Chapter 8 – Renewable Energy Resources

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<th>Activity</th>
<th>Homework</th>
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<td>1</td>
<td>Notes (I, II)</td>
<td>Energy Audit</td>
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<td></td>
<td>Are People the Problem?*</td>
<td>(due in 1 week)</td>
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<td>2</td>
<td>Notes (III, IV, V)</td>
<td>Solar Cooker* or ExploreMore WebQuest*</td>
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<td>3</td>
<td>Notes (VI, VII, VIII)</td>
<td>As Earth Warms Article/Questions*</td>
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<td>4</td>
<td>Graphing Energy Activity</td>
<td>Assessment</td>
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* found in "Supplemental Activities"

Alternate Activities

1. Assign “Graphing Energy” as homework on Night 3 and use the “Great Energy Debate”* as an alternate assessment on Day 4.

2. Create a newsletter about alternative energy as an alternate assessment.
   Each group should make a newsletter with an editorial, feature articles, a cartoon, and creative advertisements.

3. Have each group prepare a “virtual field trip” using power point. Each group will focus on a different energy source and present the field trip on Day 4 to the class.

SCOS Goals

2.06 - Investigate and analyze the importance and impact of the economic development of earth’s finite fossil fuel resources to society and our daily lives.

2.07 - Analyze the sources and impacts of society’s use of energy
   - Renewable Sources
   - The impact of human choices on Earth and its systems
Chapter 8 – Renewable Energy Resources

What will we do when we run out of oil?

I. Importance of improving energy efficiency
   A. We are not using our energy resources carefully.
      1. 84% of all commercial energy used in the U.S. is wasted.
      2. People in the US unnecessarily waste as much energy as two-thirds of the world's population consumes (about 300 billion dollars worth per year).
   B. General solutions
      1. Individuals can reduce energy consumption
         a. Ex. Using mass transit
         b. Turning off unneeded lights
      2. Increase energy efficiency (the percentage of total energy input that does useful work)
         a. Buy energy-efficient models of machines (water heaters, fuel-efficient cars, etc.)
         b. Use alternate sources of energy that do not produce as much waste (such as solar heating)
   C. Benefits of reducing energy waste
      1. Makes non-renewable fossil fuels last longer
      2. Gives us more time to phase in renewable energy resources
      3. Decreases dependence on oil imports
      4. Reduces local and global environmental damage
5. It is the cheapest and quickest way to slow projected global warming.

6. Saves more money, provides more jobs, improves productivity, and promotes more economic growth per unit of energy than other alternatives.

Review Questions

1. What is energy efficiency?

2. What are some ways we can improve energy efficiency?

3. What benefit was most convincing to you? Why?

II. A Need for Alternative Energy Sources

A. 90% of our energy comes from fossil fuels; the remaining 10% comes from other energy sources – nuclear, solar, wind, and hyrdroelectric.

B. Many energy sources, and especially fossil fuels and nuclear fission, produce a lot of pollution – which damages our ecosystems.

C. The present energy resources will not be enough to provide for continued use and a growing human population.

D. Renewable resources regenerate quickly (such as animals, energy from the sun or wind) unlike the non-renewable resources on which we currently depend.
III. Solar Energy - energy provided by the sun

A. When light energy from the sun strikes objects, the energy is changed to heat (thermal energy). Solar energy can be harnessed and used to generate heat and electricity.

1. **Passive Solar Energy** - the sun's energy is collected, stored, and distributed naturally in an enclosed dwelling. Passive solar energy is not used to produce electricity but can reduce the need for electricity or fuels by providing an alternate source of heat. (Ex. building your house with many windows facing south provides heat)

2. **Active Solar Energy** - devices (tubes, tanks, pumps, fans) are used to collect, store, and circulate heat produced from solar energy. Buildings use solar collectors in active solar energy.

3. **Photovoltaic Cells** - a solar cell uses thin wafers of semiconductor material to produce electricity directly from solar energy. (Ex. solar-powered calculators).

B. **Pros:**

1. The source of solar energy (the sun) is free.
2. Solar energy is clean and nonpolluting.
3. The cost of equipment for capturing and storing solar energy may be recovered by the savings in fuel bills over many years.

C. **Cons:**

1. The energy source is not constant (limited sunlight on rainy days, no sunlight during the night). However, solar energy collected during the day can be stored.
2. The devices for harnessing and storing solar energy are not very efficient, and the size and cost of the equipment are not convenient.
IV. Hydroelectric Energy - electricity that is produced from the energy of moving water

A. People have made use of hydroelectric energy for centuries (ex. through waterwheels). Today, dams are built across waterways to generate electricity. The power of tides is being used in limited ways to power turbines, as well.

