

## Unit 5

# How Can Community Values Affect the Energy Resources We Select?

## Activity A

Do different resources for generating electricity have different community impacts?

### Introduction

Several sources of energy can be used to produce electricity. Some, like hydropower, solar and wind, are renewable because the resource is available as part of nature's ongoing cycle of activity. Other energy sources, like coal, oil, natural gas, and nuclear, are not renewable because they are a finite natural resource.

For both renewable and non-renewable energy sources there are costs and benefits to their use. Some costs to the community are not necessarily apparent at the time power is purchased. Environmental considerations sometimes fall into this category. As more energy is demanded and more sources tapped, our environment changes to reflect this new order. Over time, communities, legislative bodies, special interest groups, media, and government agencies have become more sensitive and concerned with the choices being made and the long term community cost. While agreement concerning the "best" choice is often elusive, the democratic nature of our society has resulted in more public involvement.

In this activity, students examine the costs and benefits of using different sources of energy to generate electricity. A community rating for each one that effectively prioritizes "preferred choices" will be made. In the next activity, the actual per megawatt hour cost paid by consumers will be evaluated as part of considering the long term energy mix students would like to see.

The Electricity Generation Resource Sheet is predominantly derived from materials provided by the Northwest Power Planning Council (NWPPC). The NWPPC was established after the Northwest Power Act of 1980 was passed by the U.S. Congress. The act authorized the states of Idaho, Montana, Washington, and Oregon to enter into an interstate compact and form the NWPPC. The governor of each state appoints two individuals to be members. Their role is to develop a long term electric power plan that assures reliable, low cost energy; to develop a program to protect fish and wildlife that have been affected by hydroelectric projects; and to extensively involve the public in their decision-making process.

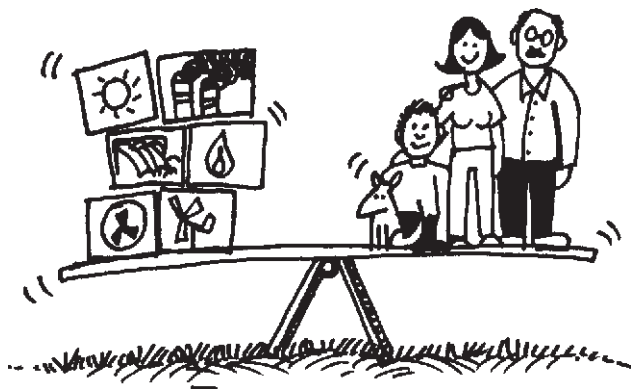
## Scientific Learning Goals and Objectives in this Activity:

### Goals

- Students will understand the interdependence among science, technology, and mathematics, and their connections to the world beyond the science class.
- Students will understand how historical contributions and philosophical, societal, and ethical issues relate to science and technology.

### Objectives

- Students will demonstrate an understanding of how much different energy sources have - and are - contributing to meet the electricity generation needs in the Northwest.
- Students will identify the range of electricity generation sources available and demonstrate an understanding of the costs and benefits of each.
- Students will collaboratively consider their attitudes regarding the costs and benefits of different electricity generation sources.



## Teacher Preparation

**Preparation Time:**  
*5 minutes*

### Materials

*Prepare for the Entire Class:*

- Electricity Generation Resource Sheet

- transparency of Electric Generation Sources

*Prepare for Each Student:*

- copy of journal pages

## Student Involvement

**Activity Time:**  
*50 minutes*

### Activity Processes:

*? In the Northwest, what sources of energy do you think we use to generate electricity today?*

*? What sources do you think we will use in 2010? Why?*

1. Discuss responses and list on a board or overhead the possibilities. Students share ideas and reasoning with class. Place transparency of journal page showing empty bar chart on overhead. Demonstrate how to draw bar chart to show predictions. In their journal, students draw a bar graph predicting percentage of sources currently used and what they think will be used in 2010.

Place transparency of Electric Generation Sources on overhead. Students compare their 1995 predictions to actual percentages. 1980 data is available to compare whether the "resource mix" has changed over time.

*? If you could choose two electric generation resources to use in the future, what would you choose? Why?*

2. Assign teams resource(s) to represent from Electricity Generation Resource Sheet. Pass out resource information needed by each team. For each resource, team members summarize for the class how it works, and its positives and negatives.

3. The class asks questions and then votes on giving the resource a community rating of 1, 2, or 3. One represents their most favored choice and 3 their least favored choice. Students should set parameters for what factors are most and least important when considering the community impact of each resource.

