 feet to the south wall of the house. Using a 34 foot radius strike an arc from the center of the south wall as illustrated in Figure 2, part B. At 9:00 a.m., December 21, at Stillwater, the sun is 42.6 degrees from high noon, which is the time when solar heating begins. So set 42.6-degree angles from the southeast and southwest corners of the house to intersect the arc at 34 feet. Thus, the "area of concern" is formed where we must pay attention to tree height and type. It may be easier to run 45-degree angle lines from the corners. It will change the area of concern very little. Planting points of the first or last, east/west shade trees, will be on the angular lines from the corners.

Now notice tree heights and their locations by measuring a perpendicular line to the sun's angle at various dates and times in Figure 2, part A. If your tree is planted 15 feet from the house, has a height of 23 feet, an approximate spread of 30 feet, your eave height is no more than 8 feet and your overhang is at least 2 feet wide, no summer sunlight will touch the south wall of the house. If your eaves are taller and overhang shorter, the tree will have to be taller and may have to be planted closer to the wall. Notice the height of the line at noon on June 21 at 10 feet away from the house must be 49 feet tall to intercept the sun's angle. But at 8 feet, it only has to be 39 feet tall. The "X"s in the "area of tree height and open branching concern" mark these locations along State Highway 51. At this latitude, shade trees would be planted due south between 10 feet and 15 feet from the wall. To shade on the south should be decided by your current and projected heating and cooling costs.

Remember, as slope changes, usually soil type also changes. Slope permits or necessitates a change of tree species or planting spot. Height limitation is controlled by slope.

Planting for Shade

A shaded home has 2/3 less heat flowing into it from shaded walls versus sunlit wells. Unshaded roof temperatures often exceed 140° F. Light-colored roofs help, but not as much as trees. Well adapted oaks and other trees with full crowns are best for summer shading. Their high branches permit greater visibility and do not block the flow of cooling summer breezes. Where we want maximum winter sun, we should choose open branched species like Kentucky Coffee tree (*Gymnocladus dioicus*). A "thermodynamic" tree drops all its leaves between October 15 and November 15 (see Table 2).

Evergreens and pin oaks have cone-shaped crowns which provide less summer shade on walls and roofs. Their branches often extend to the ground, blocking visibility and the flow of cooling breezes. If planted in the wrong location, they may shield your house from the sun's warmth in winter (see Figure 3).