1. Water behind a dam is directed at the blades of huge turbines.
2. When water pushes against the turbine blades, the energy in the moving water is transferred to the turbine causing it to turn.
3. The motion of the spinning turbine is transferred to coils of wire located within generators. The coils spin through a magnetic field, producing electricity.

B. Pros:

1. Dams are helpful for flood control, and lakes created by dams serve as recreation areas for fishing, boating, and swimming. Dams also create reservoirs that store water for irrigation and home use.
2. Hydropower generation plants emit very little air pollution.

C. Cons:

1. Dams can harm the environment.
   a. By altering water depth and flow, they can alter the natural plant life of streams, which affects the entire ecosystem.
   b. There may be flooding of the land behind the dam and erosion.
   c. Fish can get caught in the blades of the turbines, and the dam is a barrier to fish who must return upstream to spawn (ex. salmon)
2. Tidal generators can damage wetlands and disrupt the ecosystem; there are few suitable sites, and construction costs are high
Review Questions

1. What are some of the positives of solar energy? Hydroelectric energy?

2. What are some of the drawbacks specific to hydroelectric energy?

V. Wind Energy - most commonly this means using wind turbine generators (called aerogenerators) to generate electricity using vanes (blades)

A. Today's windmills are constructed of strong, lightweight materials.

Vanes of aerogenerators are connected to coils of wire. Wind blowing against the vanes cause them to spin. As the vanes are turned, electricity is produced by a generator similar to one for hydroelectrics. Wind farms (sites of many aerogenerators) use one of two models, and are located in open areas where wind conditions are favorable.

1. Traditional aerogenerators - vanes turn on horizontal axis (like the propellers of an airplane). This shape allows great speeds and tremendous amounts of electricity.

2. Darrieus rotor - turns on a vertical axis and is shaped like an upside-down eggbeater. The rotor can produce electricity at a lower wind speed.

B. Pros:

1. Wind power is free and unlimited.

2. Wind power is nonpolluting.

3. The land under wind turbines can be used for grazing cattle and farming.
4. The current cost of constructing towers and generators is high, but new technology and mass production should make wind power one of the world’s cheapest ways to produce electricity.

C. Cons:
   1. Wind power is not constant, and elaborate storage devices are needed to make wind power available when there is no wind.
   2. Wind farms take up a lot of land and may interfere with radio and television reception.
   3. Birds may be severely injured when they fly into the spinning vanes.

Review Questions
1. What are the two types of windmills?

2. How does the wind produce electricity?

VI. Biomass Fuels – fuel formed from the products of plant material
   A. Wood – potentially renewable resource if harvesting is controlled
      1. Pro – No net increase in atmospheric levels of heat-trapping carbon dioxide as long as the rate of removal and burning does not exceed the rate of replenishment.
      2. Con – Burning wood releases pollutants known to harm humans. Also, without effective land-use control, widespread removal of trees can deplete soil nutrients and cause erosion, water pollution, flooding, and a loss of wildlife habitat. Finally, wood is expensive.
   B. Garbage – much of the garbage produces in homes is largely composed of organic materials, such as paper and food scraps. About two-thirds of
the material in garbage can be burned. However, many are concerned about emissions of toxic gases and disposal of toxic ash.

C. Methane - as organic materials decay, methane gas is produced. This can be used in the same way as natural gas. Simple and cheap devices can be built that use anaerobic bacteria to convert waste into methane fuel. However, they are slow and unpredictable.

D. Alcohol - plants such as sugarcane and corn can produce alcohol through bioconversion. The alcohol called ethanol is made by yeast during fermentation. Ethanol burns cleanly and is a renewable resource. Gasoline mixed with ethanol makes gasohol, which can be burned in conventional gasoline engines.

Review Questions
1. What are the four basic types of biofuels?

2. What are the potential drawbacks to burning garbage? The potential benefits?

VII. Geothermal Energy - heat energy generated within the Earth by the decay of radioactive elements.

A. Over millions of years, the geothermal energy from earth's mantle has been transferred to underground concentrations of dry steam (steam with no water droplets), wet steam, and hot water. If these geothermal sites are close to the surface, wells can be drilled to extract the steam or water. This thermal energy can be used for space heating and to produce electricity or high-temperature heat for industry.
B. Pros:
   1. Vast, reliable, and sometimes renewable supply of energy
   2. About 96% fewer CO$_2$ emissions than fossil fuels
   3. Competitive cost of producing electricity

C. Cons:
   1. Scarcity of easily accessible reservoir sites
   2. Must be carefully managed, or the resources will be depleted
      (although the potential supply is so vast it is considered renewable)
   3. Geothermal development can destroy ecosystems or cause land sink
   4. Noise, odor, and local climate changes can be problems

VIII. Possible Future Alternate Energy Sources

A. Hydrogen Gas – water can be split by electricity into gaseous hydrogen and oxygen. Hydrogen contains no carbon, thus when burned does not produce carbon-dioxide or other air pollutants. Current technology prohibits using hydrogen gas a fuel because it takes too much energy.

