

**Summary:** Through a game of hide and seek, students identify systems in their school that use energy and make the school's physical environment livable.

# Seeking Inhabitable Schools



**Grade Level:** K–12

**Subject Areas:** English Language Arts, Mathematics, Science, Social Studies

**Setting:** Classroom

**Time:**

**Preparation:** 30 minutes

**Activity:** One 50-minute period

**Vocabulary:** Air handler, Central cooling system, Central heating system, Chiller, Ecosystem, Energy recovery, Habitat

**Major Concept Areas:**

- Energy flow in nonliving systems
- Quality of life

**Getting Ready:**

Make one set of **School Habitat Cards** for each student in the class (or for each student group if working in pairs or teams). Cut cards into squares and mix them up. Scatter cards around the classroom so that they are visible but require a little sleuthing to find. For durability, cards can be laminated and reused.

**Objectives**

By the end of this activity, students will be able to:

- identify qualities of a school building that are essential for healthy living and learning; and
- compare systems in a school building to an ecosystem.

**Rationale**

Some of the most important ways a school building uses energy are not readily visible to the inhabitants of the building. Learning some of the “behind the scenes” systems that make school buildings inhabitable helps students appreciate the school building as a living and learning environment.

**Materials**

Copies of **School Habitat Cards** (see **Getting Ready**)

**Background**

No matter where living organisms reside, they have basic needs for survival; they need a healthy habitat, which includes food, water, shelter, and space. Given the considerable amount of time students, teachers, and staff spend in a school building, it is reasonable to consider the site a habitat. Many schools provide necessities such as food and water. Of particular interest are the building's shelter and space provisions: unbeknownst to most of the building occupants, energy-consuming systems are constantly working to provide fresh air, adequate lighting, and comfortable temperatures.

These systems include a boiler or furnace for space heating; a chiller for air conditioning; a water heater for hot water; air handling units and their fans and motors for bringing in outside air and exhausting stale air; energy recovery units for capturing waste heat from the exhaust air; pumps and their motors for moving fluids (chilled and hot) around the school to the classroom ventilators; and lighting designs (See **School Energy Systems**).

Similar to the “behind the scenes” activities in a natural ecosystem such as climate and biogeochemical cycles, these school systems provide components that make a habitat livable for its residents. Like an ecosystem, these activities require the flow of energy to sustain their actions. In addition to powering school appliances such as projectors and computers, a reliable energy supply ensures that school buildings provide its occupants with food, water, shelter, and space. Comfortable temperatures and adequate lighting provide students, teachers, and staff with conditions needed for productive living and learning.

**Procedure**

**Orientation**

Ask students what organisms need to survive in a habitat. Help students to identify essential components of food, water, shelter, and space. Challenge students to relate these components to a school building habitat. Tell students that while school provides all these, this lesson will focus on shelter, space, and water. Discuss what makes a school building a physically comfortable learning place or habitat. Could they learn if it was too dark, too hot, too cold, no water? Ask students if they can identify any of the equipment or systems in the school that make the school building a livable habitat.

**Steps**

1. Inform the class that each student represents a school building and that school building needs to find the proper components it needs for its inhabitants to learn and live comfortably.
2. Tell students that these components are symbolized by small squares of paper that are hidden around the room. Their mission is to seek out enough of these pieces of paper to support their healthy school. Share the following rules (adjust these as needed for the room setting and time available):

- They will have five minutes to find pieces of paper that are hidden around the class room (see **Getting Ready**).
  - They need to get at least six pieces of paper.
  - After securing each piece, they need to return it to their desk before finding the next piece.
  - All the papers should be visible and they do not need to open any drawers or cabinets.
3. Provide students with five minutes to collect papers. If the class is large, have students work in pairs or small groups and send one member to seek out the papers or take turns.
  4. After time is called, tell students to return to their seats and to count their squares. Point out that the squares have different letters on them and they should organize the squares into groups of like letters.
  5. Inform students that each letter represents a different piece of equipment or system in the school that makes the

school a comfortable space in which to learn. There are a couple of squares with letters that might be nice for a school to have, but do not necessarily make it inhabitable.