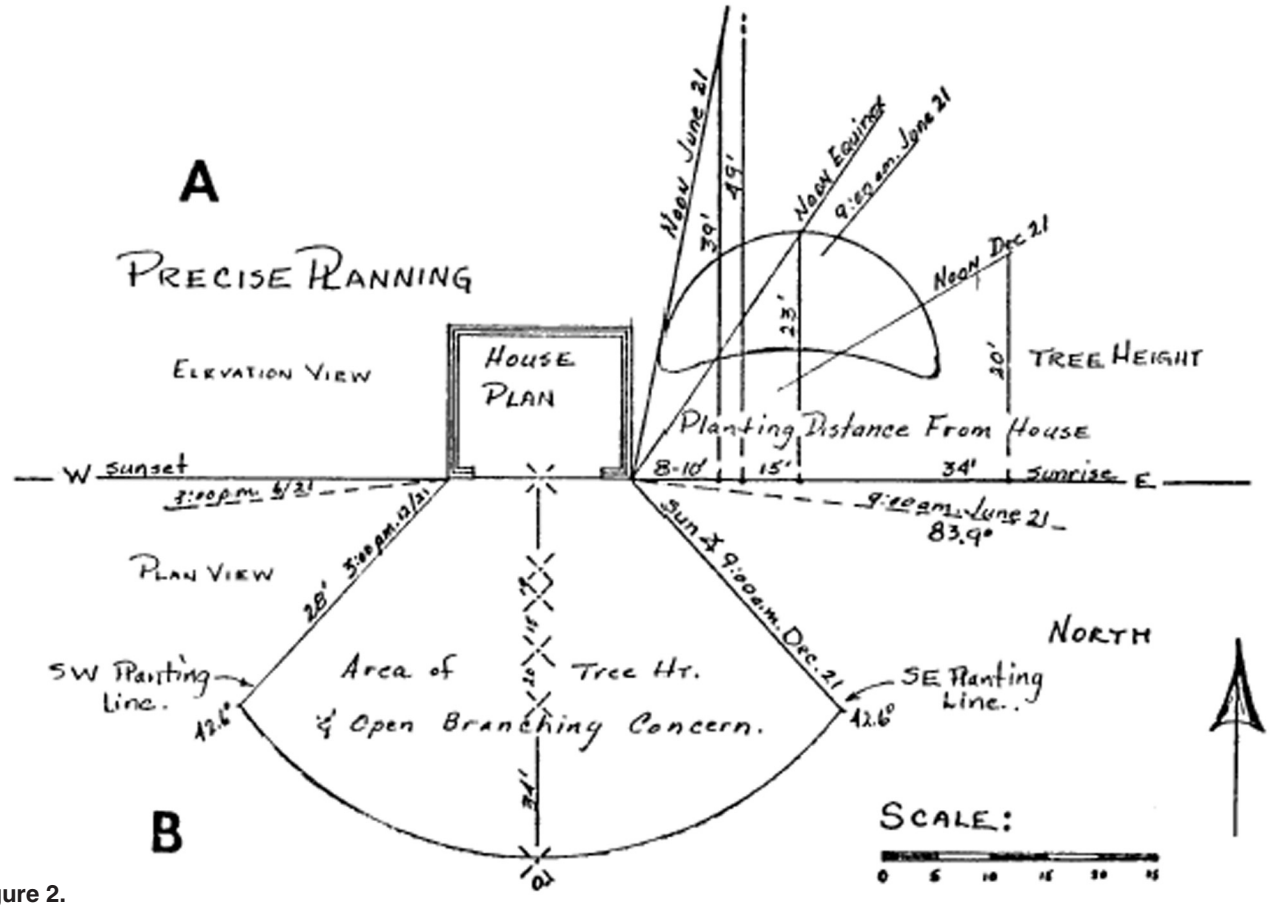


Figure 2.

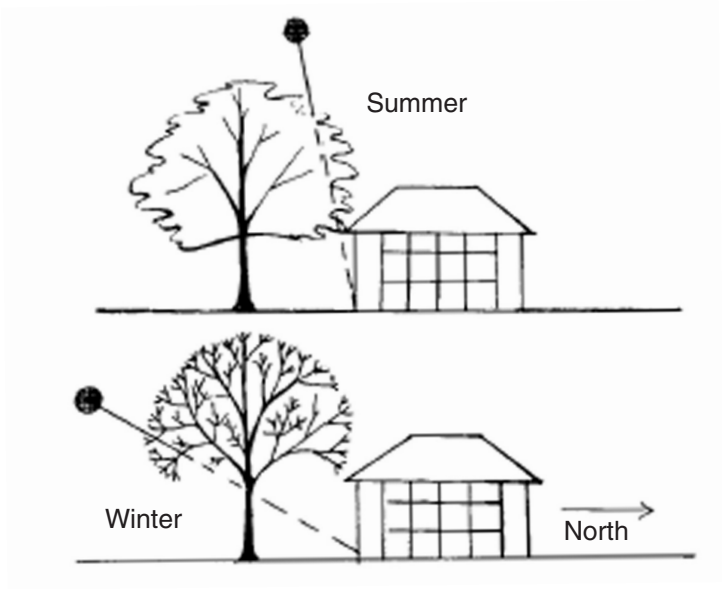


Figure 3.

Choose open branched trees for the south side where conserving energy in both winter and summer is about of equal concern. Any tree taller than 20 feet in the "area of concern" will impede winter sunlight from 25 percent to 95 percent depending on species. See Table 2.

Trees provide maximum shade when planted in groups beside your house. However, a roof need not be totally shaded to achieve excellent results. Strive for 20 percent or more of the roof shaded for the entire day.

