



## Heat Exchangers: Heating and Cooling a Home

*Grade/Subject: Physics*

**Strand/Standard PHYS.2.4 Define a problem and propose a solution** for a major global challenge that specifies qualitative and quantitative criteria and constraints and that accounts for societal needs and wants. Emphasize problems that require the application of conservation of energy principles through energy transfers and transformations. Examples could include feasibility studies examining the capacity of renewable energy resources to perform functions currently performed by nonrenewable fuels.

### Lesson Performance Expectations:

- Students will design an energy-efficient heating and cooling system for a home using the principles of energy exchange.
- Students will understand the economic and environmental significance of conserving heat and preventing energy waste in home heating and cooling.

**Materials:** computers for research, drawing materials (paper, pencil, ruler).

**Time:** Three total periods. One 50 minute period for research and planning, one 50 minute period for drawing, and one 50 minute period for peer review.

### Teacher Background Information:

- Teachers should know the source of household electricity in their area. There are several sources of information.  
[Utah's Energy Resources \(OED\)](#)  
[Using Natural Resources in Utah - Office of Energy Development](#)  
[Passive Solar Home Design](#)  
[NY Times: How Does Your State Make Electricity?](#)
- Passive solar design utilizes a building's site, climate, and materials to minimize energy use. A well-designed passive solar home reduces heating and cooling requirements (load) from external sources by incorporating energy-efficiency strategies and then meeting the adjusted load in whole or part with on-site solar energy. For example, passive solar homes are oriented to the daily rise and fall of the sun, utilizing daylight to reduce energy costs ([DOE](#)).
- Heat pumps, a common component of refrigerators, move heat from a cool space to a warm space using electricity. Heat pumps are an energy-efficient alternative to furnaces and air conditioners for climates with moderate temperatures. During winter, heat pumps move warm air from the underground to warm your house, and during the summer, heat pumps move cool air from underground to cool the home. When heat is generated rather than transferred, the cost is a quarter of conventional heating or cooling. There are three types of heat pumps: air-to-air, water source, and geothermal. They collect heat from the air, water, or ground outside your home and concentrate it for use inside. [DOE Heat Pump Systems](#).  
This [website](#) has information about methods of heating homes.

- **Air conditioning in the home** since students need to know about air conditioning in their own homes, this [short article](#) has background information.

#### **Student Background Knowledge:**

Students should have a basic understanding of the heating of homes during the winter and cooling during the summer.

**Teacher Step by Step: A 3-d lesson should insist students do the thinking. Provide time and space for the students to experience phenomenon and ask questions. The student sheet provided below provides guidance but is only an example of how students might respond.**

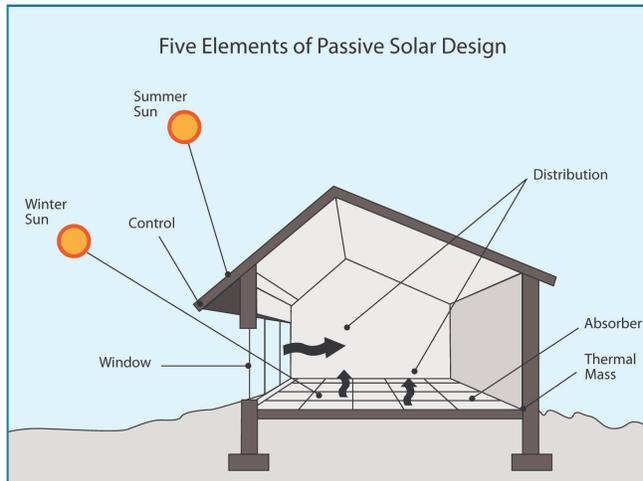
1. **Day one:** Present this [Slide Show](#) to introduce the activity. And explore the energy plans for their homes.
2. Students will work in pairs to brainstorm, design, and draw an energy-efficient home.
3. **Day two:** Students continue to work on their designs and their reports (described below). A computer and access to the internet are essential but watch that students do not directly import designs.
4. Students must explain in 300 words or more how their home is energy efficient as compared to traditional housing that we might see.
5. **Day three:** Students review and recommend changes to 2 other students' projects using the form below. Students should also have two students review their projects and recommend improvements. You can also require students to make changes according to their reviews.