6. Describe each system or piece of equipment with students and explain what it does and where it is located in the building (see **School Habitat Cards Key** and **School Energy Systems**). Older students can be assigned to read the equipment background and share the information with the class.
7. Explain that each of these components uses energy. Review the forms of energy and how each might be used by the component (electricity, heat, motion, etc.).

#### Closure

Have students summarize the importance of each piece of equipment and whether “inhabiting” the school would be possible without the system.

Review the qualities of an ecosystem that provide a livable habitat for organisms. Ask student to compare these qualities to systems in a school building. Discuss the importance of these qualities to creating a healthy school environment.

## Assessment

### Formative

- Did students act responsibly while seeking out squares of paper?
- Can students compare qualities of an ecosystem to a school building?
- What types of equipment or systems can students list that schools use to provide fresh air and comfortable temperatures?

### Summative

Have students create a mural of their school building as an ecosystem. The mural should picture the components that make the school a healthy learning habitat. Challenge students to draw arrows diagramming energy flow through the school ecosystem that incorporates these components.

## School Habitat Cards Key

Letter	Component	Equipment or System	Is the school “inhabitable” without this system? (Yes/No/Maybe)	How it uses energy
H	Space Heating	Boiler	No	Natural Gas or Propane
C	Air Conditioning	Chiller	Yes, but perhaps uncomfortable	Electricity
W	Hot Water	Water Heater	No	Natural Gas/Electricity
Q	Air Quality	Air Handling Units	No	Electricity, Sometimes Natural Gas
L	Lighting	Lighting Systems	No	Electricity
R	Reusing Waste Heat	Energy Recovery Units	Yes, but inefficient	Electricity
V	Vending Machines	Plug Load	Yes	Electricity
P	Projectors	Plug Load	Yes	Electricity

# School Energy Systems

## Central Heating System

All schools have some type of heating system that keeps the building warm when it's cold outside. There are many ways to keep a building warm, but the most common central heating system in school buildings is a hot water boiler system. As the name implies, a "hot water" boiler burns fossil fuels such as natural gas or propane to heat water. Once the boiler has heated the water, the water is then circulated around a main loop of heating pipes by large pumps. Every room that has a thermostat calling for heat will receive hot water from the main heating pipes to the heating equipment that serves the classroom or other space. In most instances, the hot water from the main heating loop is sent through a heating coil that resembles a car radiator which is part of the air handling system. The air passing through the heating coil is warmed and exits the duct work into each classroom to keep it warm.

There are some variations to the hot water boiler method of heating a building that you may find in your facility. Some of these other methods include steam boilers, condensing boilers, furnaces, electric heat, or heat pumps. All of these varieties of central heating systems accomplish the goal of keeping the staff and students comfortable, but by slightly different means. For instance, if you have furnaces, there is no water involved in heating the school rooms. Instead, the warm air arriving in each room is heated by passing directly over a heat exchanger where combustion of the fossil fuels is taking place.

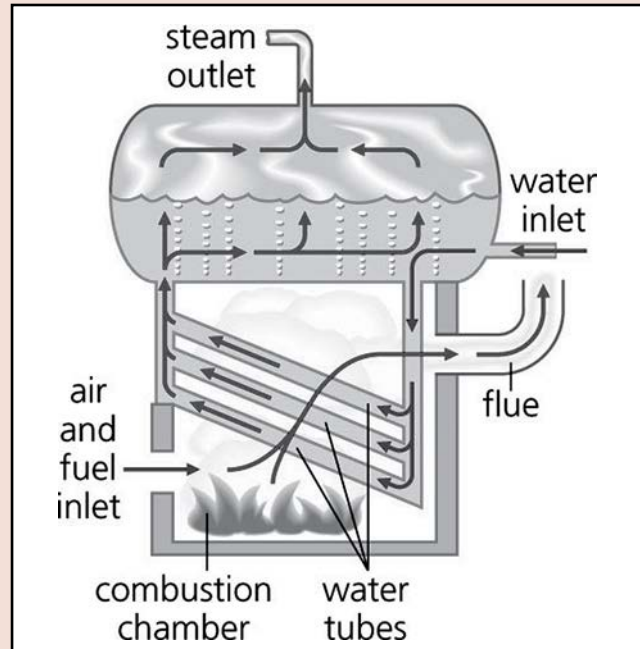


Diagram from: [daviddarling.info](http://daviddarling.info)



This pump circulates hot water from the boiler room to various parts of the school building.

