Name: _____ Date: _____

Guided Learning: Comparing Energy Sources

Learning goals
After completing this activity, you will be able to …

- Compare and contrast different energy sources.
- Identify the advantages and disadvantages of an energy source.
- Understand the impact of various energy sources on society and the environment.

Vocabulary: acid precipitation, global warming, radiation, smog, strip mining

Warm-up question:
Which energy source or sources do you think are used to generate your town's electricity?

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Energy sources
In this worksheet, you will be reading about many different types of energy sources. Each of these sources impacts society and the environment in some way. The impact may be positive or it may be negative. As you read about an energy source, you may find it useful to highlight the source's advantages in one color and the source's disadvantages in another color.

Fossil fuels
Fossil fuels, which include coal, petroleum (oil), and natural gas, are the most commonly used energy sources in the United States. Thus, the majority of your community's electricity is most likely produced by burning a fossil fuel. Fossil fuels are also used to power most forms of transportation. For example, petroleum is refined into gasoline and diesel, which are used to power cars and trucks. It is also refined into jet fuel for airplanes.

Fossil fuels are a popular fuel choice for many reasons. First, they can be easily transported from one location to another. This makes them a convenient fuel choice almost anywhere in the world. Second, in the past fossil fuels were extremely abundant and wide-spread in Earth's crust. Fossil fuel reserves could be found on every continent. Because of their abundance, fossil fuels were very inexpensive. However, fossil fuels are nonrenewable resources. It takes millions and millions of years for fossil fuels to form. Because of this, we are quickly using up the Earth's supply of fossil fuels. As fossil fuels have become less abundant, their price has gone up.

Fossil fuels are generally obtained in two ways: through drilling and mining. Drilling oil wells often causes some oil to be released into the environment or may lead to a major spill such as the British Petroleum spill in the Gulf of Mexico. This oil is dangerous to wildlife and can cause soil and water pollution. Mining also causes its own environmental problems. Much of the coal extracted from Earth's crust is obtained through a process known as **strip mining**, shown at left. During strip mining, layers of rock and soil are stripped away in order to expose pockets of coal. This destroys entire ecosystems.

Fossil fuels also cause pollution when they are used. For example, sulfur dioxide is released into the air when a fossil fuel is burned. This chemical can react with water vapor, forming sulfuric acid. The airborne acid eventually falls as **acid precipitation**, which is capable of killing plants, polluting waterways, and damaging stone buildings and other structures. Chemicals released by burning fossil fuels can also form **smog**, which is linked to many human health problems. And, finally, burning fossil fuels releases greenhouse gases into the atmosphere, which have been linked to **global warming**—or the increase in Earth's average temperature.

1. Complete the chart below.

Advantages of Fossil Fuels	Disadvantages of Fossil Fuels

2. Despite all of its problems, why do you think Americans still use so much fossil fuel?

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Nuclear power

Nuclear electric power is generated by the splitting of uranium atoms. This releases a large amount of heat, which is used to create steam. The rising steam has kinetic energy, which is used to turn the turbines of an electric generator. While no air pollution is produced in the process, the heat could cause a reactor meltdown and the release of lethal amounts of **radiation**. For this reason, nuclear power plants must have large cooling towers that release the excess heat into the environment.

Another potential danger of using nuclear energy to make electricity is the generation of radioactive wastes. The materials that result from splitting uranium atoms will remain radioactive for thousands of years. Radioactive materials are linked with human diseases such as cancer. Therefore, these materials must be stored far away from human populations and fresh water sources that might be used by humans and wildlife. The storage process is very expensive.

Considering how dangerous radioactive materials can be, you may be wondering why nuclear power plants are used at all. Despite the risks, nuclear power has many benefits. Even though the uranium fuel used at a nuclear power plant is nonrenewable, it is still relatively abundant in nature and it is amazingly efficient. In fact, about 500 g of uranium (which is about the mass of a large potato) can produce 3 million times as much electricity as the same mass of coal!

1. Complete the chart below.

Advantages of Nuclear Electric Power	Disadvantages of Nuclear Electric Power

2. How do you think the use of nuclear electric power can impact society? _____

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Solar energy

Solar energy—or energy from the Sun—is in virtually unlimited supply on Earth. Every minute of every day, Earth receives millions of watts of energy. In fact, if all the solar energy that falls on Earth over a period of 20 days were collected, it would be equal to the amount of energy stored in the world's entire supply of fossil fuels. Solar panels, such as the ones shown at right, are used to collect solar energy and convert it into electricity.

Solar panels are reliable and produce no pollution. However, they are very expensive to make. In addition, solar energy cannot be easily stored. Expensive battery systems must be used to store the energy collected during the day. Another issue with solar energy is that it cannot be easily transported from one location to another. Furthermore, not all locations on Earth's surface receive enough solar energy year-round to meet all their electricity needs. For example, places such as Seattle have cloud-cover for the majority of the year. In these places, solar energy would not be a reliable energy source.

1. Complete the chart below.

Advantages of Solar Energy	Disadvantages of Solar Energy

2. How does solar energy compare to the use of fossil fuels as an energy source? _____

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Geothermal energy

Have you ever been to a hot spring? The water in a hot spring is warmed by heat coming from deep underneath Earth's crust. This heat energy is known as geothermal energy. In places where Earth's crust is very thin, geothermal energy can be harnessed to produce electricity. Pipes are placed underground. Water is pumped through them and heated by the geothermal energy. The heated water turns into rising steam, which has kinetic energy. The steam's kinetic energy is then used to turn the turbines of an electric generator.

