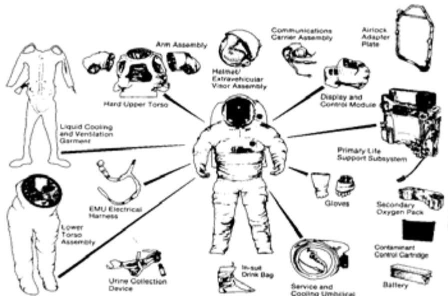
Survival in Space requires technologies that protect astronauts from the extreme thermal energy from the Sun. Their EMU (Extravehicular Mobility Unit) or space suit is such a technology.



Heat energy that we use to supply our basic needs is essential for our survival. An understanding of heat and the technologies that use heat will help us make sure that the energy available to us will sustain our planet now and in the future.

1.0 Human needs have led to technologies for obtaining and controlling heat.

1.1 History of Heat Technologies

Early Theories of Heat

Prior to 1600 - people thought that heat was a combination of fire and air.
1600 – Scientists decided that heat was an invisible fluid called *caloric*, because it seemed to flow from a hot object to a cold one. This was called the Caloric Theory.

Heat Is Energy

After further investigations and observations – Scientists decided that heat was not a substance, but a form of energy, that comes from the movement of tiny particles.

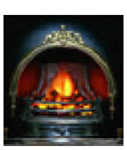
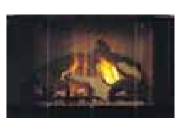
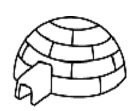
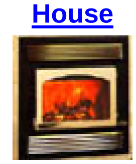
Humans Using Heat

As technology advances, so does our culture. New technologies create more demands for even better technology. The cold climate in Canada creates pressures on science and technology to meet the heating needs of Canadians. By understanding the concept of heat, we will better satisfy our needs to improve our cultural activities by adapting better to the climate.

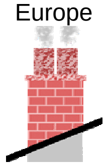
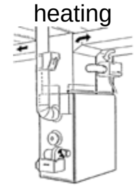
Heat and Human Needs

The importance of heat in Canada is linked to our basic **needs** of shelter, clothing, food, water, and physical activity. The human range of tolerance for temperature is between 0^oC and 45^oC. By improving our shelters, clothing and other basic needs, by making advancements in heat technologies, we can increase that range of tolerance to meet our **wants** as well.

Heat-Related Materials and Technologies

Open fires	**Pioneer stoves**	**Modern stoves**	**Wood-burning fireplaces**	**Sod House** Soddies	**Solar heating**	**Igloo**	**Modern building House**
							

Early Heating Technology Timeline

7000 B.C.	100 B.C.	A.D. 1200	1300's	1700's	Late 1700's	1800's	1906
Humans create fire	Romans develop central heating – heat travels from one source to different areas of a building	Chimneys first appear in Europe	Fireplaces with chimneys are built into the walls of buildings	Cast-iron stoves heat rooms evenly: heat does not escape up the chimney	Central heating reappears – using coal	Forced-air heating	Electric heaters
							

1.2. Heat Technologies in Everyday Life

In addition to being able to produce heat to meet human needs and wants. It is also important to be able to control that heat. As technologies develop to generate heat, ways to direct and manage that heat have also been created.

Personal and Societal choices

North Americans have a high standard of living, and as a result, take for granted the many tools and technologies that make their living easier, like the microwave oven. This is an example of a want that many people in North America consider to be a need.

Making Sustainable Choices

Both the personal and societal choices we make in using heat energy are important, because they affect our sustainability. We must use our heat energy resources wisely and be careful of the consequences to the environment when we use them. By looking for, and using, a wide variety of heat energy sources and developing technologies that will sustain this energy, we will be making ourselves a better future.

2.0 Heat affects matter in different ways

2.1 States of Matter and The Particle Model of Matter

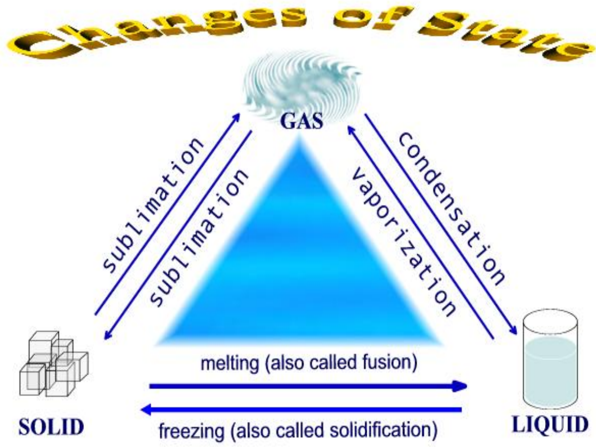
Matter is made up of tiny particles and exists in three states: solid, liquid and gas.
The Particle Model of Matter is a scientific description of the tiny particles that make up all things. The key elements in this model are:

