THE Energy-Efficient HOME

By Daniel D. Chiras

Energy conservation efforts can result in savings of tens of thousands of dollars over the 30-year life of a mortgage.

Making a new home energy efficient may add to the price tag, perhaps another $1,000 to $2,000. So why spend the extra money?

First, money invested in energy-efficient design and construction can result in substantial initial cost savings. For example, by adding extra insulation, which might cost $1,000, you can install a much smaller heating and cooling system, saving double or triple the amount invested in the added insulation.

Second, buying or building an energy-efficient home may qualify a homeowner for a lower-interest loan, which will reduce the monthly mortgage payment. Lenders such as the Federal Housing Administration, Countrywide Home Loans and Chase offer energy-efficiency mortgages. Additional financial incentives are available from some local utilities.

A third advantage is the most obvious: It saves money on utility bills. How much you save depends on how well built your home is and how many energy-efficient appliances and light fixtures were installed. Energy conservation efforts can result in savings amounting to tens of thousands of dollars over the 30-year life of a mortgage.

Energy-efficient homes are also more comfortable year-round than the average house, keeping you and your family warm in the winter and cool in the summer. The extra insulation in energy-efficient homes acts as a sound barrier, making

For dollar savings, resale value and environmental benefits, investing in energy-smart features is a no-brainer.

them quieter than standard homes, too. Energy-efficient design and construction may also increase resale value.

Last, but not least, saving energy in homes helps protect the environment. By cutting down on energy use, we reduce the nation's demand for oil, coal and natural gas. Reduced processing, transportation and combustion of fossil fuels mean less air pollution.

The question, then, isn't "Why build an energy-efficient home?" It's "Why not?"

Before you can design and build such a home, however, you need to know where the energy is used. By identifying the "big-ticket items," you can design the most efficient, environmentally friendly home possible—for the best price.

According to the U.S. Department of Energy, heating and cooling consume most of the energy required by an average home—nearly 45 percent. Savings here, even modest ones, can have an enormous impact on your monthly energy bill.

DAN CHIRAS

A passive solar home relies on south-facing windows to emit the low-angled winter sun.

Heating and Cooling a Home Efficiently

Heating and cooling a home begins with its siting. Choose a site with good solar exposure. The house should be oriented along an east-west axis for best solar gain in the winter months and reduced solar gain in the summer. A properly oriented home on a good site can dramatically reduce year-round energy demand. Carefully placed trees can also make a huge difference in heating and cooling costs, creating economy and comfort.

Planning and Design. Once you have determined the optimal siting, your goal should be to create a design that provides year-round comfort with minimal energy use. Such a design requires a holistic or systems perspective. This approach, *integrated design* or *whole-house design*, seeks to create a home that functions optimally on any given site in a given climate at minimal environmental and economic cost. It keeps in mind the fact that building components frequently interact. Changes in one component often have profound effects on others.

To be effective, integrated design must begin early on—as early as the predesign stage before blueprints are drawn. Simple design features such as proper orientation of a building cost little, if anything, but can greatly boost the energy efficiency and year-round comfort of a home.

Creating an Efficient Building Envelope. Energy efficiency requires that the outer skin, or building envelope—the walls, windows, foundation and roof—is sufficiently insulated and airtight. According to the American Council for an Energy-Efficient Economy, each year approximately $13 billion worth of energy is lost in American homes through cracks and holes in the exterior of houses, around windows and doors, near foundations, or where pipes and electrical wiring penetrate the building envelope. This leakage increases annual fuel bills on average $150 per household.

Simple design features that cost little, if anything, such as proper orientation of the building, can greatly boost energy efficiency and comfort.

Numerous construction techniques and materials can help reduce a home's heating and cooling requirements. These include such tactics as building the foundations and exterior walls from insulated concrete forms; using double-wall construction (two two-by-four walls) for exterior walls for greater insulation and to reduce bridging losses; and building walls from straw bales and other natural materials that offer superior wall insulation.

In order to be effective, most of these energy-efficient techniques require the installation of adequate amounts of insulation.

Insulation. Insulation blocks the flow of heat across walls and other components

DAN CHIRAS

of a building. How well insulation operates is measured by its R-value, a measure of how well a material resists the flow of heat through it by conduction. The higher the R-value, the greater the resistance. Thus, a ceiling with an R-value of 60 is better at conserving heat than one with an R-value of 40. Contrary to what many people think, a well-insulated home is just as important in hot climates as it is in cold climates.

Insulation is generally classified into four categories: loose-fill, blankets (batts and rolls), rigid foam, and liquid foam. Each has its own applications. For instance, loose-fill insulation, such as cellulose consisting of ground-up newspaper, blows nicely into attics and wall cavities, creating a thick blanket that resists heat movement. Blanket insulation, such as fiberglass batts, fits nicely in floor and wall cavities between framing members when properly installed, while rigid foam insulation works well on foundations and basement walls and over exterior sheathing. Liquid foam, like Icynene, also makes a nice wall insulation in wood-frame homes.

