Chapter 7 – Non-Renewable Energy Resources

Day	Activity	Homework
1	Notes (I, II, III)	
	Nuclear Reactor Demonstration*	
	Path of Pollution*	
2	Notes (IV)	
	Activity: Supply and Demand of Crude Oil*	
3	Assessment: Energy Mini-Contract (with Supporting Documents*)	

*found in "Supplemental Activities"

Alternate Activities

1. A field trip to EnergyExplorium (1-800-777-0003)
2. Group research activity – http://webwatchers.nsta.org/guides/lesson_plan_detail.asp?lesson_plan_ID=97&grade_band=3
3. Use "At A Glance" Report (found in supplemental activities) to make a public service announcement. Each group can use a different angle.

SCOS Goals

2.06 – Investigate and analyze the importance and impact of the economic development of earth's finite fossil fuel and other natural resources to society and our daily lives

2.07 – Analyze the sources and impacts of society's use of energy

- Non-renewable sources
- The impact of human choices on Earth and its systems

Chapter 7 – Non-Renewable Energy Resources

How do dead things power our lives?

I. The Need for Energy

A. The storage, transfer, and conversion of energy are the driving forces behind all life on Earth.

1. The ultimate source of energy for life is the Sun.
2. Food is a form of fuel your body uses for energy.

B. A fuel is any substance from which energy can be obtained.

1. Fuel does not convert to energy with 100% efficiency.
2. During conversion, some energy is lost because it is converted to heat, light, or sound.

C. Changing Energy Needs

1. Hunter-gatherer societies had very limited energy requirements. These were met using wood (a renewable resource).
2. The Industrial Revolution changed society's energy needs.
   a. A dependence on machines requires a lot of energy to manufacture, operate, distribute, and market the machinery and products.
   b. A growing population, supported by the Industrial Revolution, requires even more energy as each individual increases the consumption of fuel.

II. Evaluating Energy Resources

A. The types of energy we use and how we use them are major factors in determining our quality of life and harmful environmental effects.

B. Questions to help evaluate energy resources:
    1. How much of the energy source will be available in future?
    2. What is this source's net energy yield?
    3. How much will it cost to develop, phase in, and use this resource?
    4. How much will extracting, transporting, and using the energy resource affect the environment?
    5. What will using this energy source do to help sustain the earth?

C. Net Energy
    1. The total useful energy available from the resource over its lifetime minus the amount of energy used, lost, and wasted in finding, processing, concentrating, and transporting it to users.
    2. As certain fuels become harder to find or access, the net energy for these fuels will drop (because we will have to use more energy to acquire the fuel source).

D. Non-renewable vs. Renewable
    1. Non-renewable means resources that cannot regenerate quickly
    2. Renewable resources regenerate quickly

Review Questions

1. Why do we need to use energy?

2. How will the increasing industrialization of developing countries affect the availability of energy world-wide?

3. Why is the net energy of passive solar energy higher than the net energy of oil?

III. Nuclear Energy – nuclear fission releases energy which is used to heat water, which produces steam which drives turbines to produce electricity. Uranium is a non-renewable resource.

A. Unstable atoms (like U-235) decay, emitting particles and energy from their nuclei – this is called radioactivity. One way to release the energy holding the protons and neutrons in an atom's nucleus together is nuclear fission (splitting the nucleus of a large atom into smaller nuclei).

1. To begin, a neutron is fired into the nucleus of the atom.
2. The neutron strikes the nucleus, which splits, forming two nuclei.
3. The reaction releases energy and several more neutrons.
4. These neutrons strike other U-235 nuclei, causing those to split and continue the process – this is called a chain reaction.

B. Pros:

1. Nuclear plants don't emit air pollutants, as long as they operate properly.
2. Water pollution and disruption of land are low to moderate if the entire nuclear fuel cycle operates normally.
3. Safety measures (such as thick steel walls) greatly decrease the likelihood of a catastrophic accident releasing deadly radioactive material into the environment.

C. Cons:

1. Possibility of harmful radiation leaking into the environment
   a. Chernobyl (April 26, 1986) – a series of explosions in one of the reactors in a nuclear power plant in Ukraine blew the roof off the reactor building and flung radioactive debris high into the atmosphere. The official death toll was 3,576. However, other

estimates place the number at 32,000. Over half a million people were exposed to dangerous radioactivity, and some may suffer from cancers, tumors, eye cataracts, and increased genetic mutations in children born to these families.

b. Three-Mile Island (March 29, 1979) – a reactor at the Three-Mile Island nuclear plant in Pennsylvania lost its coolant water because of a series of mechanical and human errors. Unknown amounts of radioactive materials escaped into the atmosphere. Some studies have concluded that increased cancer rates in the area were caused by radiation released from the plant.

