



Buildings for the 21st Century

Buildings that are more energy-efficient, comfortable, and affordable . . . that's the goal of DOE's Office of Building Technology, State and Community Programs (BTS). To accelerate the development and wide application of energy efficiency measures, BTS:

- Conducts R&D on technologies and concepts for energy efficiency, working closely with the building industry and with manufacturers of materials, equipment, and appliances
- Promotes energy/money saving opportunities to both builders and buyers of homes and commercial buildings
- Works with State and local regulatory groups to improve building codes, appliance standards, and guidelines for efficient energy use
- Provides support and grants to States and communities for deployment of energy-efficient technologies and practices



ENERGY EFFICIENCY PAYS

Systems approach cuts home energy waste and saves money

ENERGY EFFICIENCY SAVES MONEY AND IMPROVES THE COMMUNITY

An Atlanta community found that the annual energy bills for newly constructed, affordable homes averaged over \$1,200. Increasing the energy efficiency of the homes saved over \$400 a year and added less than \$500 to construction costs.

Simple energy efficiency improvements can cut energy costs by over 40 percent in most affordable housing. Some low-income families may spend over 15 percent of their income on energy to operate their homes. The money that these families save on energy can help them make mortgage payments and pay for food, clothing, and other essentials. Studies show that a dollar saved on energy stays within the community.

EFFICIENT HOMES PROTECT THE HEALTH OF FAMILIES AND THE ENVIRONMENT

Energy-efficient homes provide a healthy indoor environment, reducing health risks from mold, pollen, dust mites, radon, combustion by-products, and other contaminants. In addition, they help to prevent unnecessary pollution. While homes are not often considered a source of pollution, the electricity, fossil fuels, and other energy sources they use contribute to global warming, acid rain, smog, and other serious environmental problems. Wasted energy needlessly pollutes the environment. Energy-efficient homes help to protect the environment as well as the pocketbooks of homeowners.

LITTLE IMPROVEMENTS YIELD BIG SAVINGS

Getting the most efficiency for the least cost requires careful attention throughout the design and construction process. Most energy-efficient homes have dozens of little improvements that individually add little to construction costs, yet together yield big savings.

Many energy features offer additional benefits such as increased comfort, reduced noise, greater fire safety, and improved building durability. Energy-efficient homes also have less condensation, which protects framing, windows, and finish materials. Better control of moisture and temperature means less movement of materials, which reduces floor squeaks and drywall cracks.

While some energy features add to construction costs, others can reduce costs. For example, increasing insulation and sealing air leaks reduce heating and cooling needs, allowing the use of smaller equipment and ductwork. The savings on the mechanical systems can pay for the increased cost of insulation and air sealing. Energy-efficient framing techniques can reduce lumber costs over 15 percent and prevent mold growth in outside walls and ceilings.

WHAT MAKES A HOME ENERGY-EFFICIENT?

Affordable housing programs that have successfully cut energy waste have champions who understand the importance of a systems approach to improving energy efficiency and the need for careful planning, training, and quality control during construction. The following improvements help to make a home truly affordable, healthy, durable, and comfortable.

✓ **PROPER DESIGN AND INSTALLATION OF HVAC**

Poor design and installation of heating, ventilation, and air conditioning (HVAC) equipment commonly increases energy costs 10 to 30 percent in affordable housing. Proper sizing, design, and installation are usually the top three priorities for cutting energy bills.

• **EQUIPMENT SIZE**

Equipment that is too big costs more to buy and operate and results in less comfort. To size equipment properly requires exact calculations that consider insulation levels, window type and orientation, and air-sealing measures. Do not use rules of thumb that estimate so much heating or cooling per square foot of living area.

• **EQUIPMENT EFFICIENCY AND ENERGY SOURCE**

The professional who calculates the size of the HVAC equipment should be able to determine estimated operating costs for various equipment efficiencies and energy sources. It is also important to consider the cost of energy sources when selecting equipment. Saving a few dollars on equipment is no bargain if families pay hundreds more due to a wrong choice. Look for the Energy Guide label, detailing estimated energy consumption and annual operating costs.

• **VENTILATION**

Today's homes need controlled ventilation systems. For most affordable home designs, simple systems can be economical to install and operate. In temperate climates, spot ventilation provided by higher-quality bath and kitchen fans vented directly to the outside may be adequate. In more severe climates, heat recovery ventilation and other techniques may be more appropriate.

