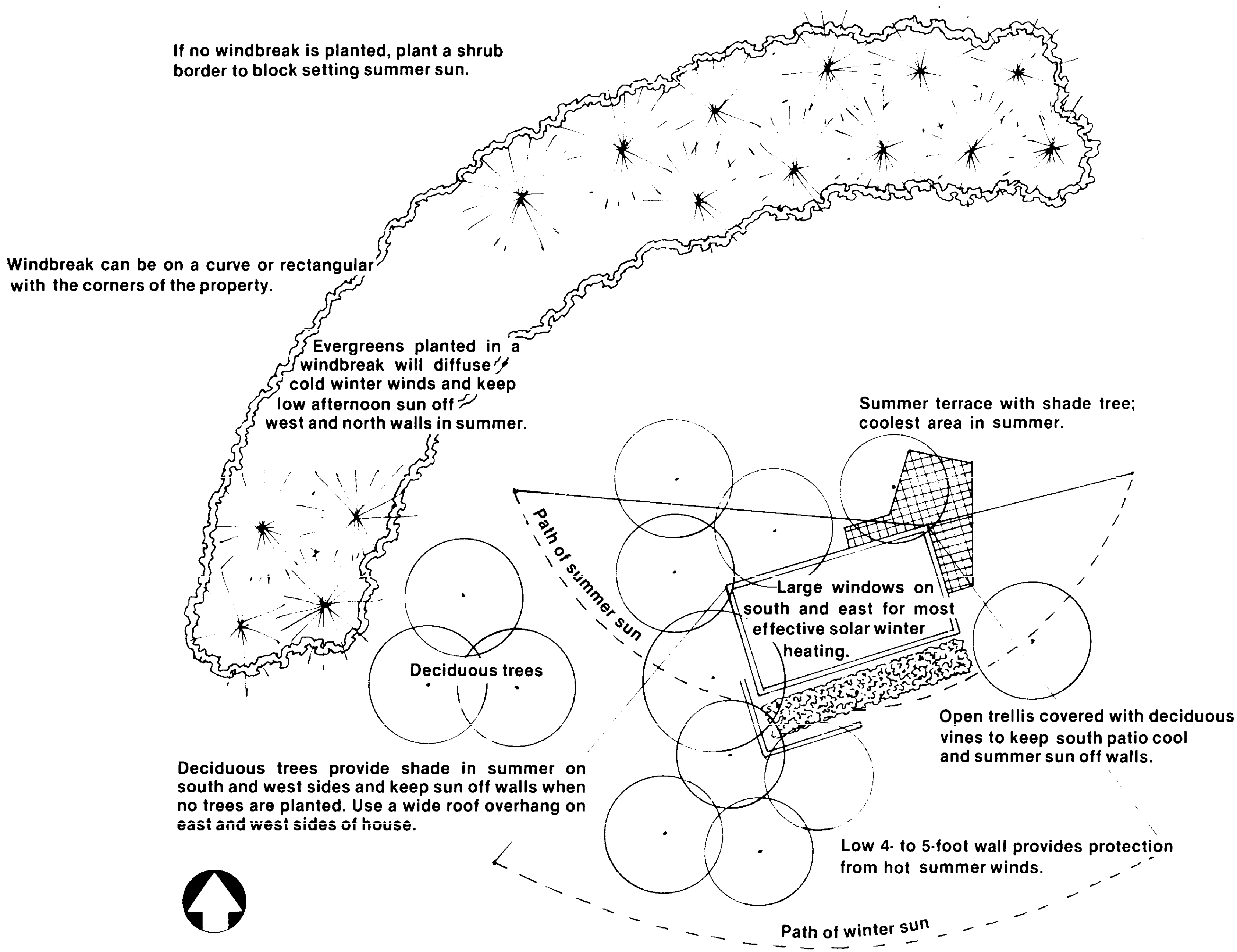
Energy Efficient Landscaping

Kansas State University
Agricultural Experiment Station
and Cooperative Extension Service



Major Plant Arrangement for Energy Efficiency

Introduction

Recently, an architect was asked to review 15 houses featured in the 1981 Parade of Homes in Manhattan, Kansas.

Many of these new homes claimed to have energy-saving features. The reviewer found that few, if any, were responsive to the energy-conserving potential of siting, orientation overhangs or external shading devices, and strategic plantings or functional landscaping.

Using plant materials wisely can help reduce your energy costs. Winter heating bills may be reduced as much as 15 percent while the energy needed for summer cooling may be cut 50 percent or more. Given rising energy costs, even a 10 percent energy saving can be significant to the homeowner.

By selecting and placing plant materials properly, you can create shade, channel cool breezes, block winter winds, and control other factors, such as glare.

Plants also can play a psychological role. For example, you feel cooler in the summer by looking at blue flowers massed together in a border, and a group of blue spruces on an open green lawn can make a hot day seem less oppressive.

Even so simple a consideration as placing your mailbox in the shade can make bringing in the mail more pleasant.

Bringing in the mail becomes a pleasant chore when your mailbox is in a shady place.

Contents

Considerations Before Planting

Radiant Heat

The amount of radiant heat the sun adds to a building depends on the sun's position in the sky and on the intensity of sunlight. Clouds, air pollution, and the density and thickness of the atmosphere affect intensity and radiation.

In winter, when the sun stands lower in the sky, it must penetrate a wide belt of the atmosphere and it loses some of its intensity; even so, it is still a reliable source for solar heating.

Approximately one-fifth of the sun's rays reach the earth's surface directly. Part of these rays are reflected.

The sun's heat combined with the reflection can be unpleasant. For example, imagine yourself sitting in a metal chair on a south-exposed concrete patio in August with a metal table in front of you. You would be well beyond the human comfort zone of 69 to 80 degrees Fahrenheit.

If you select and place shade trees properly, however, you can bring temperatures back to within the comfort zone, or at least make that patio more comfortable in the summer.