Properly located deciduous shade trees are one of the most efficient sun control devices. Shade reduces summer heat gain per square foot on: south windows by 20 percent to 25 percent; south walls by 30 percent to 35 percent; east/west windows and walls by 50 percent. Choose large growing shade trees for east and west shade and plant them 10 feet to 20 feet from the house in parallel lines. Trees in the area of concern should have open winter canopies like Kentucky Coffee tree. Refer to Table 2 for a list of trees for energy conservation.

Studies show an 8°F difference between shaded and unshaded wall surfaces are equivalent to a 30 percent increase in insulating value for shaded walls. Temperature differences larger than 8°F between shaded and unshaded building surfaces are common and interior temperatures can be reduced up to 20°F.

Deciduous vines that cling to trellises along the wall can afford protection on the south and west sides of your house. Remember that vines which cling directly to the walls like Boston Ivy, may cause some wood deterioration. By providing direct shade on the walls, vines keep surface temperatures down and reduce convection-caused heat gain. Some additional cooling comes from the evaporation of moisture from the leaves. Evergreen vines such as English Ivy should not be used on walls facing south since the vines block the winter sun's warming rays. Vines may help to insulate walls on the northern and western sides by curbing winter winds. English Ivy also climbs by clinging. Clematis, Pepper Vine, and Wisteria are deciduous twining vines that are also suitable (see Table 2).

For specific information on trees, shrubs, and vines for landscape planting in your area, contact your local extension educator.

Colors also make a difference in heat absorption, though much less if shaded. For instance, flat white reflects about 90 percent of the light and radiation while black asphalt reflects only 15 percent of solar radiation. Concrete and brick reflect about 25 percent to 30 percent of radiation. Bare, uncultivated soil reflects only 10 percent to 25 percent radiation. Grass or leaf litter will be 10°F to 14°F cooler. A stone mulch absorbs most of the solar energy and radiates the heat to the soil which it touches. Neither a stone mulch nor bare soil should be used next to the house. Do not use stone mulches for plants.

Wind Effects

Unprotected homes lose much more heat on cold windy days than on equally cold still days. Well-located trees and shrubs can intercept the wind and cut your heat loss.

Up to one-third of the heat loss from a building may escape through the walls and roof by conduction. Wind increases the convective air currents along outside walls and the roof, thus increasing heat loss.

Infiltration or air leakage accounts for as much as one-third of heating losses in some buildings. Cold outside air flows in through cracks around windows, doors, and even through pores in the walls. Both windbreaks and foundation plantings can reduce this penetrating power of the wind.

Studies of windbreaks show that windbreaks can reduce winter fuel consumption by 10 percent to 30 percent.

The amount of money saved by a windbreak around a home will vary depending on the climate of the area, location of the home, and how the house is built. A well-weatherized house with adequate ventilation, caulking, and weather-stripping will not benefit from windbreaks nearly as much as a poorly weatherized house.

In addition to reducing the force of the wind, windbreaks also can reduce the windchill impact on people outside the house.

Studies of three-row windbreaks, where trees were 25 feet tall, show that wind velocities and the windchill index were effectively reduced by 60 percent for a distance of 125 feet downwind. It is estimated that a cedar-type windbreak will reduce wind speed from 12 mph to 3 mph up to two times the height of the trees. Thus, locate your windbreaks from two times to five times the mature height of the windbreak trees from the house. However, many urban homes do not have this much space, since you can expect the windbreak to take 50 feet to 150 feet of area. Even a single row of evergreens is beneficial. Where space for the windbreak is at a minimum, try some of the fastigate (narrrow and upright) juniper cultivars like skyrocket.

Vines on a wire fence, trellis, or arbor can make a major contribution to wind and sun control in a limited space. Check with nursery and garden center personnel for upright conifers that can be kept sheared tall, thin, and dense. Windbreaks should extend beyond the area to be protected since wind speed increases at the ends of the windbreak. Where space permits windbreaks of two to five rows of trees and shrubs extending 50 feet beyond the ends of the area should provide good protection. Trees should be spaced 6 feet apart in the row and the rows should be 10 feet to 12 feet apart with trees planted in staggered arrangement. Evergreen trees provide the best protection, although dense branching deciduous trees

(continued on page 6)

Table 2. Explanation Points.

