Technologies for Obtaining and Controlling Heat

Natural Sources of Thermal Energy

Biological Energy

Living organisms burn food (chemical energy) in their bodies to generate body heat (thermal energy). A composter is another source of thermal energy. Decomposers break down food and as these chemical changes occur, thermal energy is produced, which in turn helps speed up the process of decomposition. (*Environmental Impacts:* waste management)

Chemical Energy

Chemical Energy can be transformed into Thermal Energy when wood, or coal is burned. (*Environmental Impacts:* pollution caused by the burning of these fossil fuels)

Geothermal Energy

Volcanoes, hot springs and geysers are sources of geothermal energy - energy from the interior of the earth. The thermal energy from these events can produce hot water or steam, which can be then piped to a power plant at the surface. This can be used to run turbines which produce electrical energy. HRD (hot, dry rock) can be used as another technique to generate thermal energy. (Water is pumped into cracks in the earth's crust. It returns to the surface as steam, which can be used to generate electricity. (*Environmental Impacts:* more extensive use of this *clean and environmentally friendly technique*, could reduce the threat of oil spills, the pollution caused by burning fossil fuels and the wastes from mining fossil fuels.)

Wind Energy

Wind energy is the energy of moving air, and is a result of solar energy and convection. As the sun heats up the air, the warm air rises and cools off. The cooler air falls, creating the convection currents called thermals. These convection currents, on a global basis, form the Earth's wind systems. The windmill is a turbine (a wheel with fan blades), which is connected to a generator. When the windmill spins the generator produces electricity.
(*Environmental Impacts:* aesthetics)

Mechanical Forces

Mechanical forces that push or pull objects often release thermal energy, as do Frictional forces. (*Environmental Impacts:* mechanical breakdowns due to overheating)

Electrical Energy

Electricity is produced in many ways. Hydro-electric dams use the force of gravity which pulls the water over the dam to turn turbines, which are attached to generators, which produce the electrical energy from the mechanical energy of the generators. Electricity can also be produced at thermo-electric (fuel-burning) generating stations that burn fossil fuels.
(*Environmental Impacts:* wildlife in the area of the dam lose valuable habitat, plants may perish when the river which was blocked overflows its banks to create the reservoir for the dam, commercial enterprises may be adversely affected, pollution by the burning of fossil fuels, heated waste water can affect organisms in lakes where this waste water is dumped.)

Solar Energy (**A Solar Energy Information Resource**)

Solar energy is clean and is guaranteed not to run out. It is not available all the time (nighttime, less in winter/ than in summer).

There are two techniques that can help to overcome these issues.

- **Passive solar heating** - uses the materials in the structure to absorb, store and release the solar energy.
- **Active solar heating** - uses mechanical devices to collect and distribute the thermal energy.

Passive

Passive **solar heating** means that the system simply lets the radiant energy from the sun to come into the home and prevents heat from escaping. These principles are also used for **solar greenhouses**. The best spot for a greenhouse is on the south or southeast side of the house, in a sunny or partially shaded area. A southern exposure maximizes sunlight to the greenhouse during the winter when it is needed the most, and the home shelters it from the northern arctic blasts. A lean-to greenhouse model gets attached to the house, and may have a doorway from the greenhouse into the house and/or to the outside. A freestanding greenhouse model, which affords more growing room, may be attached to the house at one end, or situated entirely away from the house. Components to consider:

- **Style of building**
- window size
- orientation to the sun
- landscaping
- building materials

You will want your home to be **energy efficient**.
Solar Cooker Links (**Simple Design**)

Active

Heating buildings directly using **solar heating devices**, so that as much solar energy as possible is absorbed by the material (usually a "liquid'), which then distributes It throughout the home environment.

How it works.

Solar collectors can be:

- **flat** ... collecting the solar energy by using a liquid -usually water mixed with antifreeze (Because water is cheap and readily available and has a high specific heat capacity. However, it freezes when the temperature drops below 0, so antifreeze is added to overcome this shortfall) and then recycling it throughout the house (by convection - with the help of pumps - and by radiation)
- **curved** ... collecting the solar energy by reflecting it to a central point: Both are very expensive.

Solar technology involves all of the principles you have studied thus far - conduction, convection, radiation and heat capacity. There are many myths and Unknown facts about **Solar Energy Possibilities**. Several kinds very practical solar energy systems are in use today. The two most common are **passive solar heated homes** (or small buildings), and small stand-alone **photovoltaic** (solar electric) systems. These two applications of solar energy have proven themselves popular over a decade of use. They also illustrate the two basic methods of harnessing solar energy: solar thermal systems, and solar electric systems. The solar thermal systems convert the radiant energy of the sun into heat, and then use that heat energy as desired. The solar electric systems convert the radiant energy of the sun directly into electrical energy, which can then be used as most electrical energy is used today.