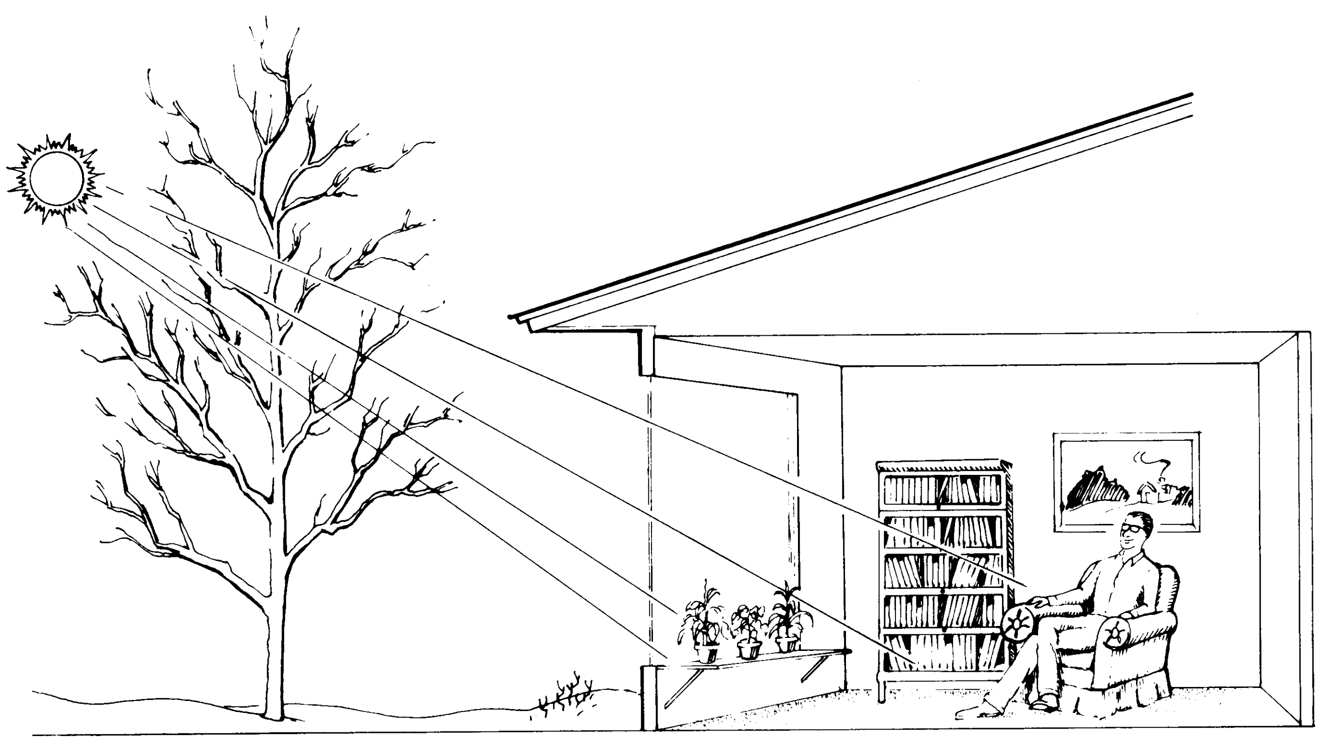
Effects of Winter Winds

We can also shelter ourselves and property from a blustery winter wind by careful landscaping. In designing residential landscapes, consider the direction of the winds in each season, the effect these winds have on human comfort, and how these winds can be controlled by plantings.

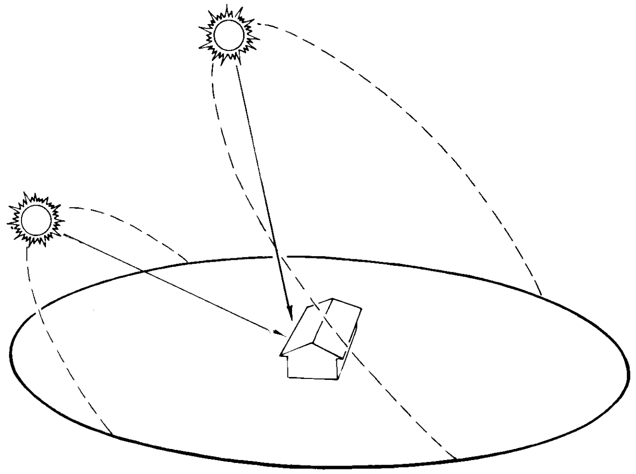
Winter winds generally blow from the northwest, the cooler portions of the United States and Canada. They have a chilling effect on the perceived air temperature. For example, a 10-mile-per-hour northwesterly wind will make an air temperature of 44 degrees Fahrenheit feel like 32 degrees Fahrenheit.

Winds accelerate the rate of air exchange between a house's exterior and interior environments, which results in an increased demand for heating fuel.

An experiment reports a difference in fuel use of 23 percent between a house that was landscaped to minimize the air infiltration and an identical house exposed to the winter wind. At times of high snowfall, winter winds accelerate snowdrifting, and



Deciduous trees lose their leaves in the winter, allowing the sun's rays to enter and heat the house.



The sun's position differs in summer and winter.

unprotected broadleaf evergreen plants may be desiccated by direct exposure to winter winds.

Windbreaks should be designed to intercept and redirect the winter winds before they reach the house, outdoor work or play areas, sensitive plants, and roads and driveways.

During winter, functional home landscaping would capture the sun's rays and block northerly winds. By selecting and placing evergreen trees properly a homeowner can help control winter winds.

Effects of Summer Winds

Summer winds in Kansas generally blow from the south. Although they may gust occasionally to high speeds, they are more moderate in velocity than winter winds, and their effects on human comfort are positive. For example, when relative humidity is in the 70 percent range, a nine-mile-per-hour wind can make an actual air temperature of 85 degrees Fahrenheit feel more like the high 70s—back into the range of human comfort (69 to 80 degrees Fahrenheit and 30 to 70 percent relative humidity). Most people enjoy those summer breezes through the house, and using them efficiently reduces the need for air conditioning. It is generally best to channel them through the living areas.

Heat Exchange in Houses

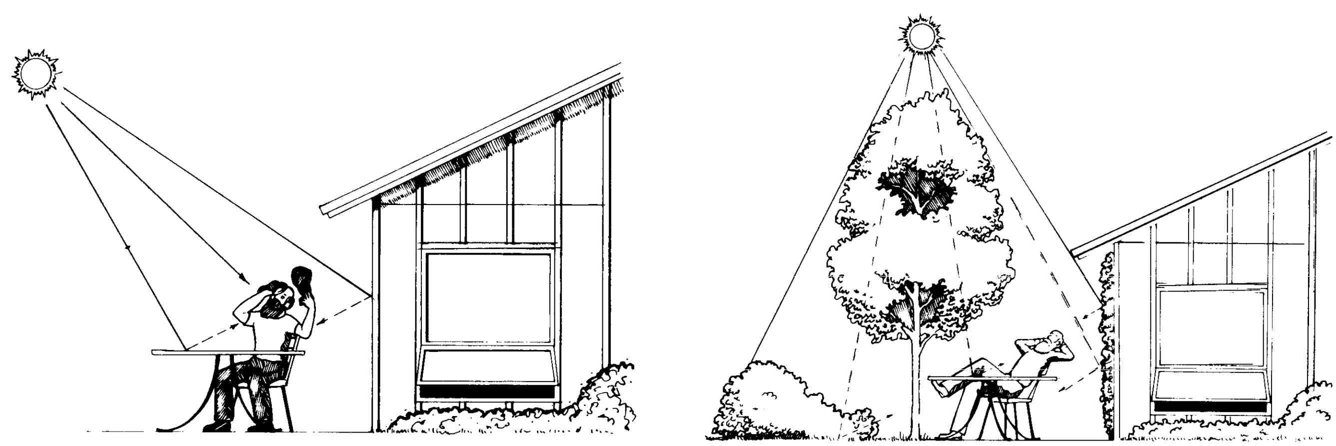
To take full advantage of the effects of landscape vegetation you need to understand the ways houses gain or lose heat. Heat exchange occurs through air infiltration, heat conduction, and radiation transmission through windows.