- **All matter is made of tiny particles too small to be seen**
- **The particles are always moving**
- **The particles have spaces between them**
- **Adding heat to matter makes the particles move faster**

Changes of State: Water

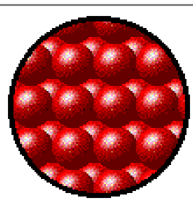
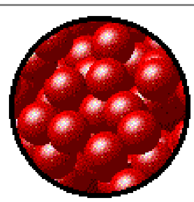
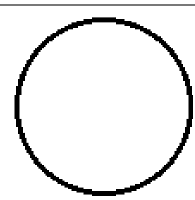
Substances such as water (or wax) can undergo observable changes through all three states of matter - solid liquid and gas.

- Ice is the **solid state** of water at $0^{o}C$
- The **melting point** of water is $0^{o}C$
- The **boiling point** of water is $100^{o}C$
- **Condensation** occurs when water changes from a gas to a liquid



Any pure substance can exist in all three states of matter.

Heat and the Particle Model

Solid	Liquid	Gas
		
Particles are closely packed together	Particles can slip past each other	Particles have lots of space between them

The Effect of Heat on Particles

When heat is added to a substance, the particles move faster. When heat is lost from a substance the particles move slower.

- The motion of the particles increases when the temperature increases.
- The motion of the particles decreases when the temperature decreases.
- Heat energy transfers from high temperature matter to low temperature matter. Heat can affect matter by causing it to change state.

How The Particle Model Explains Changes of State

During a phase change, the average energy of the particles remains the same, but, the particles are rearranging themselves.

Solid	• The particles are tightly packed together. • Solids have a fixed shape.
Heating a Solid	• Particles become less organized as their energy increases, so the substance changes from a solid to a liquid to a gas. • The space between the particles increases, so its volume increases.
Melting a Solid	• Particles move very quickly and attractions between the particles break down, so the solid melts into a liquid state.
Liquid	• In a liquid, the particles are moving very quickly. • The particles have more kinetic energy • Liquids take the shape of their containers
Heating a Liquid	• At the surface, some of the particles are able to escape into the air, while others do not have enough energy to escape and remain in the liquid. • As the liquid expands, its volume increases • As high energy particles escape, the average energy of the remaining particles is less and so the liquid cools. The cool liquid then cools the surface on which it is resting. This is called evaporative cooling. It is common and useful in many situations: Joggers cooling down as their sweaty clothes dry out; Water cools down a roof on hot summer day; A wet cloth is placed on your forehead when you have a fever.
Boiling a Liquid	• The attractions between the particles are very weak • More and more high energy particles escape, and the liquid changes into a gas
Gas	• Particles move very quickly with a lot of kinetic energy • Particles fill up the space of the container they are in. • Large spaces between the particles.
Gas to a Liquid to a Solid	• As the energy of the particles becomes less, the particles rearrange themselves more orderly, so a gas changes to a liquid and then to a solid, when even more energy is lost – the particles are slowing down.

The total energy of the particles changes - by increasing or decreasing, because the particles are not increasing or decreasing their speed, just their arrangement. The average energy doesn't change. The energy change is hidden from a thermometer and is called **'hidden hea**t' or **'latent heat'**.

2.2 Heat and Temperature

Temperature is a measure of how hot or cold matter is. Temperature indicates the average energy (speed) – kinetic energy - of the particles in motion in a substance.
The amount of temperature change, when thermal energy is added to the particles is another property that particles in different materials have. Different materials will increase or decrease their average energy depending on how much thermal energy is provided.

- Heat Capacity is the amount of thermal energy that warms or cools an object by 1^{o}C (it depends on the mass and the type of particle the object is made of).
- Specific Heat Capacity is the amount of thermal energy that warms or cools 1 gram, of a specific type of particle, by 1^{o}C.

Total Kinetic Energy

The thermal energy of a substance is the total kinetic energy of all the particles the substance contains. Energy is the measure of a substance's ability to do work - or cause changes.
There are two important elements that occur:

- **Changes happen when there is a difference of energy (every useful energy system has a high-energy source that powers the changes)**
- **Energy is always transferred in the same direction: from a high-energy source** (hot) to something of lower energy (cold).