When deciding on the type of insulation to use, builders must also consider the effects of each product on health and the environment. For years fiberglass insulation batts were manufactured with a binding agent containing formaldehyde. In contrast, most rigid foam insulations were fairly safe for homeowners, but they were manufactured with ozone-depleting chemicals.

Sensitive to such environmental and health concerns, many manufacturers are producing a new generation of insulation. Despite these improvements, many green builders prefer recycled cellulose insulation. Treated with a flame retardant, cellulose costs a bit more to install than fiberglass, but it provides more insulation per inch. It also puts an abundant waste product to good use.

Windows. Even the most energy-efficient windows can't match the R-value of a well-insulated wall. A wall may have an R-value of around 20, while energy-efficient windows frequently have R-values of 3 to 4.

With so much wall space covered by windows, it is important to select the most energy-efficient ones you can afford. The most basic distinction among window types is that some open. You can achieve good ventilation in a home by strategic placement of openable windows, usually one or two on the north side and one or two on the east, west or south side.

CENTRAL FIBER CORP.

Contrary to what many people think, a well-insulated home is just as important in hot climates as it is in cold climates.

Windows also come in single-, double- and triple-pane varieties. Even in warm climates, the use of single-pane windows is foolhardy, as single-pane windows can gain a lot of heat during the summer. Double-pane windows are standard in new construction in most cold-weather markets. But it is not the two panes of glass that account for their efficiency. Rather, it is the air space between the glass, because air is a poor conductor of heat.

An even better insulator than air is argon gas. Window manufacturers also increase the efficiency of their products by applying a clear, thin coating of tin or silver oxide on the inside surface of the glass or by inserting special films between the panes. These retard heat movement through the glass. The result is a product known as a *low-E window* (*low-E* stands for low emissivity of heat).

Efficiency can also be achieved by selecting the right window sash and frame (the sash is the material that holds the glass in place; the frame houses the sash and attaches to the wall). The most energy-efficient windows are generally made from wood. To protect the wood from moisture and sunlight, manufacturers typically install a metal or vinyl cladding over the outside surface of the wood.

Window sashes and frames are also made from fiberglass, vinyl or a composite material consisting of vinyl and sawdust. These materials offer many of the same advantages as wood, especially low heat conduction and durability. However, synthetic materials may pose risks to workers in the factories where they're made.

Look for windows with warm edges, created by placing nonconductive material, known as a *spacer*, between the panes of glass around the periphery of the double- and triple-glazed windows. Spacers can improve the efficiency of a window by 10 percent.

Radiant Barriers. Radiant barriers are foil products applied to roof rafters. They help improve energy efficiency, especially in extremely hot climates.

Radiant barriers block heat absorbed by roofs, preventing it from entering a home through attics and ceiling cavities. By reducing heating and cooling loads, they reduce energy consumption and utility bills. In Florida, for instance, a homeowner can reduce cooling bills 8 percent to 12 percent by installing a radiant barrier, according to the Florida Solar Energy Center.

Creating an Airtight Building Envelope. Movement of air in and out of our homes, known as *infiltration* and *exfiltration*, is responsible for losses of 20 percent to 40 percent of our total annual heating and cooling bills. For instance, if you're paying $200 a month to heat and cool your home, you're wasting approximately $500 to $1,000 a year because of air leaks.

What to Look for in Windows

- Double- or triple-paned glazing
- Nonconductive sashes and frames
- Metal cladding on exterior surfaces
- Low-e glass
- Argon-filled air spaces
- Glazing spacers (warm edges)
- Low air infiltration

DAN CHIRAS

The most energy-efficient windows are generally made from wood. To protect the wood from moisture and sunlight, manufacturers typically install a metal or vinyl cladding over the outside surface of the wood.

The key to an airtight house is to make sure that cracks in the building envelope are caulked, sealed and weather-stripped. Sealing a home is inexpensive and relatively easy. However, many energy-efficient builders prefer to hire a weatherization subcontractor after the house has been framed and insulated and windows and doors have been installed. In addition to caulking and weather-stripping, these specialists may apply a vapor barrier on walls to further reduce infiltration and exfiltration and prevent moisture from entering wall cavities, reducing the R-value of insulation.

Passive Solar Heating and Cooling. Passive solar energy is a system designed to heat a home primarily through sunlight and without mechanical heating systems. Passive solar heating relies on south-facing glass to let the low-angled winter sun into a home, insulation to hold heat in, overhangs to block the sun during the cooling season and other design features.