Air infiltration is the movement of outside air into the home through cracks around doors and windows, porous materials, open doors and windows, and other openings.

There is a pressure difference between inside and outside caused either by the force of the wind on the outside of the home or by temperature differences between inside and outside air.

The surfaces that face the wind will experience increased air pressures as wind velocity increases, and air will enter through openings in these surfaces. The incoming air will force an equal amount of interior air out through openings in the surfaces facing away from the wind. A properly placed windbreak will control this infiltration.

Because warm air rises, temperature differences between inside and outside also will create a natural circulation of air in the home. Warm interior air will rise and flow out through openings near or at the top of the house while outside air is drawn through the lower openings. This type of circulation has been referred to as the "chimney effect."



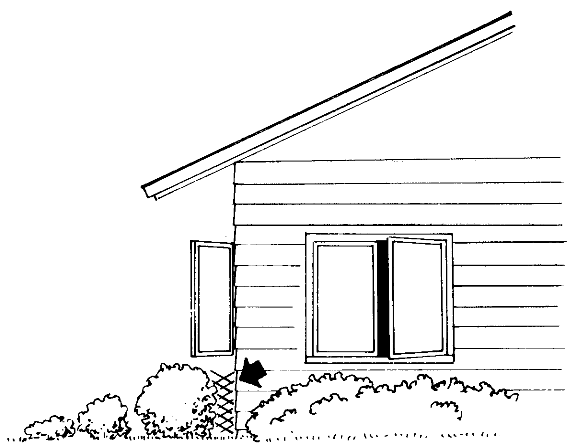
Direct and reflected radiation is reduced greatly with the use of plant material.

Air infiltration created by temperature differences and that caused by the wind often occur at the same time. The chimney effect is more important in winter because of the large temperature differential between interior air and the outside air. The combination of high winds and temperature difference can cause a high air infiltration rate.

The result may be a complete air change within a house as often as several times an hour. In winter, heat losses from air infiltration may represent up to half the total losses. For the average home during normal winter conditions, from 20 to 33 percent of the heat loss is by air infiltration.

In the summer, air infiltration is a minor component of heat exchange in cooler northern climates. Conversely, in hot arid climates summer air exchanges may be effective in decreasing the heat load on a home—hence the benefit of trees shading the roof and exposed walls.

Properly placed landscape vegetation reduces air infiltration by cutting the velocity near the house. Its effect on air infiltration will depend on the extent to which wind pressure rather than temperature differences is causing the air exchange.



Dead air space and double-pane windows reduce heat conduction.

Heat transfer also occurs via the building materials of the home. Heat conduction through solids is controlled by the thermal conductivity of the building materials, their thickness and the surface area available for heat flow (for example, area of walls, floor, glass, or ceiling), and the temperature difference between the inner and outer surfaces of the material.

Thermal conductivity is a way of comparing the rate at which heat can be transferred through materials—from a hotter to a cooler surface for a standard thickness, surface area, and temperature difference.

A layer of still air has the lowest rate of conductivity of materials commonly found in the home. Insulation is effective in reducing the rate of heat conduction because it traps air within its pores.

Most walls and ceilings are composites of materials and reduce heat conduction by trapping air within or between the layers. Glass windows conduct heat rapidly unless you use the double-pane or storm window.

To reduce heat conduction, control the temperature difference between the inner and outer surfaces of walls, ceilings, and floors.

The inner surface temperature is largely the result of the interior air temperature. One way to conserve energy in winter is to lower the interior temperature, thus reducing the temperature difference between inside and outside surfaces.

Outside air temperature, wind velocity and solar radiation, as well as the amount of heat being conducted through the material, affect the outer surface temperature. Full sunlight can raise exterior surface temperatures to levels considerably above the outside air temperatures, but this difference will be reduced somewhat at higher wind velocities.

Landscape vegetation can reduce the amount of sunlight reaching the outer surfaces of a house. It thereby reduces the temperature difference between inner and outer building surfaces in summer when heat is being conducted rapidly *into* the home. In winter, however, sunshine on the building's outer surfaces can help reduce heat loss, and winter shade would interfere. Only deciduous plant material should be used close to the house on the east, south, and west exposures.

Heat conduction generally represents from 33 to 50 percent or more of the total heat exchange between a house and the surrounding environment.

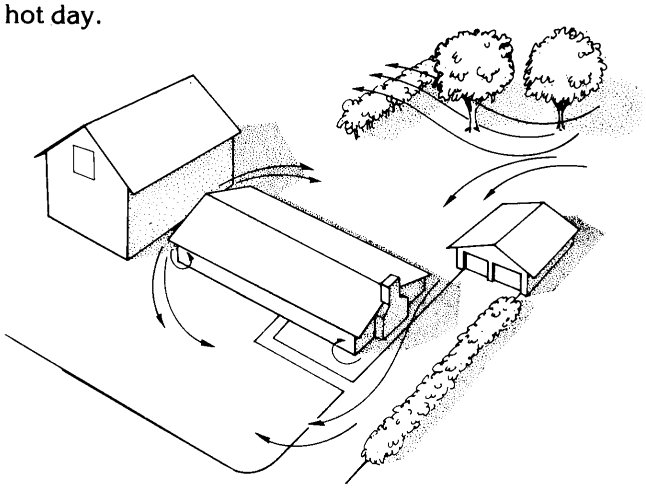
A third and highly variable mechanism for heat transfer into homes is solar radiation transmitted through windows or other glazed surfaces. *Radiation* transmission is essentially a one-way process. Short-wave radiant energy from the sun can pass easily in through the windows, but long-wave radiation from inside the house cannot be transmitted back out.

Obviously, the size, position, and type of windows in a home relative to the position of the sun in the summer and winter sky greatly influence the role of transmission in home heat exchange. Vegetation around a home also can influence radiation transmission by blocking sunlight to windows at midday.

Microclimates

The climate of a local area, a modification of the general climate, often is referred to as the microclimate.

Microclimates are the result of the structures and plantings on your property as well as those of your neighbors. For example, the house, garage, fence, and plantings alter and direct wind patterns, create shade, and increase light and heat reflection. Narrow spaces between buildings can act like wind tunnels, increasing air flow on a summer day. These wind tunnels can be very beneficial especially on a hot day.



A microclimate includes the buildings and trees on your property and those in the vicinity.

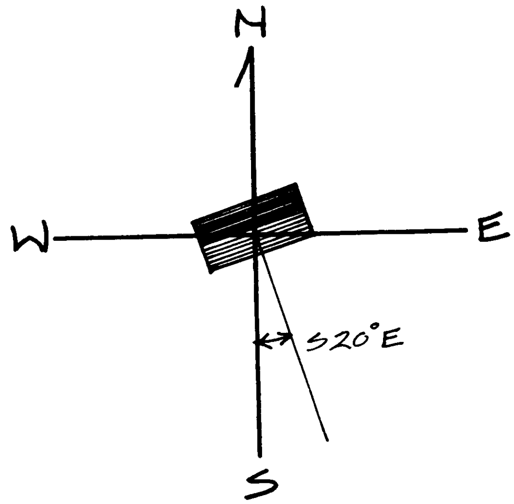
Other characteristics of microclimates include ground surface and vegetation. Dark ground surfaces absorb more heat and reflect less than light surfaces; smooth surfaces reflect more heat than rough surfaces; the amount and character of the vegetation affect the amount of heat absorbed or reflected. Vegetation, in general, absorbs more and reflects less than bare ground and water.