## Boilers Commonly Found in Schools

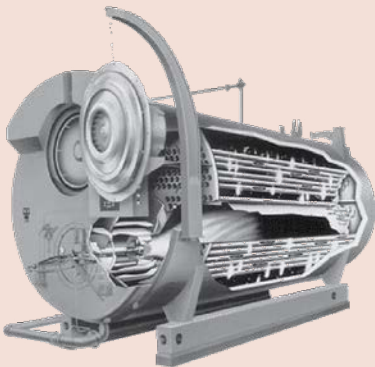


Diagram from: [bjmuirhead.com](http://bjmuirhead.com)



Photo courtesy of CESA 10 staff



Photo courtesy of CESA 10 staff

# School Energy Systems

## Central Cooling Systems

Some school buildings have a central cooling system or as it's popularly referred to "air conditioning" and some buildings do not. There are a couple of different ways to keep a building from getting too warm and most schools would utilize two or more of these options.

One of the more popular central cooling systems set ups is to utilize a piece of equipment called a "chiller." There are different types of chillers, but they all have the same function of using electricity via the refrigeration cycle to cool down or "chill" large amounts of water. Once the water in the central cooling system is cooled down by the chiller, it's circulated around a main loop of chilled water pipes by large pumps. Every room that has a thermostat calling for cooling will receive chilled water from the main chilled water pipes to the cooling equipment that serves the classroom or other space. In most instances, the chilled water from the main cooling loop is sent through a cooling coil that resembles a car radiator which is part of the air handling system. The air passing through the cooling coil is cooled and exits the duct work into each classroom to keep it cool.



Photo courtesy of CESA 10 staff

There are some variations on the chilled water method of cooling a building that you will most likely find in your facility. Two popular methods include direct expansion (DX) systems and economizing. Direct expansion is similar to the chilled water method of cooling, but the coil that is located in the duct work contains refrigerant instead of water. Economizing is a method of central cooling that utilizes the building's large ventilation fans to bring in air from outside the building to help cool the building down when the outside temperatures are low enough to permit it. This method of cooling doesn't use any extra electricity since the fans need to run to provide ventilation air to the building occupants anyway.

## Domestic Hot Water

In schools, hot potable water is necessary for washing dishes, washing hands, taking showers, and other tasks. The three most common methods of heating water for domestic use in schools are fossil fuel combustion water heaters, electric water heaters, and heat exchangers that utilize the central heating plant. The most common domestic water heating method is the fossil fuel combustion water heater. This piece of equipment burns fossil fuels such as natural gas or propane to warm the water that's being used. Electric domestic water heaters use electricity to generate heat which then heats the water. The central heating system can also be used by incorporating a heat exchanger to transfer heat from the main heating loop to the water being used for domestic purposes.

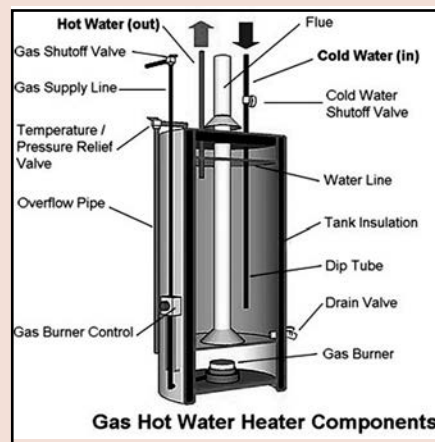


Diagram from: [morrisheating.com](http://morrisheating.com)

Since the use of domestic hot water is variable, the hot water is stored in large tanks and circulated throughout the building to all of the different points of use via a small pump until it's needed. By circulating the hot water around a loop, this insures that there is always hot water available when the tap is turned on. Some schools save energy by putting the domestic hot water circulation pump on a timer so that the pump will shut down and hot water isn't circulated around the building when no one is going to be using it.