2. Radioactive Waste – waste continues to be radioactive and dangerous. It is classified based on the amount of radioactivity.

a. High-level waste must be sent to permanent, secured sites and will have to be stored for 10,000 to 240,000 years.

b. Low-level waste was dumped into the ocean in the U.S. from 1940s – 1970s. Now it must be carefully stored for 100s of years.

c. After approximately 15-40 years of operation, a nuclear reactor becomes too contaminated and the entire plant must be dismantled, or shielded with a barrier.

3. Expense – building and maintaining nuclear plants and storing wastes.

Review Questions

1. How does can radioactive element create electricity?

2. Why can't we safely dump radioactive waste into the ocean, or send it to space in a rocket?

IV. Fossil Fuels – fuel formed hundreds of millions of years ago from the remains of dead plants and animals.

A. Fossil fuels are rich in hydrocarbons – substances that contain the elements hydrogen and carbon. When the hydrocarbons are combined with oxygen at high temperatures, heat energy and light energy are released – this is called combustion.

B. Coal – plant remains converted by heat and pressure into a solid rock over millions of years. With each stage of development, coal becomes more concentrated and the amount of energy it releases increases.

1. There are four basic stages of coal –

a. Peat – low percentage of carbon; least energy (not true coal)

b. Lignite – 40% carbon, must be mined

c. Bituminous Coal – 85% carbon, deep in Earth's crust (most abundant type of coal mined in the United States)

d. Anthracite Coal – 95% carbon; deepest in ground. This is the final stage of coal and thus has the least water, fewest impurities, and most energy.

2. Pros :

a. World's most abundant fossil fuel - identified reserves of coal should last at least 220 years at current usage rates

b. Coal has a high net energy yield (25 – 28%)

3. Cons:

a. Coal mining is dangerous due to accidents and black lung disease. Coal mining also harms land and causes water pollution.

b. Coal is the dirtiest fossil fuel to burn, releasing many air pollutants (like carbon monoxide, carbon dioxide, and radioactive elements)

c. Burning coal is a threat to human health – in the U.S. air pollutants from coal burning kill thousands of people, cause respiratory disease, and result in several billion dollars of property damage.

C. Natural Gas – a mixture of mostly gaseous hydrocarbons. Methane is the primary component.

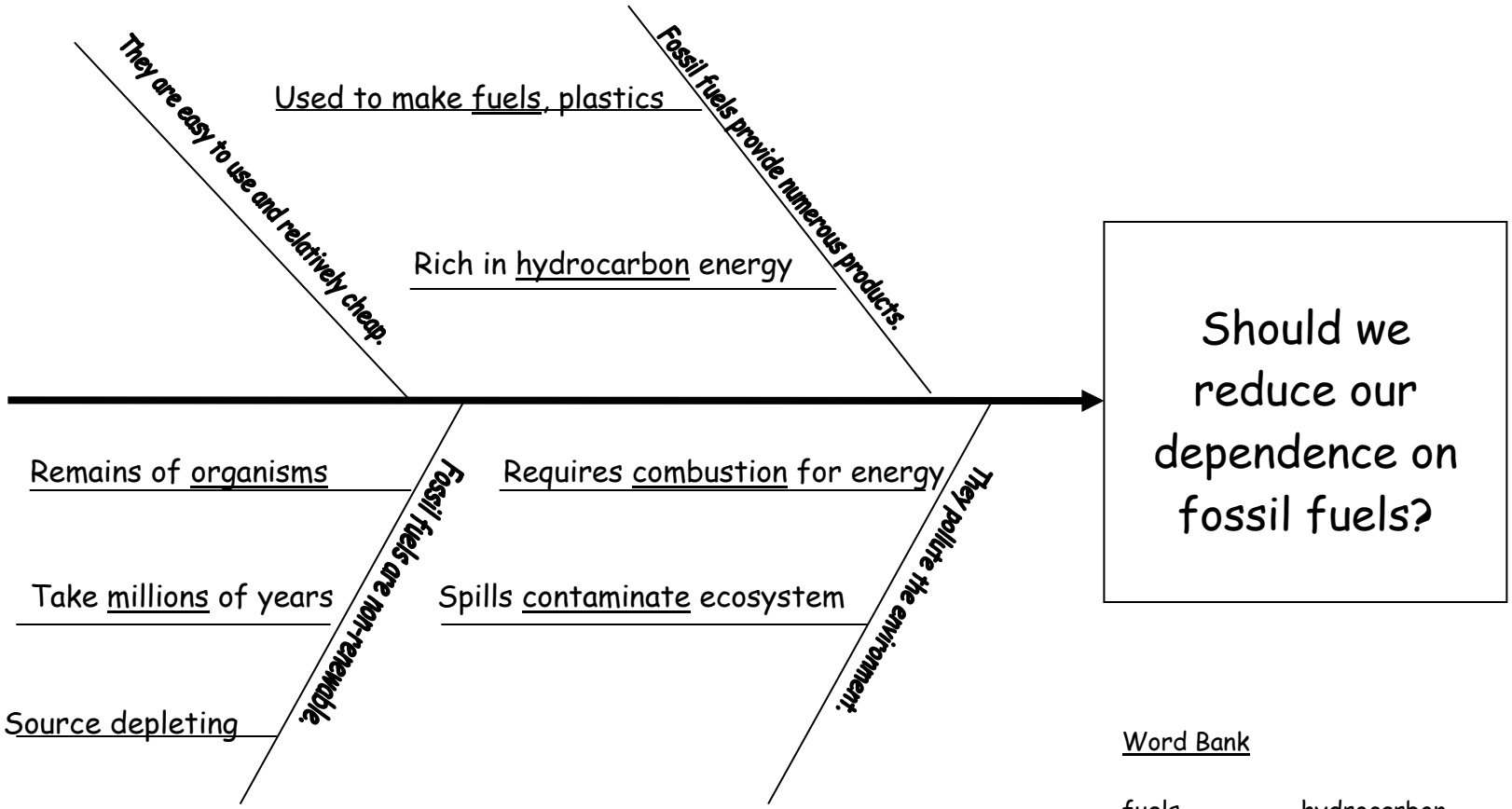
1. Forms from the remains of plankton, plants, and animals living in shallow seas millions of years ago. The pressure of overlying rocks force the gas to move upward, where it became trapped.
2. Pros:
   a. Natural gas is cheaper than oil.
   b. World reserves of natural gas are expected to last 125 - 200 years.
   c. Natural gas can be transported easily over land.
   d. It has a high net energy yield (4.9%).
   e. Produces less air pollution than any other fossil fuel.
   f. Extracting natural gas damages the environment less than extracting coal, and it is easier to process than oil.
   g. Can be used to power vehicles and in highly efficient fuel cells.
3. Cons:
   a. When processed, some toxic H_2S can be released into the air.
   b. Must be converted to liquid form before being shipped by tanker from one country to another overseas. This is expensive and dangerous (explosions!), and reduces net useful energy yield.
   c. Leaks of natural gas into the atmosphere from pipelines, tanks, and distribution facilities add methane to the greenhouse gases.