Energy Transfers

Heat is the energy that transfers from one substance to another because of the difference in kinetic energy. The average energy of the particles - the **temperature** of the substance **-** is affected, by increasing or decreasing. The change in temperature depends on the number of particles affected.

The Difference Between Heat and Temperature

Energy is not a substance. It cannot be seen, weighed or take up space. Energy is a condition or quality that a substance has. Energy is a property or quality of an object or substance that gives it the ability to move, do work or cause change.

Understanding The Difference

Thermal Energy is the total kinetic energy of all the particles in a substance
Heat is the energy that transfers from a substance whose particles have a higher kinetic energy to a substance who particles have a lower kinetic energy.
Temperature is a measure of the average kinetic energy of the particles in a substance.

Measuring Temperature With Thermometers

A relative idea about temperature is that it tells you how hot or cold something is. This can be done by using our senses: **Touch** (sensitive nerve endings on your skin can detect changes in temperature); **Sight** (the color of the material giving off heat). Relative ways to determine the temperature are not always reliable or safe. Thermometers are more reliable devices that measure temperature. The Italian scientist Galileo invented the first air thermometer around 1600 and it has, and will continue to be, improved upon.

History Of Thermometers

200 B.C. The first thermometers were called thermoscopes

1590's Several inventors invented a version of the thermoscope at the same time, Italian inventor Santorio Santorio was the first inventor to put a numerical scale on the instrument. Galileo Galilei invented a rudimentary water thermometer in 1593 which, for the first time, allowed temperature variations to be measured.

1630's Early thermometers (like the one Galileo invented) did not have any scale (markings with numbers) to determine precise temperature.

1650's

1701 Ole Romer created one of the first practical thermometers, which used red wine as the temperature indicator. The temperature scale for his thermometer had 0 representing the temperature of a salt and ice mixture (at about 259 K), 7½ representing the freezing point of water (273.15 K), and 60 representing the boiling point of water (373.15 K).
Daniel Gabriel Fahrenheit (1686-1736) was the German physicist who invented the alcohol thermometer in 1709

1714 In 1714, Fahrenheit invented the first mercury thermometer, the modern thermometer. And in 1724, he introduced the temperature scale that bears his name - Fahrenheit Scale.

1742 The 1st precise scale was developed by Anders Celsius in 1742. He used 'degree' as the unit of temperature. Centigrade means "consisting of, or divided into, 100 degrees". All of his standards for comparison, to make his markings (on his scale), were based on the properties of water.
0^o was assigned the temperature at which ice melts at sea level
100^o was assigned the temperature at which liquid water boils at sea level
The region between (above and below, as well) these two extremes was separated into 100 equal units (degrees)
The two fixed temperatures that Celsius chose can be used to calibrate a thermometer. The Celsius temperature scale is also referred to as the "centigrade" scale.
The term "Celsius" was adopted in 1948 by an international conference on weights and measures

1852 Lord Kelvin invented the Kelvin Scale in 1848. The Kelvin Scale measures the ultimate extremes of hot and cold. Kelvin developed the idea of absolute temperature, what is called the "Second Law of Thermodynamics", and developed the dynamical theory of heat.
Absolute zero is the coldest possible temperature - 273^o and is used by scientists. The markings on the scale are not called degrees, but are simply called kelvins.
(0^o Celsius is equal to 273.15^o Kelvin)

1861 The electrical-resistance-thermometer was invented in Germany. It used an electrical current to measure temperature.
English physician, **Sir Thomas Allbutt** invented the first medical thermometer used for taking the temperature of a person in 1867.

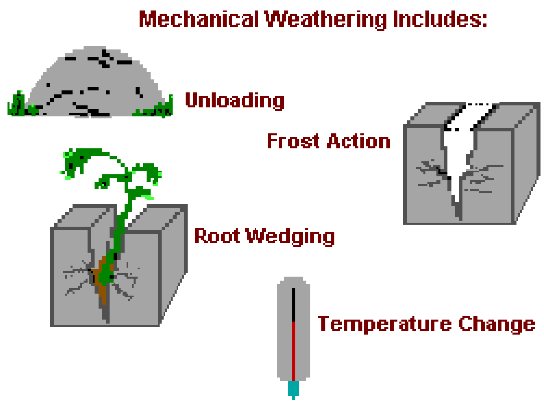
1970's Theodore Hannes Benzinger invented the ear thermometer.
David Phillips invented the infra-red ear thermometer in 1984.