Houses can also be cooled without expensive, energy-hungry air conditioners or evaporative coolers. This technique, known as *passive cooling*, is achieved through simple yet effective measures including proper orientation, adequate insulation and shade.

Installing an Efficient Heating System. Heating systems vary considerably, from simple wood-burning stoves and masonry heaters to complex mechanical systems, such as radiant-floor heating.

Wood-burning technologies rely on a renewable resource, and many new woodstoves and masonry heaters are efficient and clean burning. Wood-burning stoves and the like, however, do produce pollution and require considerable operator involvement.

If you need automatic heat, look into mechanical systems such as radiant-floor heat and hot-water baseboard. These systems rely primarily on natural gas or fuel oil. Water is heated in a boiler and transported via pipes to the rooms of the house. In a radiant-floor system, hot water typically travels through pipes in the floor, releasing heat into adjacent rooms. In a hot-water baseboard system, heat is released into rooms from special radiators, usually installed along the base of the walls.

Many manufacturers have introduced boilers for radiant-floor and hot-water

baseboard systems that can achieve efficiencies in the 90 percent range, making these systems economical and relatively clean burning. High-efficiency furnaces are also available, operating in the 80 percent efficiency range.

Many modern boilers and furnaces feature sealed combustion chambers to ensure that pollutants from fossil fuel combustion do not escape into the room. Many also feature power venting—a fan that draws fresh air into the combustion chamber and forces exhaust gases out through another pipe. Heaters and boilers with these features cost a bit more, but they reduce energy bills and help ensure healthy indoor air.

Forced-air heating systems are the most popular, least expensive of the mechanical heating systems. Like radiant-floor and hot-water baseboard systems, they typically rely on natural gas or fuel oil to produce heat within a combustion chamber in the furnace. Hot air produced in the furnace is then transported throughout the house by a series of ducts. Forced-air systems warm rooms quickly. Blowing air, however, tends to increase exfiltration, which makes these systems somewhat less efficient than radiant-floor and hot-water baseboard systems.

BIOFIRE INC.

Masonry heaters burn wood efficiently, produce little pollution and provide long hours of comfortable heat.

Two options that heat a home with minimal environmental impact are heat pumps and solar water-heating systems. Using refrigeration technology, heat pumps extract heat from the ground or the air, even when outside air temperatures are low. This heat is then transferred into the house, where it is distributed via ducts as in a forced-air system or via pipes containing hot water in a radiant-floor or hot-water baseboard system. Besides using renewable fuel, heat pumps are super-efficient.

Solar hot-water systems consist of panels, usually mounted on the roof, that gather sunlight energy and transfer its heat to a fluid that is pumped into the house, where the heat is transferred to water used for domestic purposes, such as washing clothes or bathing, or to provide

Major Appliance Shopping Guide

Appliances that require less energy and water to operate are the most economical over time.

Appliance	Rating	Special Considerations
Water Heaters	Look for the Federal Trade Commission EnergyGuide label that tells how much energy the water heater uses in one year. Also look for the first-hour rating (FHR), which measures the maximum amount of hot water the heater delivers in the first hour of use.	If you typically need a lot of hot water at once, the FHR will be important to you. Sizing is important—call your local utility for advice.
Windows	Look for the National Fenestration Rating Council label that provides U-values and solar heat gain coefficient (SHGC) values. U-value is a measure of heat transmission, while SHGC refers to the amount of solar heat transmitted through a window when the sun is shining. The lower the U-value, the more insulating the window. The colder the climate, the higher the desired SHGC.	Look at the Climate Region Map on the label to be sure that the window, door or skylight is appropriate for where you live.
Refrigerators and Freezers	Look for the EnergyGuide label that tells how much electricity the unit uses in one year. Energy Star units exceed federal standards by at least 20 percent.	Refrigerators with top freezers are more efficient than those with side freezers. Look for heavy door hinges that create a good door seal.
Dishwashers	Look for the EnergyGuide label that tells how much electricity the dishwasher uses in one year. Energy Star dishwashers exceed federal standards by at least 13 percent.	Look for features that reduce water use, such as smart controls. Dishwashers that use the least amount of water cost the least to operate.
Clothes Washers	Look for the EnergyGuide label that tells how much electricity the clothes washer uses in one year. Energy Star washers use less than 50 percent of the energy used by standard washers.	Look for design features that reduce water usage: water level controls, "suds-saver" features, spin cycle adjustments and large capacity.

Source: U.S. Department of Energy

space heat. New models are inexpensive and efficient, producing heat even on cloudy days.

Installing Efficient Cooling. Mechanical cooling systems fall into three groups: (1) evaporative coolers, (2) air conditioners and (3) heat pumps.

Evaporative coolers mount in windows or on rooftops. Outside air is drawn into the unit by a fan and flows over a constantly wetted mesh. The cool, moist air then enters the house, usually at a central location.