**Assessment of Student Learning.** Use the rubric to evaluate student projects.

#### **Standardized Test Preparation:**

##### Heat Exchangers

1. Which design takes advantage of a building's site, climate, and materials to minimize energy use?
  - a. Active geothermal
  - b. Passive solar\*
  - c. Thermal sinks
  - d. Geologic heat
  
2. How does a heat-pump move water in the winter to heat a house?
  - a. From the warmer ground to the cooler house.\*
  - b. From the cooler ground to the warmer house.
  - c. From the warmer ground to the warmer house.
  - d. From the cooler ground to the cooler house.
  
3. Why is a heat pump an inexpensive source of energy?
  - a. The Earth's residual energy is free.\*
  - b. The energy from the sun is free.
  - c. The energy from the water is free.
  - d. The energy from the fuel is free.



4. What is the function of the thermal mass?
- To circulate air in the room.
  - To store the sun's energy and release it as heat at night.\*
  - To cool the house in the summer when the control blocks the sun.\*
  - To provide a cool surface for people to walk on.

**Extensions of lesson:** Students could visit a model passive home in the area. Students could build a solar home model and test its ability to heat up, especially on a cool day.

**Career Connections:** Potential careers related to this activity are HVAC Technician, Architect, and Energy Auditor

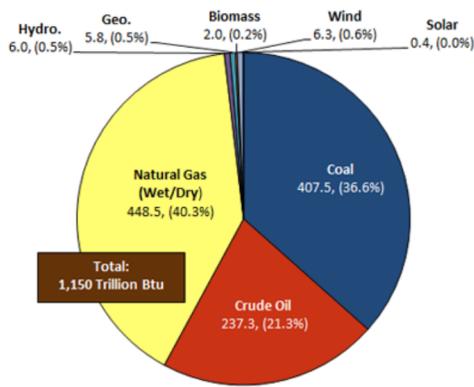
# Heat Exchangers: Heating and Cooling a Home.

Names \_\_\_\_\_

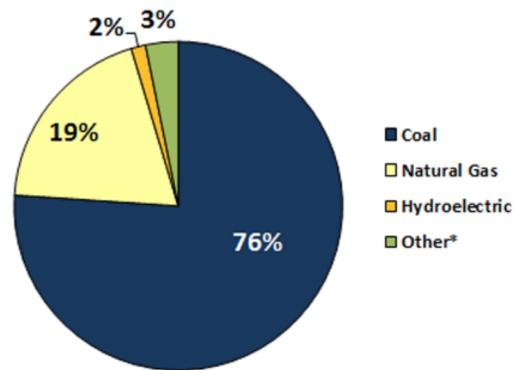
What is your challenge?

**Research:** Use the information below and the internet to see where Utahns get energy and how usage could be reduced.

### Utah Energy Production 2014



### Utah Electricity Generation 2015



1. How does your family heat your current home?
2. Where does the energy come from?
3. How does your family cool your current home?
4. Where does the electricity come from?

5. What are ways a home can use less energy?

6. What are the characteristics of passive energy heating or cooling?

**Your Challenge:** Design an energy-efficient home with passive heating and cooling systems.

- Assume your home is located in a temperate climate (warm summers, cold winters)
- There should be space for a family of four.
- Space for cooking, eating, sleeping, and relaxing should be included.

**Peer Review-** Include a positive statement and a suggestion for improvement.

Name of Peer:

Name of Peer:

Names of 2 peers you reviewed:

Rubric

Energy worksheet completed with appropriate research (10 points) \_\_\_\_\_

Rough draft of home designs (5 points) \_\_\_\_\_

Use of alternative sources of energy (5 Points) \_\_\_\_\_

Finished floor plan and front view of your home (20 points) \_\_\_\_\_

Artistic and viable (10 points)\_\_\_\_\_

Neatness (10 points)\_\_\_\_\_

Review by 2 other group (5 points each)\_\_\_\_\_

Review of others project (5 points each) must include name 1 positive and improvement\_\_\_\_\_

### **Review of projects**

Remember you must have 2 reviews of your project and you must review 2 projects and they **cannot** be the same people

Names of reviewers' (2) \_\_\_\_\_

Positive thing they liked about your house

Improvements

Changes you will make

Names of reviewers' (2) \_\_\_\_\_

Positive thing they liked about your house

Improvements

Changes you will make

Names of people that you reviewed\_\_\_\_\_

Thing you liked

Improvements

Names of people that you reviewed \_\_\_\_\_

Thing you liked

Improvements