

Unit 5 How Can Community Values Affect the Energy Resources We Select?

What resources can we use to generate electricity, and do they 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 first examine where our power comes from, how the resource mix has changed over the years and how it might change in the future. They then 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.

Much of the information is provided is from materials provided by the Northwest Power and Conservation Council (NWPPCC). The Council 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 NWPPCC. 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.

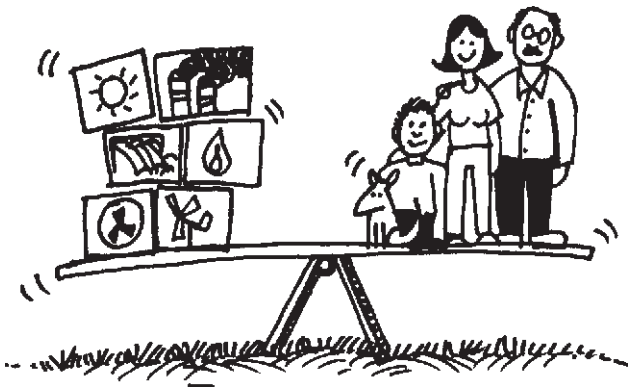
□ Students will understand how historical contributions and philosophical, societal, and ethical issues relate to science and technology.

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, 2005 Power Generation Capacity, 2025 Power Generation Capacity Forecast, Changing Pacific Northwest Power 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? Why?*

? *What sources do you think we will use in 2025? 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 2025.

Place transparency of 2005 Power Generation Capacity Sources on overhead. Students compare their 2005 predictions to actual percentages. Place transparency of 2025 Power Generation Capacity Sources on overhead. Students compare their predictions to Power Council forecast.

Place transparency "Changing Pacific Northwest Power Sources on overhead. How have power sources changed over time? e.g. - 100% hydropower to 57% hydropower. What is causing rise in power usage? e.g. - population growth. Are new power sources coming from renewable sources? Why?

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

2. Assign teams to represent resources from Electricity Generation Resource Sheet. For the purpose of this exercise, conservation is considered a resource. Pass out resource information needed by each team. For each resource, team members summarize for the class how it works, positives and negatives, cost and availability. They can use the Internet to find out more information.

3. After presentations, they can use the Internet to find out more information. 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 5

Do different resources for generating electricity have different community impacts?