• **DUCTWORK**

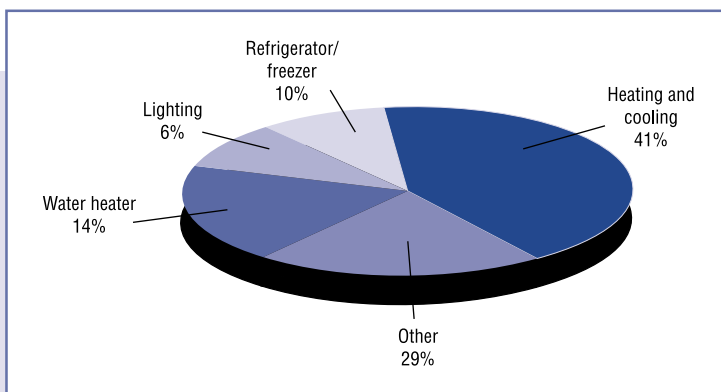
Improving the efficiency of ductwork is the single most important energy measure for most affordable homes. Poor ductwork can waste hundreds of dollars each year and cause serious health and safety problems. It is best to locate ducts inside the living area—not in attics or crawl spaces. Do not use building cavities, such as closet returns, as part of the duct system.

Make sure all joints in the ductwork are sealed permanently with mastic; duct tape and insulation do not provide an effective seal. After ducts are sealed, ensure that they have adequate insulation. The Model Energy Code sets minimum requirements, but higher levels are often cost-effective. (See page 4 for details on how to obtain a copy of the Model Energy Code.)

✓ **REDUCED AIR LEAKAGE**

Excess air leakage in homes can increase heating and cooling bills by 30 percent. Although windows, doors, and outside walls contribute to air leakage, the biggest holes are usually hidden from view and connect the house to the attic, crawl space, or basement. Reducing air leakage typically costs less than \$200 for the average home and is required by the Model Energy Code.

HOME ENERGY USE



- *A systems approach to improving energy efficiency looks at energy usage throughout the home to identify key ways to cut energy waste.*

ENERGY EFFICIENCY PAYS

✓ PROPER INSTALLATION OF INSULATION

Gaps and compressed areas of insulation can cut the energy-saving potential of insulation by over 25 percent. Poor installation also leads to condensation and comfort problems. The Model Energy Code sets minimum requirements for insulation levels, but it is often cost-effective to exceed these levels.

✓ WATER CONSERVATION

A family of four can spend more for hot water than heating or cooling. Consider the cost of various fuels for heating water as well as the efficiency of the water heater, which is often addressed on the label of the water heater. Simple conservation measures, such as low-flow showerheads, tank insulation jackets, and convection traps in hot and cold water lines, pay back quickly. Replacing inefficient plumbing fixtures in older homes can save families hundreds of dollars.

✓ EFFICIENT WINDOWS

While energy-efficient windows cost more than standard models, they can cut energy bills significantly and reduce heating or cooling needs enough to permit smaller and cheaper HVAC equipment and ductwork. They greatly improve comfort by increasing surface temperatures and cutting drafts. They also reduce condensation, protecting building materials and reducing mold growth. Look for the Energy Star® label when choosing windows.

Window orientation greatly affects energy use—as much as 25 percent for some designs. Major glass areas should face south for maximum winter heating. Avoid unshaded glass on east and west sides to reduce summer overheating. Use solar shade screens, roof overhangs, awnings, and trees and other landscaping to provide shade.

✓ EFFICIENT LIGHTING

Energy-efficient lighting saves on electric bills, helps keep the home cooler by reducing waste heat, and lasts longer. Specify compact or tubular fluorescents for interior fixtures that will be on for four hours or more each day—usually kitchens, hallways, and some living areas. Their extra cost is repaid in energy savings.