1990's Dr. Jacob Fraden, invented the world's best-selling ear thermometer, the Thermoscan® Human Ear Thermometer.

2.3 Heat Affects the Volume of Solids, Liquids, and Gases

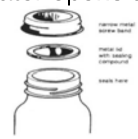
Observing The Effect of Heat

Cracks in rock, due to ice

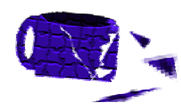


Fitting a nut to a bolt

Hot water opens a jar lid



Boiling water cracks the cold mug



Thermal expansion is the process of expansion of a substance caused by an increase in thermal energy.

Expansion and Contraction in Solids	Solids can become longer or shorter depending on the temperature (average energy of the particles).
Expansion and Contraction in Liquids	When the particles in a liquid are heated, their average energy increases and they need more room, so they **expand**. When the particles in a liquid are cooled, the volume decreases, or **contracts**, because the particles need less room. This is demonstrated by the liquid used in a thermometer. As the liquid expands and contracts, it moves up and down the inside tubing (the *bore*) of the thermometer.
Expansion and Contraction in Gases	When the particles in a gas are heated, their average energy increases and they need more room, so they **expand**. When the particles in a gas are cooled, the volume decreases, or **contracts**, because the particles need less room. Under extremely high temperature conditions (like the temperatures inside the Sun, particles can be split into what makes them up (electrons and ions). This creates a fourth state of matter called **plasma**.

Heat Affects the Volume of Solids, Liquids and Gases

As the average energy of particles increases, the space between the particles increases. They expand (increase their volume) as the temperature increases. As the average energy of particles decreases, the space between the particles decreases. They contract (decrease their volume) as the temperature decreases.

	Solids	**Liquids**	**Gases**
Shape and Size	**Keep their shape and size**	**Take the shape of the container**	**No definite shape or size**
Compressibility (volume)	**Cannot be compressed (fixed volume)**	**Almost incompressible (fixed volume)**	**Can be compressed (volume changes)**

2.4 Heat Transfers by Conduction

Conduction
In solids, where the particles are closely packed together, thermal energy can be transferred from one particle to another very easily. Thermal conduction is the process of transferring thermal energy by the direct collisions of the particles. The space between the particles, in different solids, determines how quickly these collisions can take place. Good conducting materials are those materials where there is little space between the particles - like most metals. Poor conductors, like glass and wood are called heat insulators. These insulators when wrapped around an object slow down the rate of thermal conduction.

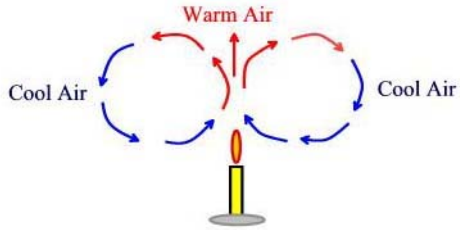
Conductors
Metals are good conductors of heat, so they are used extensively in cooking, because they transfer heat efficiently from the stove top or oven to the food. Hot and cold packs are used to treat muscle injuries. The Radiator of a car transfers heat away from the engine, so that the gasoline being used will not ignite. (Antifreeze is used to achieve this).
Applications

Insulators
Insulators are materials that do not easily allow heat transfer

2.5 Heat Transfers by Convection and Radiation

Understanding Convection

Thermal energy can be transferred in fluids, by the circular motion of the particles, called convection.



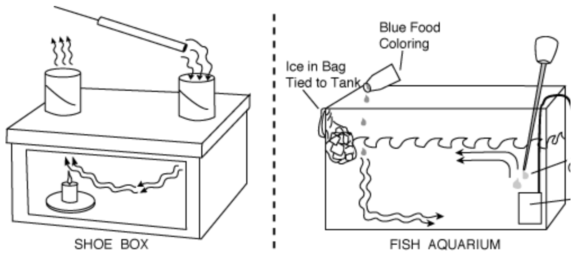
In convection, the warmer particles transfer their energy to the cooler particles as they move in a circular pattern, called, a 'convection current'. A simple experiment

The **convection oven** is one of the many practical applications of convection.
The heat inside the oven helps to provide uniform beating as the convection current transfers the heat evenly inside.

Convection Currents in Air
Birds and para-gliders make use of '**thermals**' to help them soar and glide - helping them to conserve energy when they migrate.
Heating occurs through convection currents in a fluid, such as radiator water heating - flowing from the basement to heat a radiator on a floor above.

