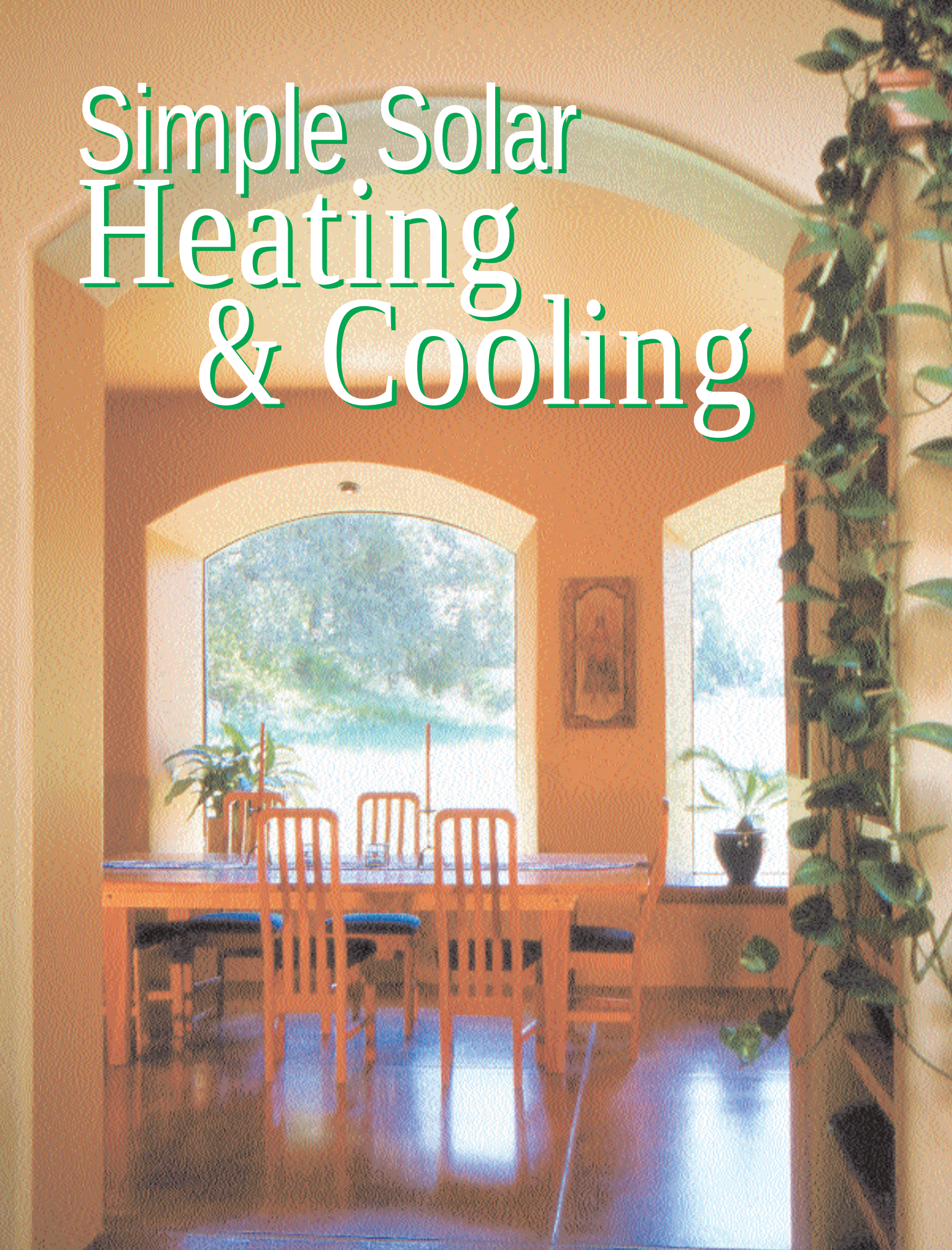
Simple Solar Heating & Cooling



Whether you're building new or remodeling, these energy-saving options should be your first choice.

By David Johnston and Kim Master

Remodeling is the perfect time to improve energy efficiency in your home using both active and passive solar designs. *Passive* solar design is both environmentally friendly and cost effective, and can cut your heating costs by up to 50 percent. It involves placing large windows on south-facing walls and locating thermal mass, such as a concrete slab floor or a heat-absorbing wall, close to the windows. Passive cooling involves using overhangs, windows with reflective coatings and other natural cooling approaches. *Active* solar retrofits include collectors to capture heat from the sun and use pumps to distribute it throughout your home. If the sun shines on your home for most of the day in the winter, it is a good candidate for an active solar-heating retrofit.

For passive solar heating, thermal mass works in conjunction with south-facing windows to capture and store the sun's heat.

