



COURTESY OF WAUSAU HOMES

# Zero-Energy Homes



A SYSTEM BUILT WAUSAU HOME



Faced with rising fuel costs, consumers building new homes are looking for ways to make their residences more energy-efficient. Many people are also interested in reducing the consumption of fossil fuels and helping our nation move toward energy independence.

TVA, Oak Ridge National Laboratory (ORNL), and local power companies have energy specialists who can help in selecting options for heating and cooling, lighting, siding and insulation, roofing, and solar power. The most advanced energy-efficiency features are incorporated into **zero-energy homes**.

**Zero-energy homes** are structures built with the eventual goal of producing as much energy as they consume. They are designed so that the separate energy-saving features, including Energy Star appliances, work together to create efficiencies that haven't previously been achieved. The attainment of zero energy involves not only the selection of the right high-efficiency components, but also the prudent use of electricity throughout the home.

From 2002 to 2005, TVA and ORNL built five such homes in Lenoir City, Tennessee, through the Habitat for Humanity program. As each new home was built, the lessons learned from the earlier homes were incorporated into the design to produce even greater energy savings. The goal of a fully sustainable **zero-energy home** has not yet been reached but should be affordable for new homes within a few years.



Zero energy home features can be added to any home – large or small. The more features installed and used, the closer it comes to being a zero energy home. Through its *energy right*<sup>®</sup> program, TVA helps consumers adapt many of the technologies described in this brochure to any new home. They can be used individually or adopted as part of an entire energy-management system.





## Insulation and ventilation

Zero-energy homes feature airtight construction using structural insulated panels (SIPs), or something similar in energy efficiency. The SIPs, which consist of two pieces of wood sandwiching a foam core, are used to construct the exterior walls, roof, ceilings, and floors. The system forms a tight envelope for the interior of the house and provides superior insulation and faster installation compared with comparable wood-framed homes. Because the SIPs can insulate the home so effectively, the size of the equipment needed to heat and cool the home can be reduced. The walls, floors, ceiling joints, and openings for electrical wiring are sealed to reduce the infiltration of exterior air.

A mechanical ventilation system is required to ensure the exchange of air from outdoors. Proper ventilation of a home's interior is important to reduce the potentially negative effects of substances inhaled from cleaning products, glues from furniture and carpets, pet dander, cooking, and other sources. Research indicates that indoor air pollution may be as much of a problem as outdoor pollution. The zero-energy home solves this difficulty with a mechanical ventilation system in the ductwork that uses the heat pump's circulating fan (equipped with a variable-speed electronically commutated motor, or ECM) to ventilate the home. If the heat pump does not cycle on within a certain period of time, an automatic sensor activates the fan and opens a damper to an air duct that allows the system to distribute fresh air to every room.

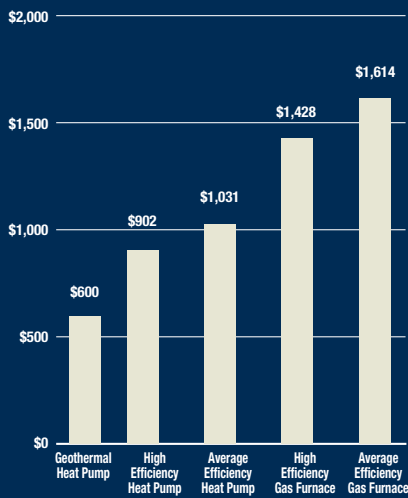
## Windows and siding

Efficient windows are critical in an energy-efficient home. Multi-pane glass is no longer the main measure of efficiency. New advanced technologies and designs have dramatically improved the performance of the most energy-efficient windows. Glass coatings, gas fills, warm edge spacers, and improved framing materials enable today's windows to deliver more benefits than simple double-pane windows. When selecting a window, choose the best window your budget will allow. Windows are rated two ways: the U-factor and the solar heat gain coefficient (SHGC). The U-factor tells you how well the window insulates: the lower the U-factor, the better the window performs. The SHGC tells you how well the product blocks heat from sunlight. The lower the SHGC, the less solar heat the window lets in. Among the choices for siding, the more-efficient materials include brick, stone, and fiber cement that's made of cellulose, sand additives, and water. Efficient siding can be both attractive and cost-effective.



## Comparison of Estimated Annual Operating Costs

2,000 sq. ft., single-family, typical insulation,  
average Valley rates



## Heating, cooling, and water heating

Through *energy right*, TVA offers assistance with high-efficiency air source or geothermal heat pumps. Unlike other types of systems that convert fuel to heat, heat pumps operate by moving heat from one place to another. Since they move heat rather than generate it, they are very efficient. They are more efficient than gas furnaces, and that's good news today when gas is more expensive than electricity.