Convection currents are also involved in creating the force of magnetism that surrounds the earth.

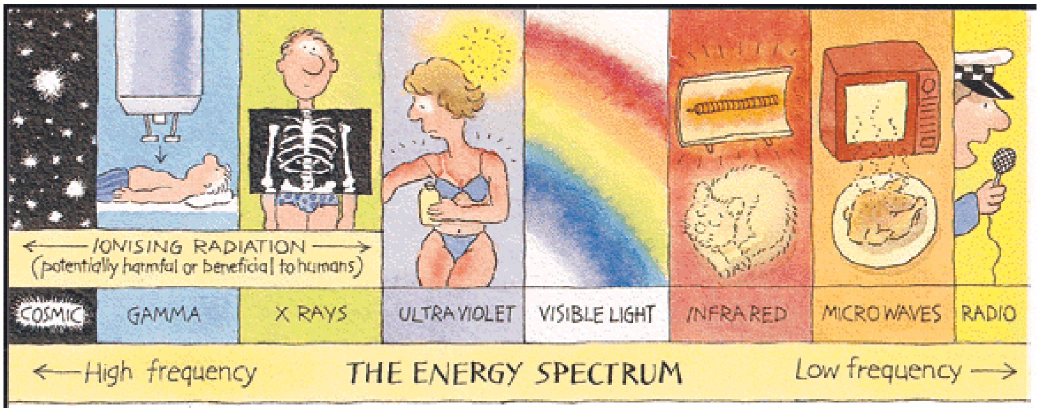

Lava lamps are good examples to convection currents in action.



As are the **convection box** and aquarium

Heat Transfers By Radiation

Energy can be transferred even though there are no particles to transfer the energy. This type of energy transfer is called **radiation**. Radiation is the transfer of energy without any movement of matter. Energy that is transferred in this way is called radiant energy or **electromagnetic radiation** (**EMR** for short). Radiant energy travels in waves. These waves can travel through space, air, glass and many other materials. There are different forms of EMR, including radio waves, microwaves, visible light and X-rays.



If the energy source is a warm object, like the sun, some of the thermal energy is transferred as a type of EMR called **infrared radiation** (IR) or '**heat radiation**'.

Waves of radiant energy can travel in a vacuum. All waves travel, across empty space, at an extremely high speed (300 Million m/s). Radiant energy travels in a straight line.
All kinds of radiant energy interact with matter:

Radiant Energy waves can be absorbed and reflected by objects.

- Absorption occurs if the energy penetrates part way into the object. Dull dark objects absorb radiant energy when they are cool, and emit radiant energy when they are hot. (eg. asphalt sidewalk)

- Reflection occurs if the energy cannot penetrate the surface of the material it comes into contact with. Light, shiny objects or surfaces do not absorb radiant energy readily and do not emit radiant energy readily. (eq. ice surface)

- Transmission occurs if the energy penetrates completely, passing through the object with no absorption of energy.

Radiation is a natural part of our environment and it can be detected, measured and controlled.
The measurement of radiation is by the amount of radioactivity present, or the amount of radiant energy given off. Natural radiation reaches earth from outer space and continuously radiates from the rocks, soil, and water on the earth. Background radiation is that which is naturally and inevitably present in our environment. Levels of this can vary greatly.

3.0 Human Needs have led to technologies for obtaining and controlling heat

3.1 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:*

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. (See Figure 3.32, page 243)

- **Passive solar heating** - uses the materials in the structure to absorb, store and release the solar energy.

Passive Solar Heating

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 solar heating** - uses mechanical devices to collect and distribute the thermal energy.

Active Solar Heating
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 recirculating 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)

3.2 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.

3.3 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.

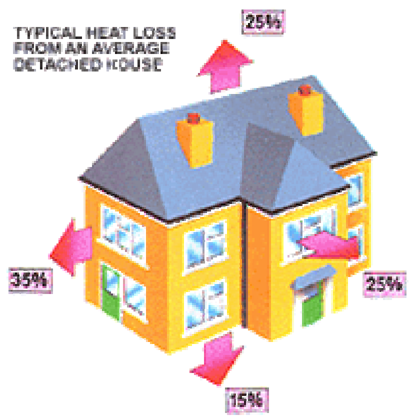
Insulation

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.

The 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

4.0 Human Needs have led to technologies for obtaining and controlling heat

4.1 Looking At Different Sources of Heat

There are two types of natural resources in the environment: **renewab**le and **non-renewable**. Renewable energy sources are those that can be replaced, while non-renewable energy sources are those that cannot be replaced – once they are used up, they are gone.