THE ROLE OF WINDOWS

Windows play a big role in passive solar design and in the energy efficiency of homes. In the summer, windows can allow unwanted heat into your house. In the winter, windows can account for as much as 25 percent of a house's total heat loss, equaling more than $20 billion in electricity costs nationwide. The cost of replacing faulty windows in an existing house is high, but doing so will make a substantial difference in the comfort of your home and likely will be well worth the cost. Upgraded windows typically add to the value and salability of your home because of their energy efficiency and resistance to outdoor noise.

Install multipane windows for efficient heating *and* cooling. Windows can be constructed with one, two or three panes of glass. Typically, the more panes of glass, the better your windows will insulate your home. Good double-pane windows add to the value of your home because they insulate almost twice as well as single-pane windows. Better-quality double-pane windows have inert gases, such as argon or krypton, installed inside the air space to further slow heat transfer from the sun.

In addition to reducing your energy bills, multipane windows also make the whole house quieter and more comfortable during all seasons. Upgrading from single-pane windows to energy-efficient multipane windows can save up to 15 percent of your heating costs. Depending on where you live, this can add up to $100 per year; over time, the savings can reach thousands of dollars. You can get a savings estimate more specific to your home by using the Lawrence Berkeley National Laboratory online energy calculator (*www.homeenergysaver.lbl.gov*). Check with your local utility company for possible rebate programs.

Install low-emissivity (low-e) windows. Low-e coatings — virtually unnoticeable to the eye — are installed on the interior glass surface of double-pane windows. One kind helps prevent heat from escaping through the glass in winter by reflecting it back inside. Another type of low-e coating blocks heat from entering the home during the summer by reflecting sunlight out of the structure. In some areas, the 10 percent to 15 percent higher cost for low-e glass can pay for itself in a few years. Many window manufacturers now include it standard in their products.

Choose one of three types of e-coatings according to your climate:

High-transmission, low-e. These windows are best suited for use in cold climates.

Selective-transmission, low-e. These windows are ideal for homes in mixed climates that have both significant winter heating and summer cooling requirements. Low-e qualities ensure winter performance by allowing sunlight to penetrate. The selective properties block most solar infrared energy, keeping the home cooler during summer months.

Tinted, low-e. This glass provides glare control along with a high level of solar heat rejection, which helps to control solar gains in hot climates, especially on east- and west-facing windows.

Install superwindows. These are windows with one or two thin, plastic films suspended between the glass panes, effectively making them triple- or quadruple-pane windows. They can reduce ultraviolet rays that can fade fabric, rugs and art. The larger the window, the more effective

LEFT: CATHERINE WANEK

superwindows are in providing a comfortable temperature.

Install windows tuned to solar orientation. East-, west- and south-facing windows work best if you choose glass with the appropriate characteristics. Glass with a low solar heat-gain coefficient (SHGC) has built-in shading that reduces the amount of solar energy that shines into your home.

On the west and east facades, windows with a low SHGC should be used to minimize heat gain that will contribute to overheating or higher cooling loads. Also, check the visible light transmittance (often referred to as VLT) so that you don't block solar heat at the expense of the light and view you want to achieve from the window. On south-facing windows, use a high SHGC to increase the amount of solar heat that can warm your home. In most climates, the north-side solar heat gain is minimal, so SHGC values are not significant. Work with your window supplier to choose the right combination for your climate.

Windows in Passive Solar Design

For optimum passive solar design, follow these guidelines as closely as possible to determine how much glass to put in specific walls.

SOUTH-FACING WALLS: At least 7 percent to 12 percent glass	NORTH-FACING WALLS: No more than 4 percent glass
WEST-FACING WALLS: No more than 4 percent glass	EAST-FACING WALLS: No more than 4 percent glass

Choose low-conductivity frames. Most window frames and sashes are made of wood, vinyl, fiberglass or aluminum. Wood, vinyl and fiberglass generally insulate better than aluminum or steel frames because they conduct less heat.

THERMAL MASS

Thermal mass (usually a floor or wall) works in conjunction with south-facing windows to capture and store the sun's heat. Choose materials such as brick, masonry, poured concrete or tile — they will soak up most of the heat that hits them and gradually release it after the sun goes down, which in turn will moderate the interior temperature of the house. Thermal mass in properly designed passive solar homes will prevent high midday interior temperatures in the summer or on sunny days in the winter, and will help keep the home from becoming uncomfortably cool on winter nights.

The thermal mass should be about six times the area of your direct-gain, south-facing glass. For most thermal mass materials, their cost and energy effectiveness increases with thicknesses up to about 4 inches. At a minimum, your drywall should be one-half to five-eighths of an inch thick to increase the thermal capacity on walls in sunlit rooms.

ROBERT BAUMGARDNER

This home's passive solar design regulates interior temperature through south-facing windows, thermal mass and window shading.