1. Common name of plant.
2. Areas of adaptation within the state. A north/south line running through Bristow will divide the eastern area (E) from the central area (C), and a north/south line running through Hennessey will divide the central area from the western area (W). Panhandle (P) stands for the panhandle counties. Plants can be expected to grow much better if they are selected on this basis.
3. Temperature as well as rainfall and wind affect plant survival. The letter (Z) stands for temperature zones. See Figure 5. Heat and cold both affect plant performance. Some plants will be shown as a fraction for the zone like Lilac (Z 3/7). Thus, lilac grows well from Minnesota south to the Arbuckle Mountains in Oklahoma, but they perform poorly along the Red River from Altus to Idabel.
4. Soil type is a major factor in plant survival too. (ANY) stands for most soils including sand and clay, however few plants grow well in pure sand or heavy clay. The letter (L) stands for a well percolated loam type soil. Impervious clay soils would be especially limiting to these plants. How you plant the tree is also important. Ask your County Educator for HLA-6414 "Planting Shade and Ornamental Trees." Sizes indicate tree heights except when (X) appears between the numbers. In these cases spread precedes height.
5. Exposure to the amount of sun or shade is another important factor in plant survival. (S) means the plant must have almost total sunlight; (Ps) means it will grow well or better in a mixture of sun and shade, from one-half day of each or 50 percent shade or sun all day; (Sh) means the plant would be scalded and probably die if that was the only column checked. Some plants like Red-Osier dogwood are somewhat indifferent to exposure.
6. Growth rate of slow (S), medium (M), or fast (F) is the relative speed of growth that can be expected from each species. Fertilizer and water can stimulate a slow growing plant to moderate or a moderate one to fast growth. Ask your County Educator for HLA-6412 "Fertilizing Trees and Shrubs."
7. Comments are designed to alert the reader to potential problems or concerns. For example, "needs training" means the first five years you must prune to guide the growth. Ask your County Educator for HLA-6409 "Pruning Trees and Shrubs" and HLA-6415, "Training Young Trees."

Table 2. Plants for Energy Conservation

(1)	Oklahoma (2) area (3)					Soil (4)	(5) Exposure			(6) Growth Rate			(7)
Plant Name	E	C	W	P	Z	Size	S	Ps	Sh	S	M	F	Comments
WINDBREAK PLANTS													
Decidous Shrubs & Small Trees													
Oklahoma Redbud	•	•	•	•	4	L/12-15'	•			•			Pest free
Euonymus, Pink Lady	•	•	•	•	4	Any/15-20'	•	•			•	•	Scale free
Honeysuckle, Winter	•	•	•	•	5	Any/8-10'	•					•	Persistant leaves
Jasmine, Winter	•	•	•	•	6	Any/3-6'	•	•			•	•	Spreading
Lilac, Persian	•	•	•	•	3/7	Any/3-10'	•	•			•		Suckers sometimes
Maple, Amur	•	•			2	Any/15-20'	•	•			•		Needs training
Maple, Hedge	•	•			4	Any/15-30'	•	•		•	•		
Mentor Barberry	•	•	•		3	Any/5-8'	•			•	•		Persistant leaves
Pampas Grass	•	•	•		5	Any/6-8'	•					•	No wet sites. Cut back in early spring.
Privet	•	•	•	•	3	Any/6-15'	•	•				•	Common hedge
Red Osier Dogwood	•	•	•	•	2	Any/4-8'	•	•	•				Wet sites. Suckers.
Russian Olive	•	•	•	•	2	L/20-30'	•				•	•	Kesleyi to 2'.
Sumac	•	•	•	•	2	L/20-30'	•				•	•	Suckers. Likes dry sites.
Tallhedge (Rhamnus)	•	•			2/7	L/3x12'	•	•		•			May be pest prone.
VINES													
American Bittersweet	•	•	•		3/9	Any/20-30'	•	•				•	Attractive fruit
Ampelopsis, Porcelain	•	•	•	•	4/8	Any/to 30'	•					•	Twines
Boston Ivy	•	•	•		4/8	Any/to 30'	•	•	•			•	Clings
Clematis, Sweet Autumn	•	•	•		5	L/to 20'	•	•				•	Twines
Crossvine 'Tangerine Beauty'	•	•	•	•	5/9	Any/30'	•	•				•	Semi-evergreen
English Ivy	•	•	•	•	4	L/to 20'		•	•		•		Clings
Grecian Silkvine	•	•	•		5/9	Any/20-30'	•	•				•	Deciduous; fast cover
Passionflower Vine	•	•	•		6/8	Any/20-30'	•	•				•	Native except in southwest and Panhandle
Sliverlace or Fleece Vine	•	•	•	•	4/7	Any/to 30'	•	•				•	Twines
Trumpet Creeper, Madame Galen	•	•	•	•	4	Any/to 30'	•	•				•	Twines, no suckers.
Trumpetor Coral Huneysuckle	•	•	•	•	4/9	Any/10-20'	•	•	•			•	Twining
Virginia Creeper	•	•	•	•	2	Any/to 30'	•	•	•			•	Clings
Wisteria, Chinese & Japanese	•	•	•		4	Any/to 30'	•					•	Twines