In colder weather air source heat pumps remove the heat from outdoor air and transfer it indoors; the process is reversed in summer to expel indoor heat to the outside, leaving cool air inside the home.

Geothermal heat pumps use the ground to absorb or dissipate heat through a series of pipes buried below the frost line. Because ground temperatures are much more constant year round—warmer in winter and cooler in summer than the air—a geothermal heat pump is one of the most efficient systems available. In addition, through the use of an auxiliary heat exchanger, excess heat that would normally be dispersed through the buried pipe can be used to meet water heating needs, providing virtually free hot water in the summer and significant savings on water heating throughout the rest of the year. Additional ownership benefits include no visible outdoor unit to suffer deterioration from weather or vandalism and no outdoor compressor noise. Geothermal systems are more expensive to install because of the excavating involved, but they can save as much as 60 percent on heating costs and 30 percent on cooling.

Ductwork in the zero-energy homes is placed inside the conditioned space, which prevents heat transfer from (or to) the ducts. This technique adds to the efficiency of the system and can be used in any home.

Heat-pump water heaters are another alternative for water heating. Research shows they are twice as efficient as conventional electric water heaters. They not only save on operational costs but have the added benefit of dehumidifying the air, which make them a great solution for basement areas.

## Lighting

In a home, lighting typically represents 6 or 7 percent of the electric bill. With standard incandescent bulbs, almost 90 percent of the energy released is in the form of heat, not light. Compact fluorescent lamps, however, use 66 percent less energy than standard incandescents, while providing the same amount of light. Fluorescent lamps last more than 10 times longer than incandescents, give off very little heat, and cost less than a third as much to operate. With recent improvements, their light coloring more closely matches natural lighting.

Today's compact fluorescent lamps fit into most fixtures on the market, and they do not produce the annoying hum that marked the original tube fluorescents. They cost a bit more than standard lamps, but the cost is quickly offset by lower operating costs. Some fluorescents can be used for exterior lighting and some are even dimmable.

Certain design elements in a structure can also reduce the amount of energy used for lighting. In the zero-energy homes, more windows are put on the south side to capture sunlight for natural indoor lighting. A three-foot overhang and special window glazing help reduce heat buildup in the summer.



## Roofing and solar panels

Roofing can also be designed to reduce energy use. One type uses standard metal construction but adds reflective paint or infrared reflecting pigments that allow darker colors to reflect heat in the same way lighter colors do. That keeps heat from being absorbed into the roof and conducted into the house, with the potential for a 30 percent reduction in heat gain during summer afternoons. These metal roofs can also be installed on conventional homes and are especially good for reducing air conditioning costs in the South, with its high summer temperatures.

Solar panels provide a way for homeowners to generate some of their own electricity. Solar photovoltaic (PV) panels are thin wafers of silicon that are connected within a glass panel or frame and mounted on a roof. When the sun hits the PV cells, the electricity produced can be used immediately, stored in batteries for later use, or sent to the utility power grid. Each PV system on the zero-energy homes has a power rating of about two kilowatts and produces 20 to 27 percent of the electricity used by the home. Homeowners may receive credits on their utility bills for electricity generated through a TVA program called Green Power Switch Generation Partners. The cost of the PV systems in 2002 was \$22,000, and by late 2004 that had declined to under \$14,000. The price should continue to come down over time. Because the solar system requires a house with a southern exposure, many existing homes aren't good candidates for the systems. But builders will have to begin considering energy-efficiency features if more consumers demand that they be incorporated into their new homes.



## Promoting energy efficiency

TVA promotes energy efficiency through programs such as *energy right*<sup>®</sup>, Green Power Switch<sup>®</sup>, and Green Power Switch Generation Partners<sup>®</sup>.

Offered in cooperation with local power companies in the Valley, *energy right* provides information and incentives that encourage energy efficiency through quality construction, better insulation, and high-efficiency heat pumps and water heaters in new and existing homes.

Green Power Switch allows consumers to buy electricity produced by wind, solar systems, and methane gas. Homeowners pay \$4 per month for each 150-kilowatt-hour block of renewable energy. Businesses buy amounts based on their monthly energy use. The GPS Generation Partners program provides incentives for the installation of solar and wind generating facilities. Consumers sell the electricity they produce to TVA.

Find out more about these programs and get energy-saving tips at [www.energyright.com](http://www.energyright.com) and [www.greenpowerswitch.com](http://www.greenpowerswitch.com).



**Reducing energy consumption will demand a national effort as we work to improve air quality and impact climate change by controlling fossil emissions. As homeowners, we can begin to have positive effects immediately by the choices we make for home heating and cooling, lighting, insulation, and building materials. The technologies employed in zero-energy homes demonstrate that real reductions are possible and that we can implement these innovations to save money and create a healthier environment for future generations.**

[www.tva.com](http://www.tva.com)