Examples of parameters include:

- cost
- environmental impact
- waste disposal
- aesthetic preference.

Students record in journal their personal rating for each resource.

## VOCABULARY

Coal  
Conservation  
Geothermal  
Hydro  
Natural Gas  
Nuclear  
Solar  
Wind

## Notes

Step 2:

An alternative is to select a five student team to act as the Northwest Power Planning Council. They, rather than a class vote, will determine rating.

When students list positives and negatives, you can draw a chart on board or transparency to help keep track.

An example would be:

<u>Positives</u>	<u>Negatives</u>
Hydro	
Oil	
Coal	
Etc.	

\*\* Additional information has been prepared regarding the Northwest energy crunch. These questions and answers will provide the facts necessary to discuss events found in current headlines.

# Journal 5A

Do different resources for generating electricity have different community impacts?

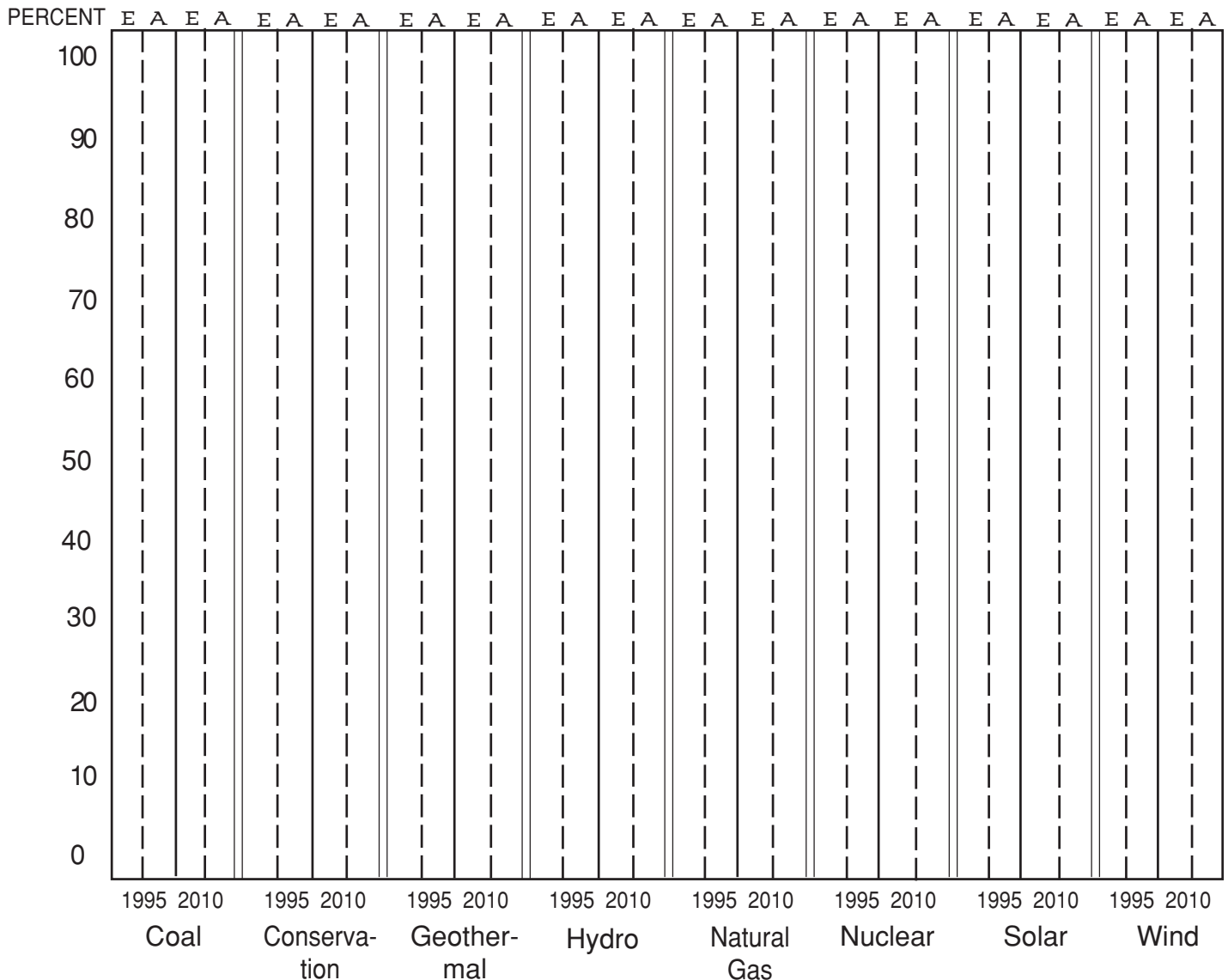
Name \_\_\_\_\_

Team Name \_\_\_\_\_

Date \_\_\_\_\_

Fill in the bar chart. For 1995, show what percent of electric generation you think comes from each energy source. For each source, what percent do you think will be available in 2010?