Table 2. (con't.) Trees are ranked in order of open winter branching systems with the most open being first. For general use landscape plants see your local Extension Educator.

(1) Plant Name	Oklahoma (2) area (3) E	C	W	P	Z	Soil (4) Size	(5) Growth (6) Exposure S	Ps	Sh	Rate S	M	F	(7) Comments
Large Deciduous Trees													
Kentucky Coffee Tree	•	•	•	•	4	Any/60-80'	•		•	•	•		Females have pods.
Pecan	•	•	•		5	L/60-150'	•	•		•	•		Messy, pest prone.
Ginkgo, Male	•	•			4	L/40-60'	•			•			Female fruit stinks.
Cottonwood, Male	•	•	•	•	3	Any/60-100'	•					•	Female messy
Black Walnut	•	•	•	•	4	Any/80-100'	•	•					Pest prone, messy.
London Plane Tree	•	•	•	•	4	L/40-60'	•			•	•	•	Messy
Sycamore	•	•	•	•	3	L/60-150'	•	•				•	Messy, pest prone.
Tulip Tree	•				4	L/60-100'	•				•	•	Not drought tolerant.
Honeylocust	•	•	•	•	4	Any/60-80'	•					•	Pest prone
Goldenrain Tree	•	•	•	•	5	Any/25-30'	•				•	•	Boxelder bugs possible.
Bur Oak	•	•	•		3	L/60-80'	•			•			Big acorn, messy.
White Oak	•	•			3	L/60-80'	•			•			
Fruitless Mulberry	•	•	•	•	3	Any/30-40'	•					•	Needs training.
Chinese Pistache	•	•	•	•	6	Any/30-40'	•			•	•		Root rot in old cotton fields in S.W. Needs training.
EVERGREENS for Windbreak													
Arborvitae, Excelsa Green Giant	•	•	•	•		Any/10-30'	•				•	•	Bagworms. Many cultivars.
Arizona Cypress	•	•	•		6b	Any/30-40'	•					•	Bagworms
Austrian Pine	•	•	•	•	4/8	L/20-60'	•			•	•		Well drained soils. For all
Japanese Red Pine	•	•	•	•	5	L/20-30'	•				•		pines. All young pines
Lumber Pine	•	•	•	•	4	Any/30-50'	•			•			but Austrian, subject to
Ponderosa Pine	•	•	•	•	5/7	L/20-60'	•			•			pine tip borer.
Scotch Pine	•	•	•		2/8	L/20-60'	•				•		
Pyramidal Scotch Pine	•	•	•	•	2/8	L/8x30'	•			•			
Pyramidal White Pine	•				2/7	L/8x30'	•					•	N.E. OK only
Eastern Red Cedar	•	•	•	•	2	Any/30-35'	•	•			•		Bagworms
Skyrocket cultivar						Any/2'x20'	•				•		Slim
Columaris Rocky Mt. Juniper			•	•	4	Any/2'x20'	•				•		Slim
Gray Gleam Juniper			•	•	4	Any/10-15'	•				•		Good for dry sites.
Keteleer Juniper	•	•	•	•	3	Any/15-30'	•				•		Disease free
Fragrant Elaeagnus	•	•	•		7	Any/8-10'	•	•				•	
Pfitzer Juniper	•	•	•	•	3	Any/10x6'	•	•			•	•	Bagworms
Pyracantha	•	•	•	•	9	Any/8-10'	•	•			•		Pest prone

* Root hardy through zone 6.