Site Selection

Carefully choose your building site. On a farm there may be more choice sites. On a lot in town you may be able to break away from the traditional house placement depending on the grid system of the streets.

The optimum site would be a gentle slope with a south to southeast exposure. If a less favorable site must be selected, architectural style and landscape planning become even more important.

In the new additions of some Kansas communities, developers have made better use of changes in topography: in some places the roads follow the land. The result is a wider choice of lots on which to landscape and build with energy conservation in mind.

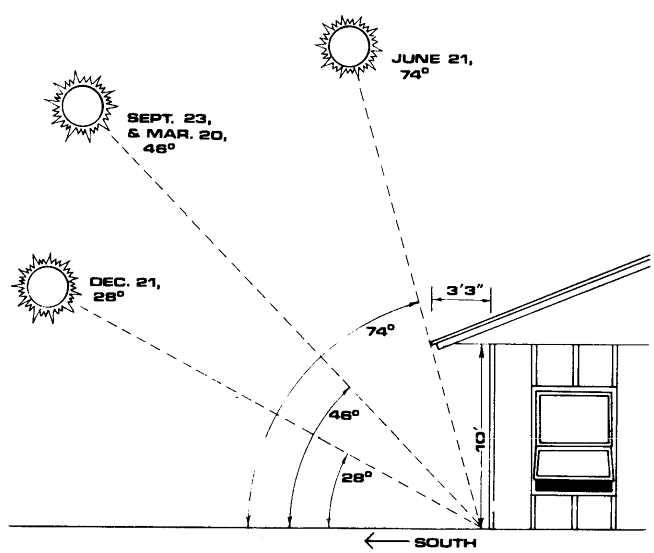


The optimum structure orientation for a house in Kansas is south 20 degrees east.

An ideal building lot has clumps of healthy, deciduous trees on the south, southwest, and west sides of the building site and a well-established wind break made up mainly of evergreens on the north and northwest.

Structure Orientation

On any site, it is critical to orient the house for optimum solar benefit. Place a rectangular home with its long axis in an east-west direction. For maximum winter solar heat gain, south 20 degrees east is optimum. That allows the setting sun to heat the northwest wall of the building. During the summer months this orientation would aid the roof overhang in shading the south-facing windows.



Good roof designs provide overhangs that create shade over south-exposed walls and windows.

Architectural Style

Next to orientation, the building design is important if you want to take advantage of solar energy.

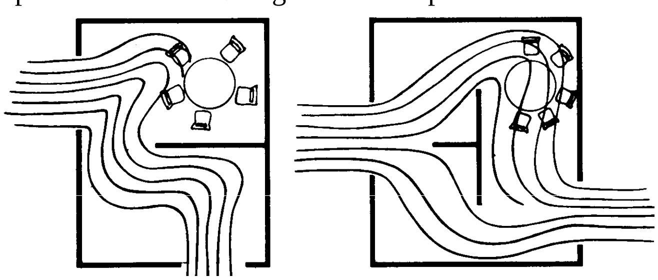
Considerable energy can be conserved by planting shade trees, but they take time to grow. In the meantime, a good roof design with overhangs can create immediate shade over south-exposed walls and windows. An adequate roof overhang and correct window placement can keep out the summer rays and admit the maximum winter sunshine.

Like sails on a sailboat, side-hinged casement windows catch the breeze.

Correct window types can capture summer breezes as well as direct the flow of cooling air. For example, low-placed louver windows allow airflow at floor level. Side-hinged casement windows catch breezes like a sail (they can also sail off in a strong wind). Many modern windows have good insulation features that should be included in any window design.

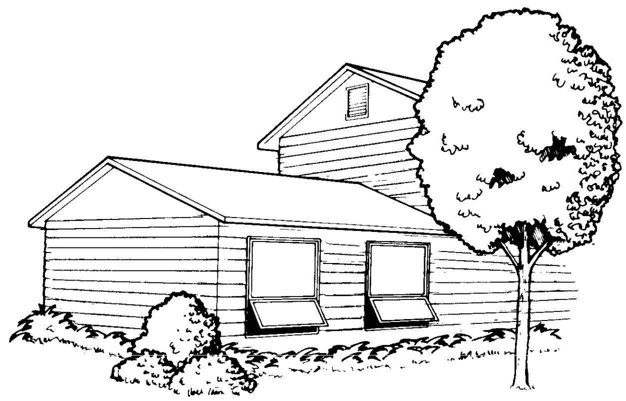
In the past, architectural balance dictated the placement and style of windows. Today, function is considered of equal, if not greater, importance. When deciding where to put the windows, study the prevailing wind flow pattern and the beneficial summer breezes, as well as winter winds.

To conduct air currents, a house must have both inlets and outlets. Maximum air flow occurs when large openings of equal size are placed opposite each other. Highest wind speeds occur when a small inlet is combined with a large outlet. Internal wall structure should be designed to facilitate air movement through the house.



A plan view: Interior walls should be designed so air moves through the house easily.

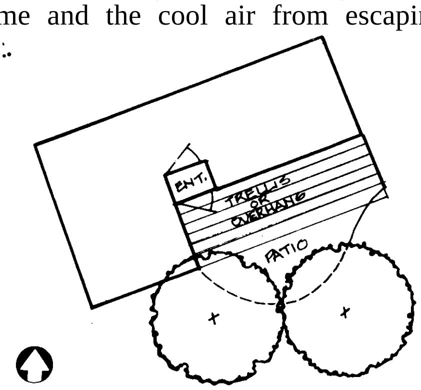
The garage can help regulate a home's microclimate. For instance, an attached garage on the north side of a house can block winter winds if the opening is to the east. A garage on the west side of the house can control solar heat gain in the summer. A protruding or free-standing garage can provide a protected area for a patio.



Low-placed louvered windows allow air flow at floor level.

The entrance can help control energy costs. The main entrance should be protected from the hot south wind and cold winter wind.

Ideally, an entry should have a protective overhang and an airlock hallway. A well-placed shade tree can serve as the overhang. Airlock hallways are found in many older homes. Sometimes called a vestibule, this closed-off entrance keeps cold air from rushing into the living quarters in the wintertime and the cool air from escaping in the summer.



An airlock entry is protected from the wind and summer sun.

Attached Greenhouses

Many homeowners today choose to build an attached greenhouse to help reduce heating costs.

Heat energy enters the greenhouse as short waves, is absorbed by objects, and is re-radiated as long waves. These long waves do not readily escape. The captured heat is known as the “greenhouse effect .”