Evaporative coolers are fairly inexpensive and generally do not require extensive ducts to distribute cool air throughout a house. They're effective enough for use in large office buildings, but only in dry climates.

Air conditioners are mounted on rooftops, alongside homes or in walls and windows. Outside air is drawn into the unit, dehumidified and cooled, then blown into the house. Large centralized air-conditioning units distribute the cool air throughout the home using an extensive duct system, often shared with a central heating system. Central air conditioners work well, but they can be costly to install and operate. They also utilize ozone-depleting chemicals that can leak into the atmosphere. They're effective in a range of climates, especially hot, humid regions.

Heat pumps also double as cooling units. They cool a home by drawing heat out of the interior and dumping it outside. Heat pumps work well in a variety of climates, and operate fairly efficiently. However, some heat pump systems can be costly to install.

Heat pumps, popular in the southeastern United States, are one of the most environmentally benign means of cooling a home. Next on the scale of environmental acceptability is the evaporative cooler. Remember, though, that it works best in hot, arid climates and consumes a fair amount of water. Last on the list is the air conditioner.

Fortunately, manufacturers have made air conditioners more energy efficient and installed better seals to prevent leakage of ozone-depleting chemicals. Room air conditioners come with stickers that list the energy efficiency rating (EER). Models with EERs over 10 are recommended. Similarly, central air conditioners come with stickers that list the seasonal energy efficiency rating (SEER). Look for units with ratings of 12 or higher. High-efficiency air conditioners cost more, but the additional investment is often quickly reimbursed through lower utility bills.

Selecting Efficient Appliances

After heating and cooling systems, water heaters, refrigerators and freezers are the next largest energy consumers in a home, followed by washing machines, dryers, dishwashers, televisions and computers.

You can find information on energy-efficient appliances by consulting the *Consumer Guide to Home Energy Savings* by Alex Wilson, Jennifer Thorne and John Morrill *(access www.aceee.org/consumerguide)*. Also look for the U.S. Environmental Protection Agency's Energy Star logo, which certifies an appliance to be among the most energy efficient in its class. All major appliances sold in the United States come with a brightly colored energy sticker noting how much energy the appliance uses in a year and how it compares to similar models. Be aware, however, that the super-efficient models may not be included in the range.

Don't expect to find the most efficient appliances at local discount stores. These outlets tend to carry the cheapest and, hence, most popular units. To purchase energy- and water-efficient appliances, you will likely have to shop at an appliance store or specialty suppliers like Gaiam Real Goods, a mail-order supplier *(www.realgoods.com)*.

Minimizing the Lighting Bill

Energy-efficient lighting also helps reduce monthly energy bills. One of the easiest ways to save on lighting is to resist the temptation to provide more light in a room than is necessary. Reducing the number of light fixtures and putting lights on separate switches so occupants can adjust lighting to meet their needs both help reduce electrical demand. Wall switches with built-in timers or motion sensors are also useful.

You can achieve even greater savings by replacing standard incandescent light bulbs with energy-efficient compact fluorescent light bulbs (CFLs). Compact fluorescent light bulbs are ideal for areas in which lamps are on for long periods each day. CFLs do cost more than standard light bulbs, selling for $10 or $12 in retail stores. Despite costing much more than ordinary bulbs, CFLs use only one-fourth as much energy to produce the same amount of light and last six to 10 times longer. In my house, CFLs that I installed in the late 1980s are still working fine. Because they are efficient and long-lasting, CFLs pay back the initial cost several times over.

Halogen lamps are also more efficient than incandescent lights, but produce a lot of waste heat and are costly. When you have a choice between a compact fluorescent light bulb and a halogen light bulb, choose the CFL.

Why Buy or Build an Energy-Efficient Home?

- Save money on monthly fuel bills
- Experience greater comfort levels
- Reduce unwanted noise from outside
- Save money on your mortgage
- Reduce maintenance costs
- Increase resale value and ease of resale
- Protect the environment

Another tactic, *daylighting*, uses natural light from windows and skylights to illuminate. These windows reduce daytime electricity use year-round.

By now it should be clear that energy efficiency makes good sense. It reduces energy use, saves money and helps protect the planet. Energy efficiency is a no-brainer. Who wouldn't want to buy or build a home that has a higher appraisal value and is cheaper to operate, healthier to live in, more durable and easier on the environment? ●

Daniel D. Chiras, Ph.D., is a leading authority on green building and renewable energy options for home construction, and principal of Sustainable Systems Design Inc., Evergreen, Colo. This article is excerpted from his latest book, The New Ecological Home, *published in May by Chelsea Green Publishing, www.chelseagreen.com. Contact Chiras at danchiras@msn.com.*