** Dies back with frost, but grows back from roots in spring.

can significantly reduce windspeed. Height and density are the most important factors when selecting plants to reduce wind.

Windbreaks can be located to control snow, too. This reduces the energy required to remove the snow from around homes, other buildings, and roads. Make sure windbreaks are located to have the desired effect on drifting snow. They should not be more than seven times the anticipated heights from the road. Maximum protection is within an area five times the height of the trees.

Foundation Plantings

Trees and shrubs planted close to buildings reduce wind currents that otherwise would chill the outside surfaces. These foundation plantings even create a "dead air" space which slows the escape of heat from a building (see Figures 4, 5, and 7). Such plantings also help reduce air infiltration losses around the foundation of the house. Again, evergreen trees and shrubs are thicker and are more effective than deciduous plants. To be most effective, the evergreens should be planted close together to form a tight barrier against air movement.

In summer, the same dead air space helps insulate your home from hot outside air, thus reducing the need for air conditioning.

In hot, humid areas it may be necessary to thin heavy vegetation, especially at the understory level, to increase air circulation in summer. However, a cooling breeze in passive

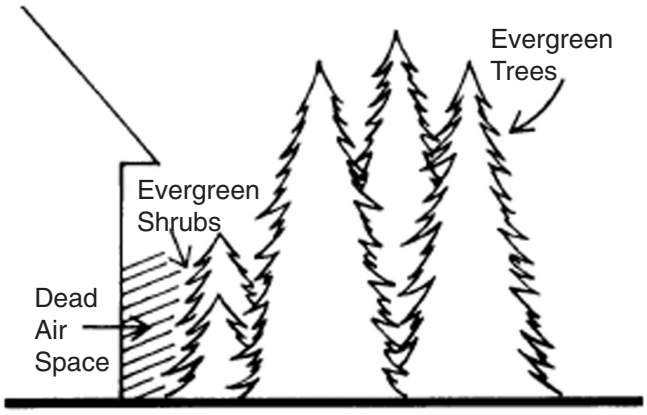


Figure 4.

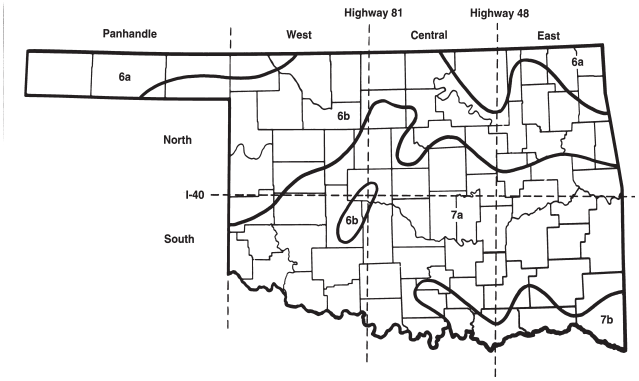


Figure 5. Average minimum winter temperatures decrease 10˚F by each lower zone number. Parts "a" and "b" within each zone vary by 5˚F. The USDA temperature zones start with 1 at the Arctic Circle and end with 10 in Florida. Oklahoma's temperature zones include 6a through 7b.

cooling actually increases cost when the air conditioner is in use due to warm air infiltration.

On the other hand, cold air flows downhill like water, especially at night. Houses, fences, hedges, and shrubbery can form a dam resulting in cold air penetrating the house and more severe freeze damage to plants. Many urban yards are little more than frost pockets in the winter. You may have to open a gate or cut a hole in the hedge to let the cold air flow out of your yard. Try to arrange plantings to shelter sliding glass patio doors from cold air without trapping it there (see Figure 6).

Windbreaks of two to five rows of trees and shrubs generally provide good protection. Height and density are the most important factors when selecting plants to reduce wind.