The greenhouse can be considered a solar collector for the home. The collector can be a solid north wall or any object in the greenhouse. The sun’s rays are transmitted most effectively at an angle of incidence perpendicular to the light source. The angle of incidence refers to that angle at which the sun strikes a collector surface. The physical properties of glass (as well as the number of layers) influence the amount of energy entering the greenhouse.

Solar energy is stored in the objects it strikes, and the amount stored depends upon the object’s surface texture, color, density, the conductivity of the material, and the temperature of the surrounding air.

Although light reflective surfaces are essential for plants to grow, dark surfaces absorb and conserve more heat. The solution to these conflicting needs is a compromise, such as a grey or tan wall.

The type and design of the thermal conductors used to make connections between the greenhouse and the house will largely determine the energy efficiency of the greenhouse. As a heat source, it is usually best to have more than one heat collector. Both the floor and north wall should be constructed of rock or concrete blocks filled with sand or other materials.

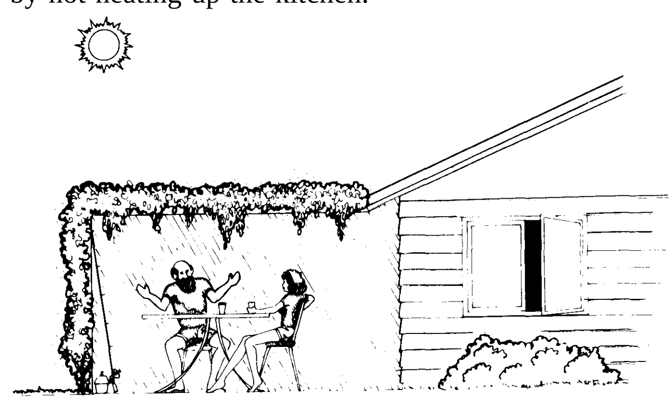
For the person designing a new home, a more elaborate greenhouse design may be incorporated. Designs that circulate warm air through the floor structure of the house or those that circulate warm air around the envelope of the house are energy-efficient. Such designs only require a small auxiliary conventional system to help with temperature extremes.

Patios

The location of a patio or deck will determine its usefulness. in the summer, for early morning breakfast, a northeast location is ideal. For evening entertainment, a south or eastern exposure is preferable. A western exposure is only useful when ample shade trees or taller shrubs control the glare of the setting sun. A southern-exposed patio has the disadvantage of excessive midday heat.

Selecting and placing shade trees carefully can overcome this problem. A patio with a southern exposure next to the house reflects heat through the windows into the home during winter. When a south-exposed patio has no area near it to plant deciduous shade trees, an overhead trellis covered with a fast-growing deciduous vine can provide the necessary shade.

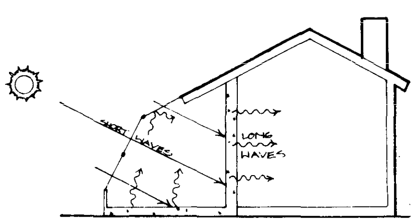
An attractive, well-designed patio encourages cooking out in the summer which conserves energy by not heating up the kitchen.



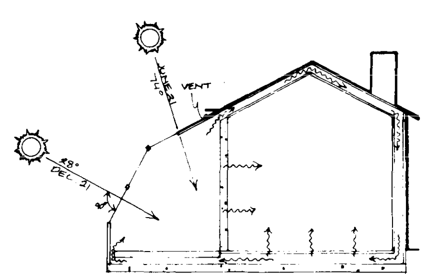
A vine on a trellis can shade a patio.

Glare

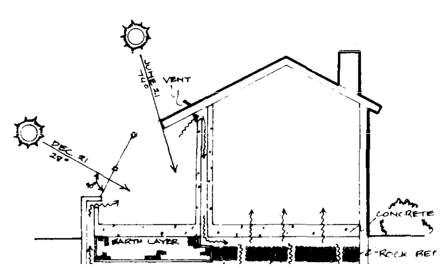
Glare from natural and artificial surfaces can be annoying and disturbing. Take into account the glare producers around your home and yard and plan to minimize them when you plant trees and shrubs.



The greenhouse effect occurs when heat energy enters the greenhouse as short waves and is absorbed and reradiated in long waves.



Hot air is forced around the envelope of the house, creating a protective layer. It radiates into the house and can be vented during the summer.



Hot air is forced through the floor and radiates into the house.

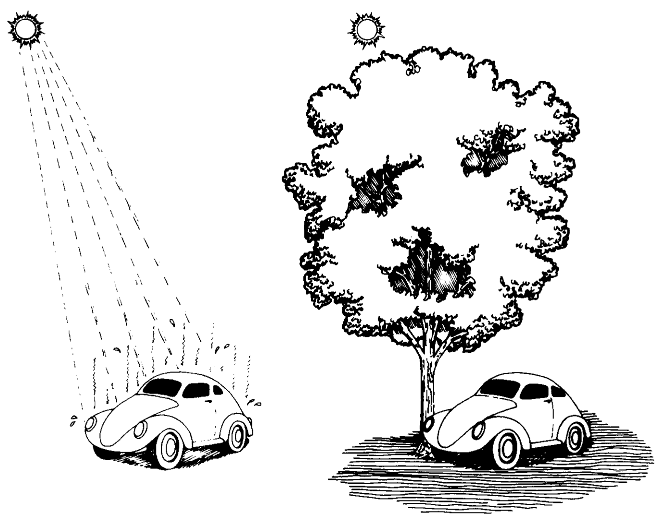
Glare is the result of reflecting light. Be aware of the glare from a body of water, sand, gravel, or snow. On a bright day, even the sky can make you squint. Notice too, if there is glare from concrete buildings nearby, or from the street surface, windows, or parking areas.

You can control sky glare by planning to screen the light coming in from above. To decrease the glare from a patio, plan to block glare from below eye level.

Window glare, which may only occur at certain hours of the day, can be minimized by placing a small tree or attractive composition of trees in the path of the annoying reflecting rays.

Driveways and Parking Areas

Shade trees can make a difference near the driveway and parking areas. Cars parked in the shade do not heat up as much from the sun so this cuts down on your need for the air conditioner in the car.



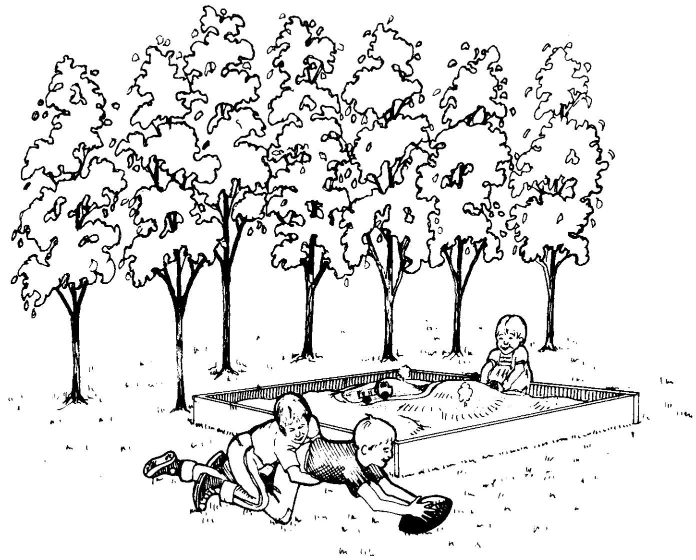
A car sizzles in sun but stays cool in shade.