Photo courtesy of CESA 10 staff

# School Energy Systems

## Energy Recovery

Energy recovery equipment isn't mandatory for a school building, but it will significantly increase the energy efficiencies and is becoming a much more popular option. There are many different types of energy recovery devices, but they all function by exchanging or "recovering" energy from exhausted air to the ventilation air that is being brought to maintain the indoor air quality for the occupants.

Energy recovery systems can save 50% or more of the cost of providing ventilation air to the occupants. They are an economical addition to equipment that have high ventilation rates such as large air handlers or swimming pool air handlers.

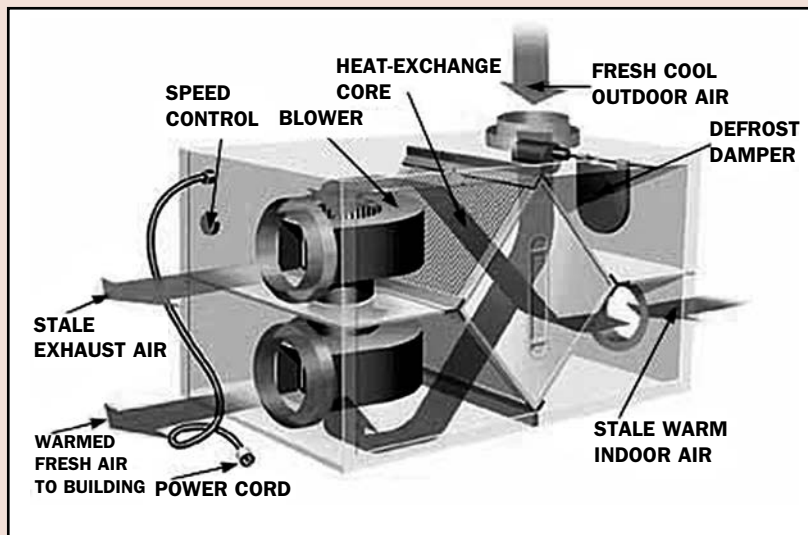


Photo from: [morrisheating.com](http://morrisheating.com)

## Air Handling

Every occupied space in a school building needs fresh air, heating, and cooling to maintain indoor air quality and occupant comfort. The way ventilation, heating, and cooling are achieved in school buildings is through air handling equipment. Air handling equipment can be big enough to serve an entire building or small enough to serve just one room.

The mechanical components that make up air handling equipment include a damper that will open to bring in outside air for ventilation, a heat source, possibly a cooling source, and a fan that distributes the conditioned air throughout the occupied space.

## Classroom Unit Ventilator



Photo courtesy of CESA 10 staff

Air handling equipment is the heart of any HVAC system and needs to function properly for a facility to be energy efficient.

## Lighting System

The lighting system in a school is one of the least complicated systems in how it functions, but it is the system that the building occupants have the most control over. Newer lighting systems give occupants choices of lighting levels by having multiple switches in each room or even sensors that will either turn off certain lights when adequate natural light is available or the room is empty. The lighting system in a school accounts for over half of the electrical use, so investing in new lighting technologies, installing sensors, and turning lights off when they're not needed can have a major impact on energy use.



Photo courtesy of CESA 10 staff

# School Habitat Cards

This page has four sets of *School Habitat Cards*. Make enough copies of this page so that each student has a set.

<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>
<b>C</b>	<b>C</b>	<b>C</b>	<b>C</b>
<b>W</b>	<b>W</b>	<b>W</b>	<b>W</b>
<b>Q</b>	<b>Q</b>	<b>Q</b>	<b>Q</b>
<b>L</b>	<b>L</b>	<b>L</b>	<b>L</b>
<b>R</b>	<b>R</b>	<b>R</b>	<b>R</b>
<b>V</b>	<b>V</b>	<b>V</b>	<b>V</b>
<b>P</b>	<b>P</b>	<b>P</b>	<b>P</b>

**Excerpt from**  
***Energy & Your School Activity Guide***  
at [keepprogram.org](http://keepprogram.org)

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The Wisconsin K-12 Energy Education Program is supported through funding from



Wisconsin K-12 Energy Education Program (KEEP)  
College of Natural Resources  
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