# BUILDING AN ENERGY SMART HOME

Missouri Department of Natural Resources

**GRADE LEVEL:**

Upper Middle School - High School

**SUBJECT AREA:**

Sciences, Art

**DURATION:**

Preparation time 30 minutes
Activity time: three 50-minute class periods

**SETTING:**

Classroom

**SKILLS:**

Application, Analysis, Synthesis

**KEY WORDS:**

Insulation, Conduction, Convection, Architecture

**CORRELATION'S TO SHOW-ME STANDARDS:**

Performance standards
1.3, 1.10, 2.1, 3.1, 2.2, 2.3, 2.7, 2.8, 4.1, 4.6

Knowledge Standards
SC-1,5,8
FA-4


## SUMMARY

*In this activity, students will work as part of a group and build a simple model home that incorporates energy saving design strategies. The students will present the approaches they implemented to the rest of the class. Following the group exercises, each student will adopt the role of an architect and design a modern home that incorporates some of the concepts learned during class. The goal of the students is to create an attractive home that will excel in conserving energy.*


## OBJECTIVES

**THE STUDENTS WILL:**

- ✓ Work in a group setting to explore various approaches in designing energy efficient homes.
- ✓ Work in a group setting to construct a simple model building that incorporates some specific energy saving design elements.
- ✓ Prepare a presentation that will explain the energy saving design elements their group utilized.
- ✓ Adopt the role of an architect and design and draw a building that incorporates some of the energy saving principles the students explored as a class.

## MATERIALS

- A cardboard box per group (photocopier paper boxes or equivalent work well…these are available in most schools main offices or the schools computer labs)
- Miscellaneous construction paper
- Aluminum foil
- Poster board
- scrap cardboard
- Styrofoam cups or packing peanuts (used to simulate insulation)
- Plastic wrap or sandwich bags (for windows)
- Tape
- Glue
- Modeling clay

- Scissors
- Colored markers
- Bucket of sand or gravel (for earth contact home)
- Tree and bush clippings (to model energy saving landscaping)

## BACKGROUND

The average American will spend from 15 to 50 percent of their budget on home energy needs. How a building is designed can significantly affect the amount of energy required to achieve a comfortable environment. Energy efficient building designs are one of the simplest ways to decrease the amount of energy consumed by our society. A home does not have to appear radical or unconventional to save energy.

### SOLAR ENERGY DESIGNS:

Passive solar buildings use south-facing windows that are designed to let the warmth of the sun in during the winter months. In the summer, when the sun is higher in the sky, window awnings or roof overhangs are employed to decrease sunlight. Window shutters, glazes (reflective coatings) and trees can also be used to deflect solar heat helping to keep a building cooler in summer.

Passive solar buildings are often also designed to use sunlight for lighting needs. These designs are especially useful in the Midwest and can significantly reduce energy costs associated with heating and lighting.

*Several tips on energy efficient homes are found in the Great Homes Checklist provided in the solar power section of this curriculum.*

### GEOTHERMAL DESIGNS:

These homes take advantage of the stable temperatures found everywhere in the earth's crust just 10 to15 feet below the surface. At these shallow depths the ground has a constant temperature (in Missouri this is 50 to 60 degrees Fahrenheit).

A type of heating and cooling system called a geothermal heat pump can be used to take advantage of these stable temperatures. Typically, plumbing for a ground heat exchanger is buried under or next to the building. Fluid is pumped through the length of the exchanger and cycled through the main heating and cooling unit. In the winter a ground source heat pump does not have to overcome the cold winter air to provide inside heating. Conversely, in summer the system uses the cooler ground temperature as a starting point for providing cooled air rather than attempting to cool the hot summer air, as would a conventional air conditioner. A variation on this idea is the earth contact home. In such cases one or more sides of the home are built in contact with the earth by digging in part of the building or pushing soil up to the side of the structure. Earth contact homes take advantage of the earth as a heat-sink and as a result such homes are easier to heat in winter and to cool in summer.

### HOME INSULATION:

A properly insulated home will require less energy to create comfortable temperatures for its residents. Insulation can be applied to the walls, the roof and the home foundation. Properly insulated water lines and water heaters can reduce the amount of energy associated with hot water use. Generating hot water is a leading source of energy consumption in homes.

Insulation is used to decrease the transfer of thermal energy to a home from its surroundings. Heat flows from areas of high thermal energy towards areas of low thermal energy in three basic ways. The first is *radiation* and involves the transfer of heat by light

energy. The heat we feel from the sunlight is an example of this process. Homes can use lighter colored shingles on the roof to decrease the amount of energy absorbed from the sun. Reflective window treatments can be used to reduce the amount of energy gained from sun. Many modern home insulation layers employ a reflective silver lining to decrease energy transfer via radiation.