Play Areas

With good landscape planning to make ample shade available, children can play outside during the summer in the early morning or afternoon.

Children need two areas to play in—open space, such as a lawn to run on, and a more private area. Fast-growing trees provide adequate shade for a play area. For instance, five small cottonwoods planted close together provide adequate shade and give the children a feeling of being "in the woods."

When the trees start to crowd each other, all but one can be removed. It will stand as a reminder of childhood.



Play areas should be shaded to protect children from the summer sun's intense heat.

Landscaping Guidelines

Energy-Conserving Landscapes

Landscape design for energy conservation requires a site-specific approach. Solutions come after a careful site analysis. Good landscape principles still hold. Plant material, however, can no longer be used only for esthetics. Functional needs are paramount and using plant material wisely can help energy conservation.

Selecting Plants

When selecting trees, shrubs, and vines, you should determine the hardiness of the particular plant, check soil conditions, space, and the site carefully. Plants should be selected for their appearance as well as for their climate control qualities.

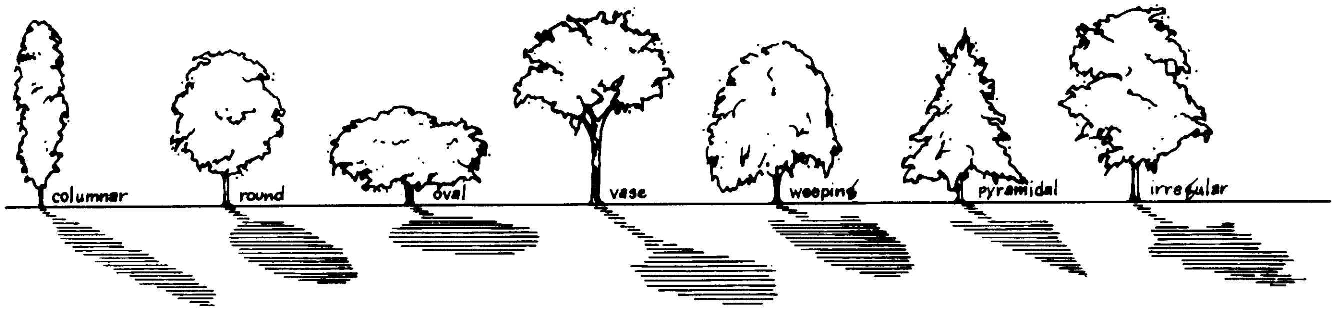
In selecting your plants, you should consult with the nursery operators in your area. They are familiar with soil conditions and landscape features and should be able to advise you about the most beneficial plant material for your locale.

The plants should harmonize with or enhance the architecture and the landscape.

Keep in mind that plants are divided into three categories: deciduous (those that lose their leaves in winter), evergreen, and broadleaf evergreens.

A shade tree which loses its leaves in the winter lets the sun's rays reach the house.

Some deciduous trees and shrubs leaf out early in the spring, and others leaf out much later. This factor should be considered when selecting shade

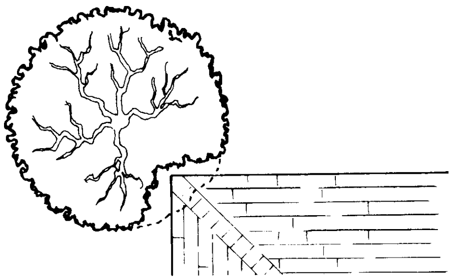


A tree's shade potential depends upon its canopy shape and the density of the shadow it creates.

trees for planting close to the house. Different shade trees exhibit different shadow patterns; some cover a larger area than others.

Some trees grow faster than others. Most fast-growing trees are not long lasting, therefore, the homeowner might interplant the fast-growing with slow-growing species. It is best to plant large shade trees. For a tree to become a functional shade tree in a few years, it should be 12 to 18 feet tall when planted. A tree this size should be transplanted by a professional.

(On the other hand, when working with a limited budget, smaller trees can be planted. With proper care a six- to 10-foot tree will grow fairly rapidly, and some shade advantages can be realized after a few years.)



A shade tree planted near the corner of a house has room to grow and requires little pruning.

It is much cooler under a tree that completely obstructs the sun's rays than under one that only filters the rays. As a general rule, plants with a light, smooth leaf reflect more of the sun's rays than those with dark, coarse surfaces. For example, a shiny, smooth cottonwood leaf reflects more light than a darker, coarse bur oak leaf.

Before planting a shade tree, you should check the shade movement for the chosen location.

Adaptability and Hardiness

When you select trees and shrubs, adaptability and hardiness should be major considerations. In Kansas, plants have to be hardy to survive the weather extremes.

The homeowner should consider a plant's adaptability to its specific location on the property.

If you are selecting for the north side of the house, choose a fairly shade-tolerant plant. A northern location also requires extreme winter hardiness unless the tree is protected by evergreens.

For the south and west sides of the house, use plants adaptable to drought, sun, and hot winds.

The southwest corner of a brick house is a tough place to grow plants. Hardy spireas and junipers will do well on the southwest; on the northeast corner, more tender plants—such as mahonia or yew—could survive.

Root Structure

When planting shade trees near the house and patio, it is important to remember that trees have different root growth habits. Some trees have shallow lateral root systems, others have deep lateral root systems, some have taproots, and some have a combination of root systems. All are influenced by soil type.

Your selection should be governed by the depth of soil. To prevent foundation damage, a tree within 10 feet of the house should have a taproot system. Such a tree would be well-anchored against the Kansas winds.

Examples of trees with a taproot system are pecan, Honey locust, black walnut, American sweetgum, red mulberry, American hophorn beam, white oak, shingle oak, bur oak, and golden rain trees.

Branch Structure

A well-structured tree will have branches growing in all directions. Select trees with a strong branch attachment for placement near the house. The locust tree, London Plane, and the male osage orange are inherently strong, and their branches do not easily snap off in storms.

Some vase-shaped trees, such as the hackberry, are good shade trees to place close to the home. Their branches tend to sweep over the roof, as compared with the pin oak, the branches of which tend to sweep the ground.

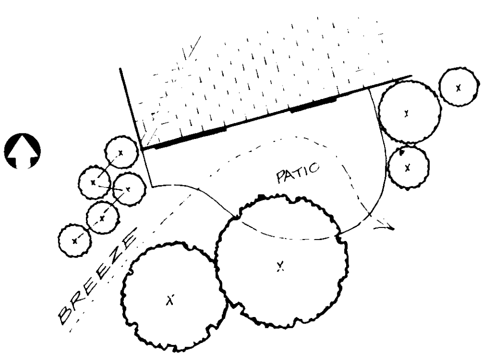
Selective pruning can open up a tree that is too dense, allow wind to pass through, yet provide adequate shade. Correct pruning improves the structural strength of the tree and lessens possible storm damage. A certified arborist can help you with the needed corrective pruning, especially for larger trees.