B. Nuclear Fusion – When two atomic nuclei fuse to become one larger nucleus, this is called fusion. The fuel for nuclear fusion is usually deuterium, which is common in seawater. Much less radioactive waste is produced than by nuclear fission, and the fuel is easily obtained. However, scientists have not yet learned to control and harness this energy and use it efficiently.

Review Questions

1. Why is geothermal energy not readily available in all parts of the world?

2. Which future source of energy do you think sounds most promising? Why?
### Renewable vs. Non-Renewable Energy Resources

<table>
<thead>
<tr>
<th>Renewable Energy Resources</th>
<th>Non-renewable Energy Resources</th>
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<tbody>
<tr>
<td>● Can be replaced by nature on a human time-scale</td>
<td>● Don’t regenerate quickly and can be depleted on a human time-scale</td>
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<tr>
<td>● Benefits include less pollution, constant reservoirs of energy, and more energy efficiency</td>
<td>● Benefits include current low costs, ease of use, and high energy yields</td>
</tr>
<tr>
<td>● Drawbacks include lack of current development and use, less reliable output, and potential environmental damage from devices</td>
<td>● Drawbacks include a decreasing supply that will not be replaced, air/water/ground pollution, safety concerns, ecosystem destruction from acquisition and processing</td>
</tr>
<tr>
<td>● Examples: Solar Energy, Hydroelectric Energy, Wind Energy, Geothermal Energy, Biomass Fuels</td>
<td>● Examples: Nuclear Fission, Fossil Fuels such as: Coal, Natural Gas, Oil/Petroleum</td>
</tr>
</tbody>
</table>

#### Word Bank
- Don’t regenerate, pollution
- Decreasing supply, Fusion
- Fossil Fuels, replaced
- Biomass Fuels, less pollution
- less reliable output, reservoirs
- high energy yields, Fission
Part 1: Graphing Energy Facts

<table>
<thead>
<tr>
<th>Primary Energy Consumption (percent)</th>
<th>1973</th>
<th>1991</th>
</tr>
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<tbody>
<tr>
<td>Petroleum</td>
<td>46.9</td>
<td>40.4</td>
</tr>
<tr>
<td>Nuclear Power</td>
<td>1.2</td>
<td>8.0</td>
</tr>
<tr>
<td>Hydropower/Other Renewable</td>
<td>4.1</td>
<td>4.0</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>30.3</td>
<td>24.4</td>
</tr>
<tr>
<td>Coal</td>
<td>17.5</td>
<td>23.2</td>
</tr>
</tbody>
</table>

1. Draw two pie graphs showing this data. Use different colors to identify each energy source and neatly label your graphs. Then answer the questions that follow.

2. What is a primary energy source? Explain how it differs from a secondary source.

________________________________________________________________________________________

3. Which source decreased the most from 1973 to 1991? ________________

   Why do you think this happened?
4. Which source increased the most from 1973 to 1991? _________________
   Why do you think this happened?

5. Sunlight, wind, and running water are essentially “free”. Yet renewable energy sources are a very small part of our energy consumption. Why is this? Explain: ______________________________________________

Part 2: Electricity

Complete the following table:

1990 United States Renewable Electric Generating Capacity (Gigawatts)

<table>
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<tr>
<th>Energy Source</th>
<th>Gigawatts</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydropower</td>
<td>75.1</td>
<td></td>
</tr>
<tr>
<td>Geothermal</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>Biomass- Municipal Waste to Energy</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Biomass (other)</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>Solar Thermal</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>Wind</td>
<td>1.4</td>
<td></td>
</tr>
<tr>
<td><strong>Total Renewable</strong></td>
<td><strong>87.4</strong></td>
<td></td>
</tr>
</tbody>
</table>

1. Draw a bar graph below showing the generating capacity. On the vertical axis, put Electrical Generating Capacity/Gigawatts. On the horizontal axis, put the energy sources. Use different colors and neatly label your graph.
2. Make a pie graph of the percent data. Use different colors and neatly label the graph.

3. Which renewable resource is used the most for producing electricity?
   ____________________
   Why?

4. Which renewable energy resource above is used the least? ____________

5. Which renewable source do you think should be used the most? Why?