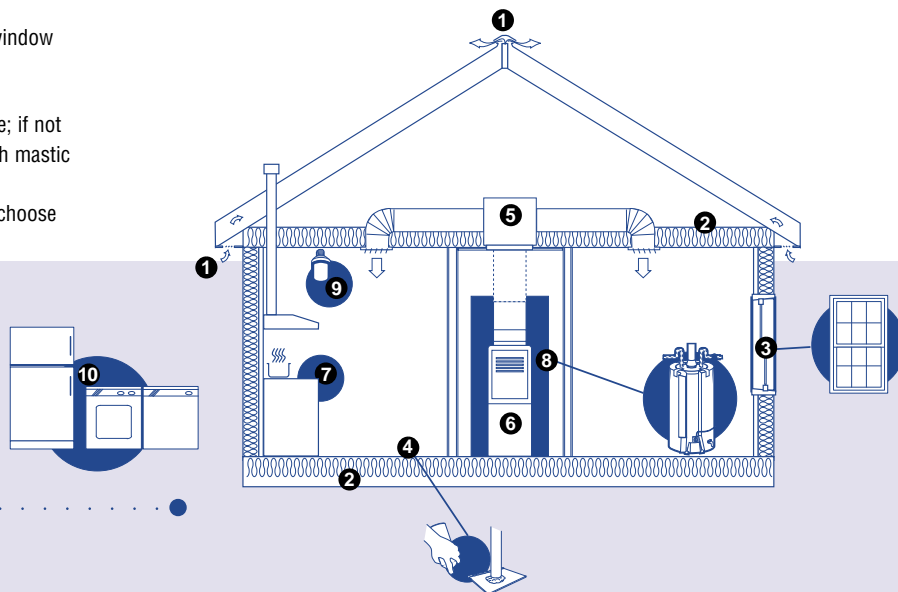
Exterior lighting can cost hundreds of dollars a year to operate if it is not energy efficient. Install only compact fluorescent or high-pressure sodium fixtures for security lighting, and consider motion sensors or photo cells that operate lights automatically.

✓ EFFICIENT APPLIANCES

Appliance energy use is usually greatest for refrigerators, clothes washers and dryers, and dishwashers. The true cost of an appliance is the purchase price plus the cost for energy and water for operation. A cheap, inefficient appliance will waste money for years to come. Federal law requires that most appliances have Energy Guide tags that compare estimated operating costs between energy-efficient and standard models. Look for the Energy Star® label when choosing appliances.

IMPROVE ENERGY EFFICIENCY THROUGHOUT THE HOUSE

1. Ventilate attic
2. Install adequate insulation with no gaps or compressed areas
3. Specify efficient windows; consider window orientation
4. Seal all penetrations
5. Locate ducts inside conditioned space; if not possible, ensure ducts are sealed with mastic and insulated
6. Size heating and cooling equipment; choose efficient models
7. Provide controlled ventilation
8. Install efficient water heating
9. Specify efficient lighting for fixtures used more than four hours daily
10. Choose efficient appliances



ENERGY EFFICIENCY PAYS

For more information,
contact:

**Energy Efficiency and
Renewable Energy
Clearinghouse (EREC)**
1-800-DOE-3732
www.eren.doe.gov

Or visit the BTS Web site at:
www.eren.doe.gov/buildings

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**Southface
Energy Institute**
404-872-3549
www.southface.org

**Oak Ridge
National Laboratory**
Buildings Technology Center
423-574-5178
www.ornl.gov/btc

The Model Energy Code
can be obtained from the
Council of American
Building Officials by
calling 703-931-4533

MECcheck, a companion
compliance software
package, can be ordered
from DOE by calling
1-800-270-CODE
or downloaded directly
from the Web at:
[www.energycodes.org/
resid/resid.htm](http://www.energycodes.org/resid/resid.htm).

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ENERGY EFFICIENCY IMPROVES HOME AFFORDABILITY

Energy improvements help make a building that is more durable and reduce the need for expensive maintenance. Money saved on energy bills can be used by homeowners to better budget for any maintenance and repairs that must be done. Energy efficiency is a great investment for homeowners. When added to a mortgage, energy improvements usually cost less than the savings they offer on utility bills. Some areas have mortgages that encourage energy efficiency, helping to offset any added construction costs due to energy improvements.

AVERAGE HOUSEHOLD ENERGY EXPENDITURES



The average American family spends \$1,291 on home energy per year. Energy use varies according to home characteristics, occupant lifestyle, and climate.

Energy efficiency makes housing rehab affordable

In Greene County, Pennsylvania, the Habitat for Humanity (HFH) affiliate closely monitored energy usage for remodeled homes. They discovered annual energy bills as high as \$1,800. The data clearly showed that the highest energy consumption occurred where little attention had been given to energy improvements to the building envelope and HVAC equipment.

By incorporating proper planning and quality control during remodeling, HFH successfully reduced air leakage in the building envelope and duct system and improved efficiencies of the insulation, water heater, and space conditioning equipment.

The results were significant: gas bills for heat and hot water dropped from between \$60 and \$110 per month to around \$30. Electricity costs were reduced by improving lighting and certain "energy hog" appliances, such as old refrigerators and dryers. Improvements in water efficiency reduced water and sewage costs.

HFH has lowered energy use in older homes to about the same levels as in new, energy-efficient homes. The key is a systems approach that considers all energy usage, including heating, cooling, hot water, lighting, and appliances.