E = Estimated    A = Actual



## Journal 5A Continued

Do different resources for generating electricity have different community impacts?

What community rating would you give each source of electricity generation?

Coal	_____
Conservation	_____
Geothermal	_____
Hydro	_____
Natural Gas	_____
Nuclear	_____
Solar	_____
Wind	_____

What costs/benefits (negatives/positives) did you use when considering your rating for each resource?

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# Electricity Generation Resource Sheet

Make one class copy, cut apart, and give each team the resource they represent.

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## COAL (Non-Renewable)

**How It Works:** Coal is mined from the earth and crushed into small particles. The coal is mixed with oxygen and blown into a furnace, where it heats water to create steam. Steam rotates turbine blades in a manner that enables a generator to create electricity.

**Positives:** Coal has historically been a readily available resource that can easily be extracted and is extremely efficient at producing heat.

**Negatives:** Non-renewable. Coal plants produce toxic ash that must be safely disposed. The combustion of this fossil fuel creates air pollution that contributes to acid rain and global warming.

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## CONSERVATION

**How It Works:** When consumers use electricity more efficiently, the need to generate it declines. Better insulation and more efficient lights are easy ways to conserve energy. Either a public relations campaign to change people's habits or the installation of conservation devices like insulation has a cost. These costs can be compared to building new power plants.

**Positives:** The act of conserving reduces the requirement for additional energy. When energy demands are reduced, so are any negative impacts of using that resource.

**Negatives:** Conservation is a finite source with limited potential. Maximizing the potential of conservation relies on individual choices.

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## GEOTHERMAL (Renewable)

**How It Works:** Geothermal energy can be produced wherever a heat source is available from deep in the earth. This heat produces steam, which rotates turbine blades in a manner that enables a generator to produce energy.

**Positives:** Renewable. Geothermal is renewable and requires less land area to produce electricity.

**Negatives:** Drilling causes land disturbance and is not aesthetically pleasing. Geothermal operations involve operating noise, residual land disturbances such as roads and power lines, and possible air pollution from sulphur fumes.

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## HYDRO (Renewable)

**How it Works:** Hydropower is generated by the force of falling water. The farther the water falls or the more water that falls, the greater the energy potential. As the turbine rotates, a generator creates electricity. Hydroelectric projects often use reservoirs as a means of storing energy potential to provide electricity on demand.

**Positives:** Dams can provide flood control in many areas and are a reliable supply of water for multiple uses. Reservoirs provide important habitat for migrating birds and other wildlife. Reservoirs also support popular recreational activities such as boating, swimming, and fishing. The process of generating hydroelectricity does not create pollution, is non-consumptive and is a renewable resource.

**Negatives:** Dams and reservoirs will initially flood sections of land. Slow or slack water behind a dam confuses small migrating fish. As a result, they can have difficulty navigating around dams and are easier for predators to catch. Fish passing through turbines also have a higher mortality rate. Dams can impede adult fish migration upstream as well. Rapidly changing water levels disturb and can harm fish and wildlife.

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## **NATURAL GAS/COMBUSTION TURBINES** (Non-Renewable)

How It Works: Natural gas is mixed with compressed air and ignited. The heat from the burning gases rotates turbine blades in a manner that enables a generator to produce electricity.

Positives: Natural gas has historically been a readily available resource that can easily be extracted. Burning natural gas is a fairly clean process, with the least pollution of all fossil fuels. New reserves have been found and pipelines built to bring this resource to power plants in the United States.

Negatives: Non-renewable. The combustion of this fossil fuel creates air pollution (but not as much as coal) that contributes to acid rain and global warming. Combustion turbine plants produce operating noise and should be located away from homes and offices.

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## **NUCLEAR** (Non-Renewable)

How It Works: A fission reactor uses radioactive elements to produce heat. The heat is used to generate steam, which rotates turbine blades in a manner that enables a generator to produce electricity.

Positives: Nuclear energy utilizes small amounts of natural resources (uranium). Uranium is a plentiful resource.