Vase-shaped trees planted close to the house provide adequate shade.

Wind Control

During winter, the wind may be intercepted, diverted, or channeled through obstructions such as fences, walls, or plants. The key to controlling winter winds is to diffuse them, not to block them. Use evergreens and deciduous plants in combination to diffuse the wind.

Channel the summer wind by selectively placing the shrubs and trees.



Plants can help channel breezes across a patio.

Directing the wind around and over plants adjacent to buildings will enhance natural ventilation.

A grouping of shrubs can lift cool breezes into a window or channel the wind flow across a patio. Generally speaking, the air under trees is moving faster.

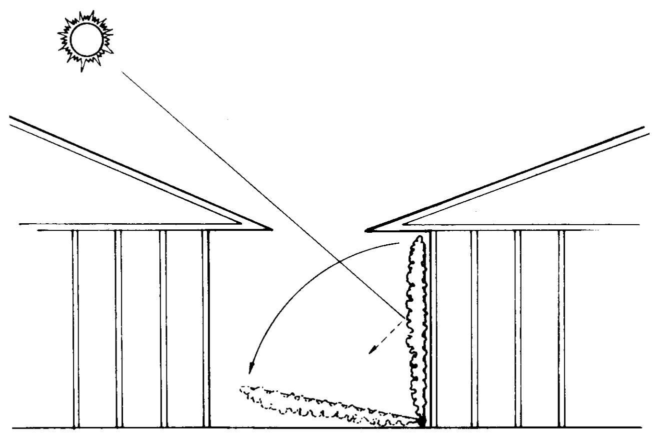
Provide an evergreen windbreak to break the strong wind from the north and northwest.

Using Plants to Conserve Energy

Plant large deciduous shade trees on the southern, southwestern, and western sides of the house. Deciduous trees block the summer sun but let the winter's warming sun through. Plant the trees approximately 15 to 25 feet apart and 10 to 15 feet from the house. Plant the strong-wooded oaks (red, scarlet, or bur), linden, London Plane, or ash, to avoid wind damage to the house. (Check for adaptability for your locale.)

Keep these orientations free of evergreen trees that will block winter sun. A recent study showed that a difference of eight degrees Fahrenheit between shaded and unshaded walls was equivalent to a 30 percent increase in insulating value needed for the shaded wall.

Plant deciduous vines so they climb directly on the southern and eastern walls of a brick or masonry



A hinged trellis can be lowered for maintenance.

house. They block summer sun but allow the winter sun in. If the house is wooden, build a trellis next to the walls and encourage vine growth on the trellis.

(Hinge the trellis at the base so you can lower it to paint the wall without seriously disrupting the vines.)

Plant deciduous or evergreen trees and shrubs on the eastern, southern, and western sides of an outdoor air conditioning condenser. The hotter a condenser gets, the harder it has to work. As much as a three percent savings in the efficiency of the air conditioning system can be realized simply by shading the condenser from the summer's hot sun. Be sure to allow ample space for air to circulate.

Plant large deciduous shade trees on the southern, southwestern, and western sides of outdoor summer activity areas. In addition to cooling these areas, they provide a "roof" for this outdoor living room.

To block the winter wind on the north and northwest sides of the house, plant two or more rows of evergreen trees together with deciduous trees. Remember that a windbreak provides the greatest reduction in wind velocity at a distance of five to seven times the height of the windbreak on its leeward side. Winter energy consumption has been reduced as much as 30 percent by a windbreak.

Plant dense evergreen shrubs on the western, northwestern, and northern sides of the house to provide additional insulation against cold air infiltration. Broadleaf evergreen vines also will help reduce air infiltration.

To channel the southwesterly summer breezes into and through the house, plant trees and shrubs that will act as wind tunnels.

This may involve selective pruning or thinning out lower branches of understory plants (the small trees and shrubs) to promote maximum air circulation.

When living on a hill, be sure that the groups of shrubs and trees you select will allow natural downhill flow of cooler air. This will promote more circulation in the summer and avoid creating "cold air lakes" near the house in the winter.

Where feasible, deflect the air from exhaust vents and air conditioners away from the heavy use areas of the house. These sources of hot air ideally should be exhausted into northern orientations where heat excesses are not so severe.

Windbreaks

A windbreak is an obstruction *perpendicular* to wind flow that alters the wind direction. The wind must move over and around the obstruction. This alteration creates a small area on the windward side of the windbreak and a larger area on its leeward side that offers protection from the full force of the wind. Windbreaks that allow some wind penetration improve the windbreak's effectiveness. The objectives of windbreak design are to achieve enough height to create protection for the desired distance on the leeward side of the windbreak, and to achieve enough wind penetrability to reduce the effects of eddy currents and the leeward vacuum around the windbreak.

To design a successful windbreak, keep these criteria in mind.

1. A good windbreak, in cross section, has vertical rather than sloping sides.

2. A windbreak should extend to the ground.

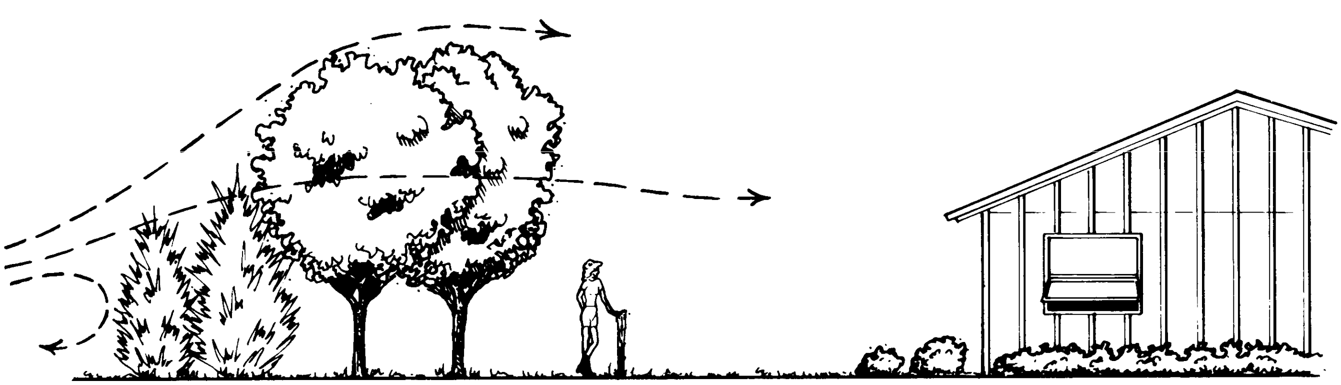
3. A windbreak should be four to five staggered rows wide if deciduous plants are selected.