Focus On Fossil Fuels

An energy resource is anything that can provide energy in a useful form. Most energy supplies come from fossil fuels (in Alberta and throughout the world). Fossil Fuels are chemicals from plants and other organisms that died and decomposed millions of years ago and have been preserved underground. The widespread use of fossil fuels has created many problems. More than 60% of the world's energy needs were met by burning oil and natural gas, while another 30% was provided by coal. Despite the many disadvantages of using fossil fuels, we continue to use them. Coal is burned to generate electricity. Oil and natural gas are abundant in Alberta and we use it, maybe more than we should. Alternatives to using these non-renewable resources need to be utilized, so that future generations of Albertans can continue to thrive in our beautiful province.

Economic Impacts	***Environmental Impacts***	***Societal Costs***
price of gasoline, drilling, processing, transporting, exploration, anti-pollution technology,	global warming, changing climate zones around the world, plant growth, depleted water resources thermal pollution	pollution causes health problems, rising health care costs, treating polluted lakes,

Alternatives For Thermal Energy

Wind Energy Wind energy is the energy of moving air. 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.

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.

Nuclear Energy **Nuclear fission** is a process that uses small amounts of radioactive uranium to produce vast amounts of heat. The Canadian developed CANDU reator provides nuclear energy in many parts of Canada and also sells this energy to other countries. A major problem is long-term storage of radioactive wastes.

Hydro-Electric Power Hydro-electric dams use the force of gravity which directs the water from the **reservoir**, through gates in the dam to turn **turbines**, which are attached to **generators**, which produce the electrical energy from the mechanical energy of the generators. This is very clean, renewable energy.

Comparing The Options

Each energy source has its advantages and disadvantages. When making choices about which type of system to utilize, take into account where, when and how the energy will be used.

4.2 Energy Consumption

Energy Consumption- Reduce Energy Waste

Home Energy efficient products to upgrade energy wasting products. There are many things we can do at home to stop wasting energy. Examples:

- turning off lights before leaving a room
- install low-flow shower heads to conserve water resources
- Recycling is another way to save energy.
- Stop your taps from dripping
- Save water and install more efficient taps and flush systems
- Insulate your roof and retrofit window to be double glazed
- Don't open doors and windows to cool down a room. Turn down your heat instead.
- Did you know that by turning down the thermostat by 1^{o}C you can reduce your heating costs by up to 10% and helping the environment at the same time
- Get your heating system serviced regularly.
- Don't forget to turn off your computer and TV properly when not in use.
- Always check that lights and fittings are clean. Dirty lights can reduce lighting output by 20%. By cleaning regularly you can maintain lighting efficiency.
- Replace ordinary light bulbs with energy saving bulbs.
- Reduce, re-use and recycle your waste
- Try to make sure you separate your waste for recycling into: paper, glass, aluminum cans, and food waste for composting.

Transportation Cars and Trucks are big energy wasters and contribute greatly to the problems we have in the environment, including nitrogen oxides which cause breathing problems and contribute to smog. Take action to reduce use of cars – ride a bike, take public transit, use hybrid, or fuel cell vehicles, car pool, reduce speed to conserve on fuel consumption.

Industry Industry is the biggest energy user. Sometime, industry's use of energy can harm the environment, but it is also responsible to find ways to reduce the negative impacts and find better ways to utilize the available energy and find better – more efficient – alternative sources of energy. An **energy audit** is utilized to determine ways to reduce energy usage One of the products (**carbon dioxide**) that is released from the burning of fossil fuels is a greenhouse gas, which traps heat energy in our atmosphere and leads to global warming.

Sulfur-dioxide is released when coal and natural gas are burned. This gas is an irritant to the eyes, nose and throat.

Carbon monoxide is produced when a fire burns without enough oxygen. It is clear, odourless and very lethal. It hinders the brain's reasoning ability and can kill you.

Co-generation This alternative uses some of the two-thirds of the energy released by the burning of fossil fuels as thermal energy, to heat a building, or a fuel, to generate electrical energy.

Being A Responsible Citizen

Making responsible decisions means purchasing products and services that will have little negative impact on the environment and will promote a clean environment. Making your voice heard, by supporting government that conducts research into helping environmentally friendly technologies develop and advance our knowledge about energy consumption.

101 Ways To Reduce Your Waste

http://www.wealden.gov.uk/Environment_and_Transport/Recycling/Ways_to_Reduce_Waste/index.aspx