D. Petroleum/Oil – forms in the same way as natural gas

1. May have enough pressure to form a gusher to the surface, or it may need to be pumped to the surface using drilled wells. The petroleum pumped from a well is separated (refined) to make a variety of products – gasoline and jet fuels, diesel fuel, fuel oil, grease (such as Vaseline), asphalt, nylon, polyester, many plastics.
2. Pros:
   a. Oil is relatively cheap
   b. Easily transported within and between countries
   c. High net energy yield (4.7%) when easily accessible
3. Cons:
   a. Because of heavy usage, reserves of oil may be 80% depleted within 44 – 84 years, depending on how rapidly it is used.
   b. Oil-drilling process causes land disturbance, which can accelerate erosion.
   c. Oil-drilling produces waste materials and can pollute soil and water.
   d. Oil spills contaminate soil and/or water.
   e. Burning fuel oil and gasoline releases heat-trapping carbon dioxide, which could alter global climate, and other air pollutants that harm people, crops, tress, fish, and other species.

Review Questions

1. What is a fossil fuel?
2. What are the three main types of fossil fuels?
3. Why are fossil fuels considered non-renewable?
4. What are some pros and cons of fossil fuel?



Word Bank

fuels	hydrocarbon
cheap	organisms
millions	pollute
combustion	contaminate

Non-Renewable Energy Mini-Contract

(created by Jennifer Day)

1. What happens at a nuclear power plant?

   Option A – Draw a model of a nuclear power plant. Label all of the important components. Then draw a flowchart demonstrating the process of nuclear fission. Write a brief explanation beside each step.

   Option B – Webquest: Answer questions (your teacher has copies) by exploring the site http://www.dukepower.com/community/learningcenter/

2. How do fossil fuels affect our environment?

   Option A - Use the article "The Hidden Costs of Fossil Fuels" to create a concept map showing the effects of using fossil fuels.

   Option B – Visit the site www.cleanerandgreener.org/schools.pollution.htm and create a concept map showing the effects of using fossil fuels.

3. How much do we depend on fossil fuels and nuclear energy?

   Read the blog journal entry of Michele Vazquez and create a table showing the ways she depends on energy from fossil fuels and nuclear energy. Use the following columns: Activity, Source of Energy, Was this Activity Necessary (Yes/No)

4. Where does our electricity come from? (Do both parts!)

   a. Use the Delivering Electricity handout to create a flow chart showing how electricity is delivered to your home.
   (from www.dukepower.com/community/learningcenter/delivering)

   b. Create a pie chart using the following information (from Duke Power)
   Nuclear Power – a little more than half
   Coal – about half
   Hydroelectricity, Natural Gas, Oil – (total) 1-3%