(*Environmental Impacts:* none)

Heating Systems Technologies

Technologies, like micro-sensors, have advanced the use of thermal energy in heating and cooking. The ones used for this purpose have:

- A sensor - a material which is affected by changes in some feature of the environment, such as temperature
- A signal - provides information about the temperature, such as an electric current
- A responder - which indicates the data with a pointer, light or other mechanism using the signal

Thermostats

Heating systems are controlled by thermostats. Thermostats are used to control the air temperature in indoor environments. They also are used to regulate temperatures in electrical devices, such as ovens or air conditioners. The switch in a thermostat is a **bimetallic strip**, made of two different metals joined (fused) together, often formed into a coil. When heat is applied to the end, one of the metals will expand faster than the other and the coil can operate a switch or valve just as the thermocouple does.

Thermocouple

Two wires of different metals are twisted together. When heat is applied to one end an electric current is produced. (the amount of current depends on the temperature and the type of wires) This current can turn on and off a switch or valve.

The Recording Thermometer

When a bimetallic coil strip is attached to a long arm lever, with a marker at the end and a drum that has graph paper, a recording thermometer can be made. This instrument works much the same as a seismograph.

The Infrared Thermogram

If an object is warmer than absolute zero it gives off infrared radiation (IR). The infrared radiation can be photographed with special films or detected by special sensors that display colored images. The brightness or color of the image indicates the temperature of the object.

Heating Systems

There are two types of heating systems:

- **Local heating systems** provide heat for only one room or a small portion of a building. Fireplaces, wood-burning stoves and space heaters are examples.
- **Central heating systems** provide heat from a single, central source, such as a furnace. Heat transfers throughout the building through pipes, ducts, vents and openings in different places. Two types of central-heating systems are **forced-air heating** and **hot-water heating**

Convection At Work

In each of the two systems described, convection is working to transfer the heat evenly throughout the building.

Keeping Cool

Thermal energy is needed to run refrigerators, freezers and air conditioners. The basic parts of a cooling system are: a storage tank, a compressor, a freezer unit, condenser coils, and a refrigerant. The refrigerant (liquid) in the cooling system evaporates at a very low temperature, which creates freezing temperatures inside the unit. A diagram of the unit is on p. 232.

Heat Loss and Insulation

One of the challenges for Albertans is to keep the temperature of their building comfortable. In winter this means keeping the cold air out and hold in as much of the warm air as possible. In summer the opposite is true.

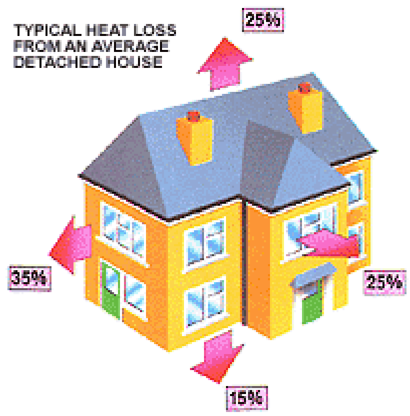
Insulation

Insulation is used to reduce heat loss and limit cold air from entering buildings. The building materials determine how effectively this is done. The thermal conductivity of a material reflects its ability to transfer heat by conduction. Materials with low thermal conductivity are useful – such as brick or stone. These are not always the most economical, so Styrofoam and fiberglass insulation is used in most buildings. Doors and windows are also very important when determining what materials will work most effectively.

Heat Loss

Infrared image of where heat is lost in a building

Typical Heat Loss In A House



Heat in a typical home is lost from the roof, doors, walls and the windows. This means that additional heat will be needed to replace the heat lost.

Research into improving the materials to prevent heat loss is ongoing. New windows, doors, siding, weather stripping, and insulation that are more efficient at reducing heat loss are constantly being developed. A system of rating these insulators has been developed to inform consumers how effective the material is. Every insulator is given an R-value. The higher the R-value, the most effective it is as an insulator. Different areas of the home have different recommended R-values, depending on how what materials are used and how much space is available for insulation.

Recommended R-values for homes:

- Attic = R-38 to R-44
- Sidewalls = R-11 to R-18
- Basement = R-10 to R-19
- Crawlspace = R-19