Negatives: Non-renewable. Nuclear power plants produce radioactive waste that is very dangerous and must be safely disposed. No completely safe method of disposal has yet been found. The potential for large-scale destruction exists if there is an accident at a nuclear plant.

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## **SOLAR** (Renewable)

How It Works: Solar energy can be used two ways. One way is to use mirrors to concentrate sunlight and thus generate enough heat to produce steam. The steam rotates turbine blades in a manner that enables a generator to create electricity. Another generation method is to expose photo voltaic cells to sunlight. These specialized cells convert the sunlight directly into electricity.

Positives: Renewable. Solar energy production has relatively minor environmental consequences. Photo voltaic cells produce no heat, noise, or air pollution when they operate.

Negatives: Solar farms cover large areas of land, disrupting desert habitats where the strongest and most reliable source of heat can be found. Solar plants depend on available direct sunlight.

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## **WIND** (Renewable)

How It Works: A windmill acts like a turbine with the wind turning the blades. The turbine enables the generator to create electricity.

Positives: Renewable. Energy production from wind has relatively minor environmental effects. A windmill does not produce heat, noise, or air pollution.

Negatives: Wind turbines contribute to avian mortality (bird deaths), and are generally considered to be visually unattractive. Areas favorable for wind farms are often remote, take up large areas of land to produce small amounts of energy, and require roads (land disturbance) and transmission lines.

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## Electric Generation Sources

	1980			1995		
	% of Total <sup>1</sup>	MW Generated	Cost/ MWh <sup>2</sup>	% of Total	MW Generated	Cost/ MWh
Coal	8	1,320	\$45	15	3,290	\$45
Conservation	2	30	\$25	4	900	\$25
Geothermal	0	0	\$80	0	0	\$60
Hydro	76	11,500	\$10	70	15,000	\$10
Natural Gas Combustion Turbines	6	1,000	\$60	7	1,570	\$25
Nuclear	8	1,280	\$60	4	850	\$60
Solar	0	0	\$100	0	0	\$90
Wind	0	0	\$80	0	0	\$60
<b>TOTAL DEMAND</b>	<b>15,130 MW</b>			<b>21,610 MW</b>		

**Notes:**

1. Numbers rounded to nearest whole number
2. Numbers rounded to nearest 5

**NORTHWEST POPULATION**  
(Includes population from the states of WA, OR, ID and MT)

1980: 8,003,800  
 1995: 10,068,995  
 2010: 11,887,942

Source: Northwest Power Planning Council

# Questions & Answers about the Northwest Energy Crunch

Newspaper headlines this year declare we are having an energy crisis in the Northwest. Your parents may be talking about higher utility bills and blackouts in California. What does this all mean? The following information may help you figure it out.

## **Where did our power go?**

We haven't built enough power plants to keep up with demand. In the last 10 years, the Northwest's electricity consumption grew 24 percent, but new generation increased by only 4 percent.

## **What about hydropower?**

Clean, renewable hydropower provides up to 80 percent of the Northwest's annual electric supply. However, in 2000-2001 the lowest predicted water runoff in nearly a hundred years drastically cut the Northwest's supply of hydropower.

## **Why is the cost of power going up?**

When utilities buy power they often secure long-term contracts to guarantee stable prices. Most utilities supplement those contracts by acquiring additional power on the spot (open) market. The price of electricity on the spot market changes constantly. In recent months shortages caused spot market prices to skyrocket from an average of \$25 per megawatt-hour to over \$700 per megawatt hour.

## **Who is responsible?**

We are all responsible for the current energy crisis. Low prices and ample energy supplies led many consumers and utilities to become complacent about energy conservation. At the same time, strict regulatory requirements and an overall lack of incentives resulted in construction of only a few power facilities. And, natural gas, the fuel for many power plants, quadrupled in price during the last year. Finally, drought conditions in the Northwest accelerated and amplified the crisis by drastically reducing the available hydropower supply.

## **What are the utilities doing to make the situation better?**

Utilities are working to improve the efficiency of their generation facilities and are aggressively seeking conservation opportunities. Many new generation facilities are planned and are in various stages of construction and permitting

## **What can I do about price increases and the power crunch?**

The most important thing you can do is to conserve energy. Many local utilities provide useful energy conservation tips on their web sites. Some also provide incentive programs to help conserve energy.

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For the latest information on the Northwest Energy Crunch, visit the Foundation for Water and Energy Education website at [www.fwee.org](http://www.fwee.org).

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