Another way heat is transferred is by *conduction*. This occurs when two objects transfer thermal energy by physical contact. Different materials have different conduction abilities. Metals are very good conductors while wood, foam and rubber are poor conductors of thermal energy. Metal-framed windows can lose energy via conduction unless properly insulated. During construction, most modern homes often install insulation between the concrete foundation and the surrounding earth in an effort to decrease conductive heat loss. Single pane windows can promote conductive heat loss. Modern energy efficient double and triple pane windows are designed to decrease conductive heat loss from a home.

A final way heat can be transferred is by *convection* involving the transfer of thermal energy by flowing currents of air. Cold air pulled through an open window into a warm house is an example of convective processes. Infiltration of outside air is often a significant source of energy loss in a home. Older homes often can benefit from application of seals to windows, doors and vents in an effort to decrease convective heat loss.

*For more information on insulation please see the Energy Management Handbook for Homeowners found in the background section of the curriculum*

## ENERGY EFFICIENT LANDSCAPING:

A home can often conserve energy by considering location and type of plants and trees that surround the building. Appropriate landscaping can save as much a 30 percent of the winter heating costs and as much as 50 percent of the summer cooling costs.

Strategically placed trees can provide shade in summer when the leaves are on the trees. Conversely when the leaves are down in winter, a summer shade tree will allow the sun's energy to reach the home. Shrubs and bushes can be used to decrease convective heat loss by shielding the side of a home from the wind.

*For more information please refer to Grow Your Own Savings in the background section of the curriculum*

## ENERGY EFFICIENT APPLIANCES:

Energy efficient appliances can help reduce the amount of energy used by a home. The cost of operating the appliance over its lifetime is as just as important as the initial purchase price. This information is provided as part of an energy guide label on the side of larger appliances. Another tip is to look for an energy star label. This identifies appliances that have been determined by the U.S. Environmental Protection Agency and the Department of Energy as being an energy efficient choice.
Using fluorescent light bulbs versus incandescent bulbs can reduce home energy use by as much as 20 percent.

*For more information on Appliances and Energy Guide Labels can be found in the Energy Management Handbook for Homeowners in the background section of the curriculum*

## ENERGY SENSITIVE HOME DESIGN:

Many times energy can be saved by designing the home's basic layout with energy use in mind. For example, installing the hot water heater closer to the main bathroom will reduce

heat loss from the water distribution system. Entryways can be designed with a foyer (small room) and a second door to reduce convective heat transfer when the large outside door is opened. Main living areas can be located in areas that receive favorable natural lighting. Central wood burning fireplaces can be designed into the main living room to provide supplemental heat. Rooms that receive only periodic use can be designed so they can be isolated from heating and cooling needs. Heavy ceramic tiles can be used along with thicker foundations to take advantage of the earth's geothermal temperature stability. Such changes are often very difficult to "add-on" to an existing home and are best applied as part of the initial building plans.

## PROCEDURE

### WARM UP

Set the stage by asking the students:

- *Can you guess how much your parents spend on heating and cooling your home?*
- *Ask the students to consider the resources and components required to provide energy for their home?*
- *Ask the students to brainstorm what an energy efficient home would look like?*

### ACTIVITY

Review with the class some basic approaches to energy efficient building designs. Divide the class up into groups. Assign each group the task of constructing an energy efficient cardboard home.

*The instructor can either assign each group a particular energy design (passive solar, earth contact, energy efficient landscaping, and insulation approaches) or each group can work free form and create their energy efficient model home. The groups can also be allowed to research home designs on the web to generate ideas for their project.*

After the groups have completed their model home, they should prepare a brief oral presentation or a poster in order to explain to the rest of the class the energy saving approaches they utilized.

### ASSESSMENT

Instruct each student to adopt the role of an energy efficient architect. They should consider the various approaches to home design explored by the class and how these approaches could be incorporated into a modern home. The students should try to design a home that is both attractive and excels in conserving energy. The students should create a drawing of the home they have designed, along with a written explanation of the energy saving approaches they incorporated into their design.

## EXTENSION

Have the students construct generic basic cardboard home and place a thermometer inside. The home can then be subjected to a heat source (a lamp can be used) to model the solar input. The class can then systematically modify the structure with window awnings, darker or lighter roof, enlarged windows, shade from model trees, insulation or building orientation to the light source. Have the class measure the effects of each change on the temperature of the model building and discuss how the results can be used to design an energy efficient structure.

## GOING FURTHER

Contact a local architect and invite them to come talk to the class (consult the yellow pages). Ask the architect to discuss the practical implications of the student's designs in terms of zoning laws, client expectations, construction cost, etc.

Image: Sandia National Laboratories

Image: Appleyard, Wayne

Showing off this Solar Decathlon home; University of Missouri—Rolla Image: Gretz, Warren