Geothermal energy produces very little pollution. When the wells are dug for the pipes, sometimes toxic gases can escape Earth's crust, but this is very rare. However, only a few places on Earth have enough geothermal energy near the surface to support a geothermal power plant. Furthermore, sometimes the crust around a site that once supported a geothermal power plant can undergo changes, rendering the power plant useless.

1. Complete the chart below.

Advantages of Geothermal Energy	Disadvantages of Geothermal Energy

2. Do you think building a geothermal power plant is a wise investment for a community located in a geothermally-active region? Explain. _____

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Wind energy

Wind is a plentiful and inexhaustible source of energy across much of the United States. The power of blowing winds can be converted into electricity by wind turbines. The blades of a large wind turbine, such as the ones shown at left, are about as long as a football field. Each turbine here can generate enough electricity to power 1,400 homes when a strong wind is blowing.

Considering the fact that wind is free and renewable, wind energy may seem like the ideal energy source. However, like every other energy source, it does have its drawbacks. One issue is the cost of a large wind turbine, which is expensive to build and maintain. In addition, like solar energy, wind energy is difficult to store and cannot easily be transported. Furthermore, wind energy is dependent on local weather conditions, and some areas never receive enough wind energy to make a wind power plant feasible.

A final issue with wind energy is noise pollution. Wind turbines are very loud, so they cannot be placed near neighborhoods. Furthermore, thousands of birds have been killed by flying into the turbine's rotors. Thus, the cost to wildlife must be considered when planning a wind power plant.

1. Complete the chart below.

Advantages of Wind Energy	Disadvantages of Wind Energy

2. How does the environmental impact of a wind power plant compare to that of a coal-burning power plant? _____

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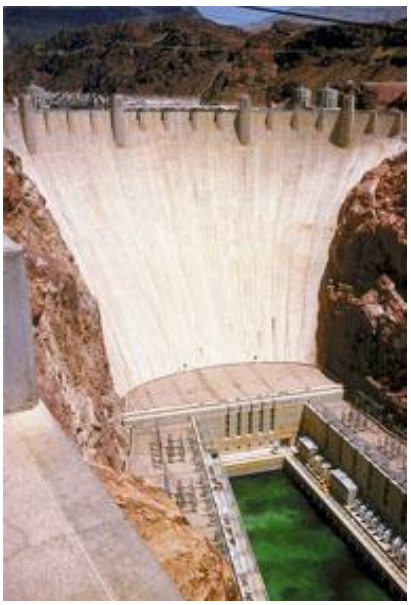

Hydropower

Flowing water, just like moving air (wind), can be used to generate electricity. This is done by building a hydroelectric dam, such as the one shown at left, across a river. The dam directs the flow of the water through turbines, causing them to spin. The turbines power an electric generator. Electricity produced in this way is called hydropower.

Hydropower is relatively inexpensive to produce and causes very little pollution. In addition, hydropower is a renewable energy source. However, hydropower is only available in places that have a major river with a large volume of falling water. Another problem with hydropower is that it disturbs river ecosystems. For example, it can disrupt the path of migrating fish, such as salmon. In addition, it increases the temperature of the water, which can disrupt the life cycles of many aquatic species. Finally, dams decrease a river's water quality and cause erosion problems downstream.

Other issues raised by hydroelectric dams have to do with the creation of reservoirs behind the dams. When dams are built, water is allowed to collect behind them. This floods land that was previously dry, thus displacing wildlife and human populations.

1. Complete the chart below.

Advantages of Hydropower	Disadvantages of Hydropower

2. **Challenge:** Why do you think dams can cause erosion problems? _____

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Biomass

If you've ever cooked over a campfire or enjoyed the warmth from a crackling fire in your home during the winter, you have used biomass as an energy source. Biomass is any type of plant or animal material used for energy. You are probably most familiar with using wood as biomass, but in the United States the most commonly used biomass energy source is corn. The corn is changed into ethanol—a liquid fuel that can be used to power cars and produce electricity.

Like fossil fuels, when ethanol is burned it releases pollutants into the air. However, the pollutants released by ethanol tend to be less toxic than those released by fossil fuels. In addition, ethanol is produced from a renewable resource (plant material). A final benefit to ethanol is that it can actually help vehicles run smoother, thus extending the life of the engine. However, ethanol contains slightly less energy than gasoline, so using ethanol may lower a vehicle's gas mileage.

Ethanol does have some other drawbacks, too. It would take a massive amount of corn in order to meet all the fuel needs in the United States. In fact, if all the corn currently grown in the United States were turned into ethanol, it would equal just 25% of our current gasoline consumption. And, of course, we cannot convert all of the corn we produce into ethanol since corn is a staple food crop for both people and livestock (although currently scientists are research alternatives to corn, including algae and sugarcane). Another issue with ethanol is that, unlike gasoline, it is highly corrosive. Because of this, it has to be stored in special tanks and pumped through fuel hoses made out of special materials.

1. Complete the chart below.

Advantages of Biomass	Disadvantages of Biomass

2. Compare and contrast the advantages and disadvantages of using ethanol and gasoline.