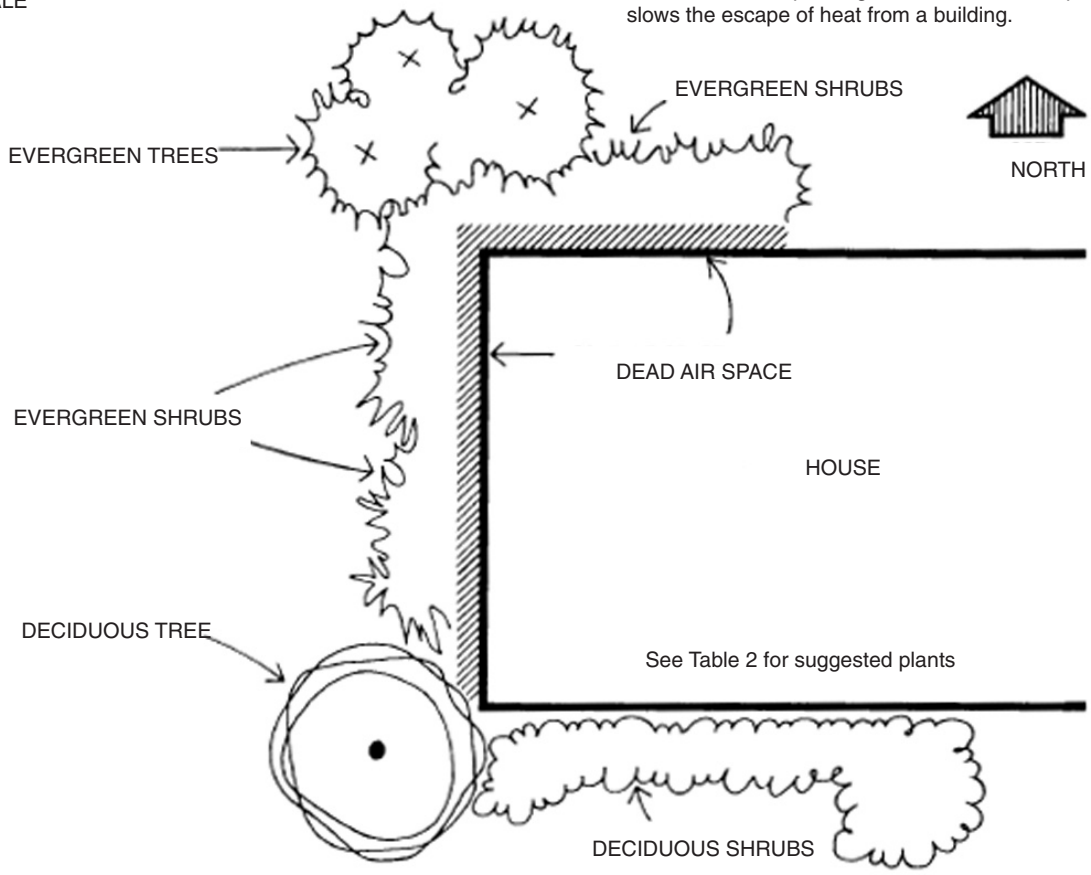
The amount of money saved by a windbreak around a home will vary depending on the climate of the area, location of the home, and how the house is built.

What and where we plant will depend on where we live. To achieve the maximum savings, plan with the day length and sun angle as they vary during the season. Note there is a 40 degree difference between the sun's angle on June 21 and December 21 in Oklahoma. Thus wind protection from the northwest is important in the winter and shade on the south and southwest in the summer. We plan for our shade trees based on the June 21 day sun's angle.

TYPICAL FOUNDATION PLANTING

NO SCALE

Trees and shrubs planted close to buildings reduce wind currents that otherwise would chill the outside surfaces. These foundation plantings create a "dead air" space which slows the escape of heat from a building.



A "Thermodynamic" shade tree drops all its' leaves between Oct. 15 and Nov. 15.

Figure 6.