WINDOW SHADING

Carefully designed shading blocks unwanted sunshine (typically in summer and early fall), but does not block sun that is desirable for heating (typically in the spring, late fall or winter). Keep in mind that when sunlight strikes any surface it turns into heat: Interior roll-down shades don't keep out much heat because the light is already through the glass. However, if you can't afford to upgrade your windows or are looking for additional ways to conserve energy, shading windows or installing exterior blinds can be cost-effective ways of reducing solar heat gain and cooling load costs. Overhangs are most effective at shading

when they are 2 feet wide and positioned 1 to 2 feet above windows within 30 degrees of true south.

In the winter, do not shade south-facing windows between 10 a.m. and 2 p.m. For east- and west-facing windows, it is best to use vertical louvers to prevent overheating. Tight-fitting, insulated window shades help keep heat inside at night. As a minimum in the summer, install white window shades, drapes or blinds to reflect heat away from the house. Close curtains on south- and west-facing windows during summer days.

Mature tree canopies reduce the average temperature in suburban areas by about 3 degrees, compared to areas with no trees.

LANDSCAPE SHADING

A well-placed tree, shrub or vine can provide effective shade and reduce energy bills. Trees are amazing in their ability to change your microclimate: Not only do they create shade, but they evapotranspire (or "sweat"), cooling the air in the process. A mature tree with a crown of 30 feet can release up to 40 gallons of water in a day — that's comparable to removing the heat produced in four hours by a small, electric space heater. Mature tree canopies reduce the average temperature in suburban areas by about 3 degrees, compared to areas with no trees.

Plant deciduous trees to the east and west sides of the house, but only those areas more than 60 degrees east or west of due south from the house. In particular, west and southwest facades should be shaded from low-angle sun that can cause overheating. It is not recommended that you place deciduous trees on the south side of a home because, even with their bare branches, these trees can block as much as 30 percent of the available winter solar energy. If it is necessary to have trees on the south side of the house, mitigate this effect by locating deciduous trees close to the house and select species with few low branches.

ACTIVE SOLAR OPTIONS

Adding a solar heating system to your home is another way to combat increasing energy costs and to raise your home's market value. If the sun shines on your home for most of the day in the winter, it is a candidate for a solar-heating retro-

fit. The two major types of active solar retrofits are solar collectors that heat a fluid circulated within them and air collectors that capture solar heat and distribute the air current throughout the house with fans.

Solar collectors are the basic component of both systems. The most common collector for residential water and space heating is a flat-plate collector, which is basically an insulated metal box with a glass or plastic cover — called "glazing" — and a dark-colored absorber plate. The sides and bottom of the collector are usually insulated to minimize heat loss. Sunlight passes through the glazing and strikes the highly conductive absorber plate, which heats it up. The heat is then transferred to the air or the liquid passing through the collector.

CHOOSE A SOLAR SPACE HEATER

Active solar space heating uses solar collectors to heat liquid or air, which then heats a space. Solar space-heating systems are usually designed to provide 30 percent to 80 percent of a house's heating needs, depending on geographical location, system type and size. Solar air heaters that directly heat interior air do not require a heat storage component and can complement most existing heating systems. They are the least expensive and simplest solar technology to install. Active solar space-heating systems are most economical in cold climates that have extended heating seasons with many sunny days and/or high utility rates. They are less cost-effective in areas with cloudy conditions during the winter, such as the coastal Northwest; in areas with short heating seasons, such as southern California and Florida; or in any area with low prices for electricity and other heating fuels.

Solar collectors are usually installed on the roof, which means the roof must be in good condition and be capable of supporting the collectors. You also can mount collectors on ground racks, vertically on a south-facing wall or on an adjacent structure such as a garage. Pipes (for liquid systems) or ducts (for air systems) that

transfer heat from the collector(s) to the interior require a roof or wall penetration. You can increase the effectiveness of liquid solar space-heating systems by storing the solar heat in a large, well-insulated tank during the day for use at night or on cloudy days.

Solar water-heating systems are good for the environment; they produce none of the harmful greenhouse gases associated with electricity production.

CHOOSE A SOLAR WATER HEATER

Solar water heaters have collectors that use the sun's energy to heat water in much the same way as water in a hose left on the lawn gets hot on a sunny day. The heated water is then stored in a tank similar to a conventional gas or electric water tank. Some systems use an electric pump to circulate the fluid through the collectors. Solar water-heating systems also are good for the environment; they produce none of the harmful greenhouse gases associated with electricity production. Solar water heaters can operate in any climate, but in almost all areas, you will need a conventional backup system. In fact, many building codes require a conventional water heater as a backup.

Always take steps to use less hot water. When you lower the temperature of the water you use, you reduce the size and cost of your solar water heater. Look for solar water-heater systems certified by the Solar Rating and Certification Corp. or the Florida Solar Energy Center. A licensed and experienced solar contractor should install these systems. Vendors and service providers who are selling units in cooperation with a utility program are likely to remain in business long enough to repair your system if it ever gives you trouble. ⊖

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