Preview of Period 18: Uses of Solar Energy

18.1 Energy Sources

What are the advantages and disadvantages of the various sources of energy?

Which energy sources are ultimately derived from solar energy?

18.2 Solar Insolation

What determines the amount of solar insolation striking a region of the Earth?

How is solar energy used?

18.3 Energy Efficient and Passive Solar Homes

What are some features of a passive solar home?

Biomass

- Biomass is plant material or animal waste used as a fuel.
- Examples: wood, alcohol, dried animal waste.
- Biomass fuel is renewable.
- Plants absorb carbon dioxide as part of photosynthesis. The complete combustion of biomass returns carbon dioxide to the atmosphere.
- Overall, there is no net change in the amount of carbon dioxide in the atmosphere due to the use of biomass.

Fossil Fuels

- Fossil fuels include oil, coal and natural gas
- Fossil fuels are formed when organic matter is subjected to heat and pressure for millions of years.
- Fossil fuels are not renewable on a useful time scale
- Burning fossil fuels releases carbon dioxide into the atmosphere.

Tidal energy

- **Energy source: gravitational attraction between the Moon and the Earth.**
- **The gravitational attraction of the Moon causes the oceans to form two bulges, one on either side of the Earth.**
- **As the Earth spins on its axis, land bordering the oceans passes through both bulges, causing two high tides and two low tides each day.**
- **Tidal water flowing into or out of a harbor can be used to turn turbines and generate electricity.**

Non-Solar Energy Sources

Tidal energy

- Two high tides per day can be used to generate electricity
- Energy source: gravitational attraction between the moon and the Earth

Nuclear Energy

- Fission of uranium-235 releases thermal energy.
- This thermal energy can be used heat water into steam, which turns turbines in an electric generating plant.
- Energy source: uranium ore

Geothermal Energy

- The interior of the Earth (molten rock) contains thermal energy. Some of this energy is released by volcanoes, geysers, and hot springs.
- Geothermal energy can be tapped to generate electricity and heat buildings.

Comparison of Energy Sources

Energy	Advantages	Disadvantages
Fossil		
Biomass		
Wind		
Tidal		
Hydro-electric		
Nuclear		
Geothermal		
Solar		

Comparison of Energy Sources

Energy	Advantages	Disadvantages
Fossil	Plentiful (at least for now) and inexpensive	greenhouse gases, acid rain, soot. Non-renewable
Biomass	plentiful, inexpensive, renewable	Soot. (No net carbon dioxide is released.)
Wind	Inexpensive to operate, renewable	Expensive to install, noisy, affects scenic vistas, can harm birds
Tidal	Renewable. No atmospheric pollution	Limited locations. Can change aquatic ecosystem
Hydro-electric	Renewable. No atmospheric pollution	Dams can change the aquatic ecosystem
Nuclear	No atmospheric pollution	Thermal pollution. Nuclear accidents. Storage of radioactive waste.
Geothermal	Limited atmospheric pollution.	Large quantities available only in areas with hot rock close to the surface.
Solar	No atmospheric pollution. Renewable	Low efficiency, expensive, not always available.

Solar Insolation

Solar insolation is the amount of solar power received by a given area of the Earth.

The amount of solar insolation on a region of the Earth depends on

- the **season** of the year. Due to the tilt of the Earth's axis, the northern hemisphere receives more insolation during the summer.
- the **latitude**. Higher latitudes near the poles receive less insolation and the equator receives more.
- the **alititude** above sea level. Higher elevations receive more.
- the amount of **cloud cover and pollution** in the atmosphere that reflect and absorb radiation from the Sun.

The Solar Power from a Solar Cell

The power from a solar cell depends on

- **the amount of solar insolation striking the cell**
- **the size (area) of the cell**
- **the efficiency of the solar cell**

$$P = I \times A \times Eff$$

where

P **= power (in watts)**

I **= solar insolation striking the Earth (in watts/meter^2)**

A **= area of collector (in meters^2)**

Eff **= the efficiency of the solar cell**

Features of a Passive Solar House

- **Deciduous trees or a roof** overhang on the south side of a house to shade windows from the direct sun in the summer (when the sun is higher above the horizon), but allow the sun to shine in through windows in the winter (when the sun is lower).
- **Embankments and non-deciduous trees** on the north side of the house to block winter winds.
- A **thermal mass** may be used to store solar energy gathered during the day for use at night when the temperature drops.
- Rooftop **solar collectors** to supplement the heating system and to generate electricity.
- **Fiber optic light pipes** to bring outside light into the interior of the house.
- **Insulation** of walls and attic to reduce heat transfer.
- **Vents** to exhaust hot air from the house.

Period 18 Summary

18.1: Energy from water power, wind power and biomass are derived from solar energy.

Water power can generate electricity by using the gravitational potential energy of the water to turn a turbine.

Wind power can generate electricity when windmill blades turn turbines.

Biomass is plant material or animal waste used as fuel (wood, alcohol, or animal dung).

Fossil fuels (coal, gas, oil) formed from plant materials subjected to high temperatures and pressures for long periods of time.

Nuclear energy is released during fission when atomic nuclei break apart. This thermal energy is used to produce steam that turns generator turbines.

Tidal energy comes from the gravitational interactions between the Earth and the Moon. Gravity causes the oceans to form two bulges. As the Earth spins, land bordering the oceans passes through the bulges, causing tides. Tidal water flowing into or out of a harbor can turn electric generator turbines.

Geothermal energy taps thermal energy from the hot interior of the Earth.

Period 18 Summary, Continued

18.2: The amount of solar insolation striking the Earth depends on

- **the season of the year.**
- **the time of day.**
- **the latitude. Higher latitudes near the poles receive less insolation, the equator receives more.**
- **the amount of cloud cover and pollution.**

Solar energy can be used to heat water or to generate electricity

The average power of a solar cell is found from $P = eff \times I \times A$

18.3: Features of a passive solar home include

embankments and trees to protect the home from weather,

overhangs to reduce solar heating in the summer, and south-facing windows to maximize solar heating and light in the winter,

insulation to prevent the flow of thermal energy into and out of the house,

vents to exhaust hot air from the house in the summer,

thermal masses that absorb heat during the day and release the heat at night,

rooftop solar collectors to heat water.

Period 18 Review Questions

R.1 **Explain how water power, wind power, and biomass are derived from solar energy.**

R.2 **Why aren't solar cells used to generate electricity on a large scale?**

R.3 **On sunny days, the best orientation of a solar collector is at and angle to the ground that is equal to the angle of the latitude at which the collector is located. Why is this?**

R.4 **On cloudy days, the best orientation of a solar collector is flat on the ground. Why is this?**

R.5 **What are features of a passive solar home?**