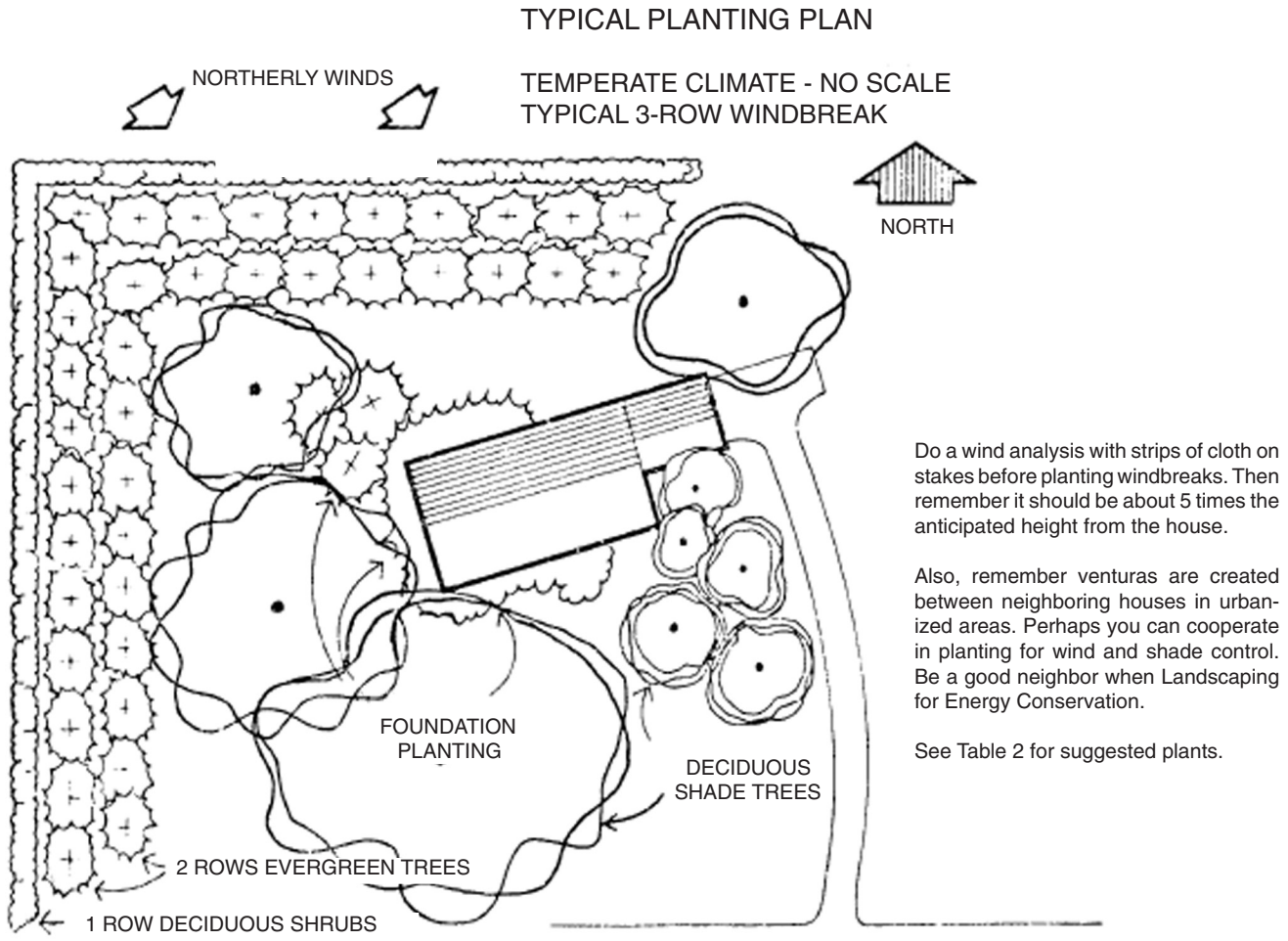


Figure 7. Typical Planting Plan.

The author greatly appreciates the help given by Ken Jones, former Extension Agriculture Specialist, for assistance in preparing the sun angle tables, and former Extension Ornamental Horticulturist Paul Mitchell for providing original material for this fact sheet.

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