4. Within the windbreak's width, species height should be varied to create rough edges.

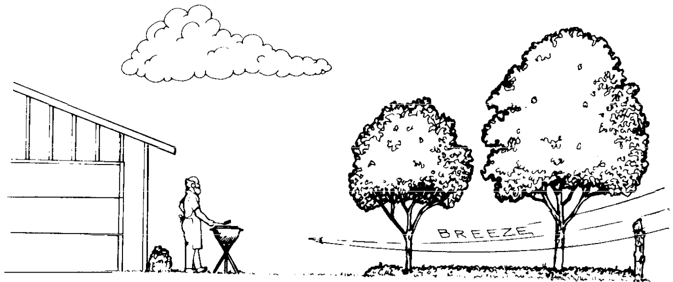
The protective zone created by a windbreak with these characteristics extends leeward for a distance equal to 30 times the height of the windbreak. Maximum protection occurs at a windward distance of five to seven times the height.

Distance from Windbreak (in units of windbreak height)	Percent of Wind Speed Reduction
2 ½ times the height	10-20
5-7	50
10	30-40
15	10-20
20	10
30	less than 1

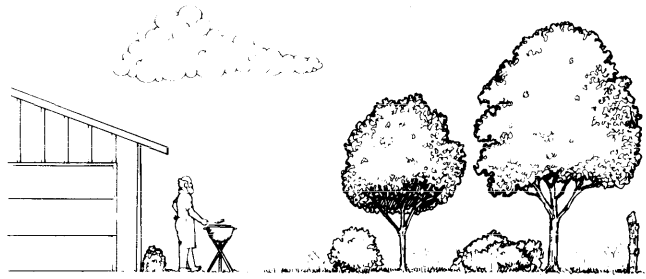
Windbreaks work most efficiently when their length is 11.5 times greater than their mature height.



Windbreaks alter and direct the wind flow pattern to protect the house from the wind's full force.



Ground cover eliminates mowing around trees and channels breezes.



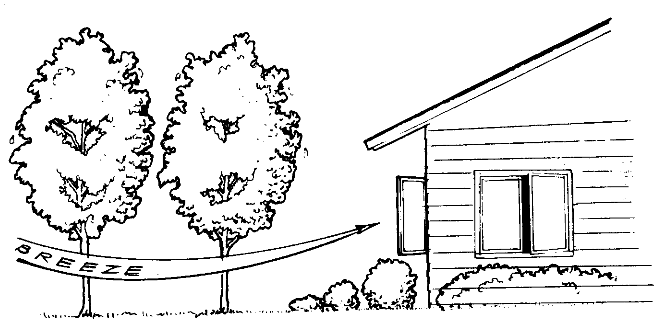
Naturalistic planting in layers minimizes maintenance.

Wind Channels

Windbreaks are designed to block wind; wind channels are designed to guide its circulation. This is accomplished by deflecting wind currents into specified locations. Materials must be fairly impenetrable, but they must be oriented so that the deflected wind is funnelled into a desired area without decreasing the initial velocity.

Evergreen plants with dense foliage extending to the ground, such as red cedars, could be planted so that the branches of one mature plant will overlap with those of its neighbor. By aligning the row of trees toward the northeast, a southerly summer breeze can be captured and directed into the area on the north side of a house. In this case, a southerly breeze is converted into a southwesterly breeze.

Deciduous shade trees with dense canopies, like the male osage orange and bur oak, also can be used to create wind channels. As the wind strikes the canopy, part of the wind stream will be forced through the gap between the lower edge of the canopy and the ground. In the process its velocity is increased. A planting on the south side of a house would promote internal air circulation within the house if the channel were directed into an open window. It would also help shade the house from noontime and hot summer afternoon sun. Low, dense shrubs placed underneath windows to the south of the shade tree would help circulate southerly breezes through a house. The shrubs would deflect wind upward and increase its velocity while the shade tree would deflect the wind into the house.



Place trees and shrubs so that they help channel the breezes through your windows.

Not all plants with height and foliage density characteristics conducive to wind control can tolerate continuous exposure to harsh winds. The desiccating effects of wind can kill many plants, particularly in winter. Plants with brittle wood will not stand up well to winter wind exposure.

Designing a successful wind control device requires understanding the principles of wind control and knowing how to use different materials to take advantage of these principles. It is equally important to understand how the plants look against the surrounding landscape and how well they will hold up under exposure to the wind.

Conclusion

This publication is not all-inclusive. It is intended to emphasize the functional use of plant material in combination with other home design principles. A list of related reading material is included.

You should talk to an architect, a landscape architect who can help you design an energy-efficient home and landscape, and nursery operators who “design-build” and who can help you solve your home landscape problems. Remember, a combination of many factors gives you an energy-efficient and comfortable living environment.

The following is a partial listing of related publications available from the Kansas Cooperative Extension Service and your County Extension Office.

Pub. #	*Title*
C-562	Residential Landscape Design
C-581	Naturalistic Landscaping
C-568	Farmstead Landscaping
C-468	Groundcovers, Rock Garden Plants and Ornamental Grasses
MF-434	Answers to What Shall I Plant
MF-317	Planting Ornamental Trees and Shrubs
C-550	All About Pruning
MF-353	Selecting a Grass for Your Lawn
MF-452	Planting Your Cool Season Lawn
MF-454	Improving Your Lawn by Overseeding
MF-438	Mowing Your Lawn
MF-440	Watering Your Lawn
XC-391	Fertilizing Lawns in Kansas
XL-133	Perennial Flowers for Kansas
XL-134	Annual Flowers for Kansas
MF-650	Hedges for the Home Landscape

Additional Readings

Eckbo, Garrett. 1956. *The Art of Home Landscaping.* New York: McGraw-Hill, Inc.

Environmental Design Press. 1977. *Landscape Planning for Energy Conservation.* Reston, Va.

Fisher, Rich and Bill Uanda. 1976. *Solar Greenhouses.* Santa Fe, N. M.: John Muir Publications.

Hightshoe, Gary. 1978. *Natiue Trees for Urban and Rural America.* Ames, Iowa: Iowa State University Research Foundation.

Mazria, Edward. 1979. *The Passive Solar Energy Book.* Emmaus, Pa.: Rodale Press.

Olgyay, Victor. 1963. *Design with Climate.* Princeton, N. J.: Princeton University Press.

Robinette, Gary. *Roofscape.* Reston, Va.: Environmental Design Press.

____________. 1972. *Plants, People, and Environmental Quality.* Washington, D. C.: United States Government Printing Office.

University of Minnesota. 1979. *Earth Sheltered Housing Design.* New York: Van Nostrand.

Weber, Nelva. 1976. *How to Plan Your Own Home Landscape.* Indianapolis, Ind.: The Bobbs-Merrill Company, Inc.

Please check your local library and your nursery for additional tips on energy-efficient planting.

All KEES materials and programs are available without discrimination on the basis of race, religion, national origin, sex, handicap, or age. Anyone who feels that he or she has been discriminated against should send a complaint within 180 days to the Department of Energy, Office of Equal Opportunity, Washington, D. C. 20585. This material is made available through federal Department of Energy grant funds under P. O. 94-385 and is distributed by the Technical Energy Information Service of the KSU Cooperative Extension Service under contract to the Kansas Energy Office.

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