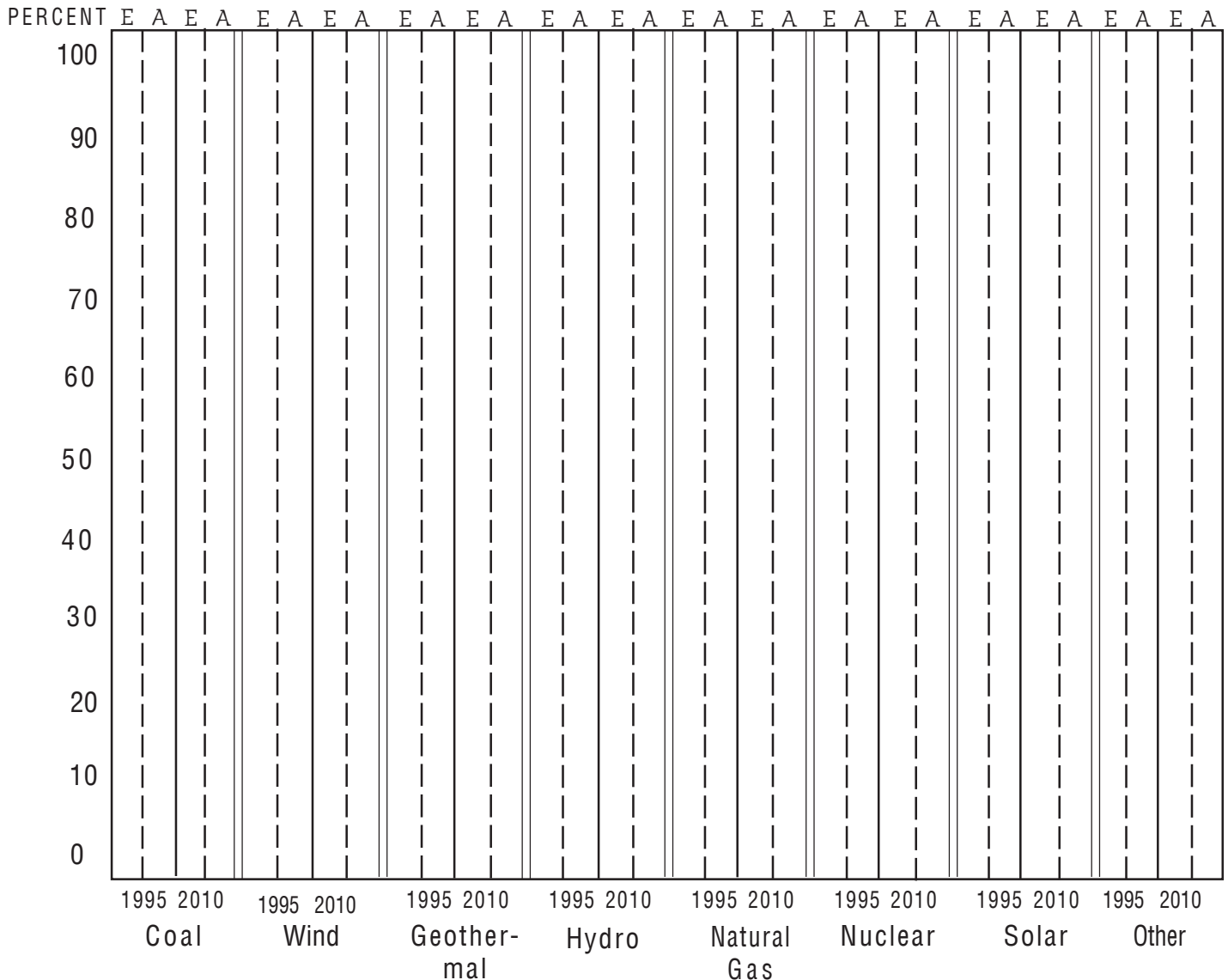
Name _____

Team Name _____

Date _____

Fill in the bar chart. For 2005, 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 2025?

E = Estimated A = Actual



Journal 5 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 _____
Wave Energy & _____
Tidal Currents _____

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

Electricity Generation Resource Sheet

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

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. New technologies are being developed to address negative environmental impacts. The price of coal has been fairly stable.

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.

2007 Cost: \$43 /Mwh

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 and maintaining new power plants. From 1980 to 2000, conservation programs resulted in 1,800 megawatts of energy being saved annually. That savings means about 6% of additional generating capacity did not need to be developed.

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. Another 2,700 average annual of conservation is considered possible by 2020.

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

2007 Cost: Variable

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. The first small project in the Northwest began in 2007 in southern Idaho.

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. Very few potential sites have been identified in the Northwest.

2007 Cost: \$35/Mwh

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. In the Northwest, most feasible sites have been developed. Cost is stable.

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, or contribute to global warming 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. Generation opportunities may be lost to meet environmental needs.

2007 Cost: \$35 - 46 /Mwh

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. Significant capacity was developed between 1995 and 2004. Higher gas prices has reduced attractiveness since then.

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. Gas prices have been unstable since 2000.

2007 Cost: \$46 - 100/Mwh

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. No new nuclear plants are expected in the Northwest by 2020.

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.

2007 Cost: \$33/Mwh

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. The best bulk solar resources in the Northwest are in southern Idaho and southeastern Oregon. The cost to produce in bulk is seven times higher than other resources.

Positives: Renewable. Solar energy production has relatively minor environmental consequences. Photo voltaic cells produce no heat, noise, or air pollution when they operate. Costs for installation are attractive for remote locations without access to the power grid.

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. Direct sunlight is most available in the Northwest only during summer.

2007 Cost: Variable

Electricity Generation Resource Sheet

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. Wind is a fast growing component of regional capacity, from zero to three percent from 1996 to 2006. This capacity is expected to continue to grow rapidly over the next decade.

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. Wind “blows” intermittently, meaning other generating resources must be available during low wind periods.

2007 Cost: \$35 -45 /Mwh

Wave Energy & Tidal Currents (Renewable)

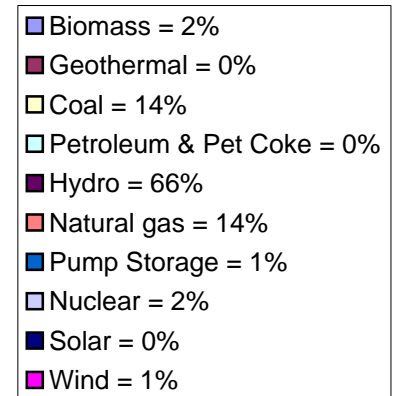
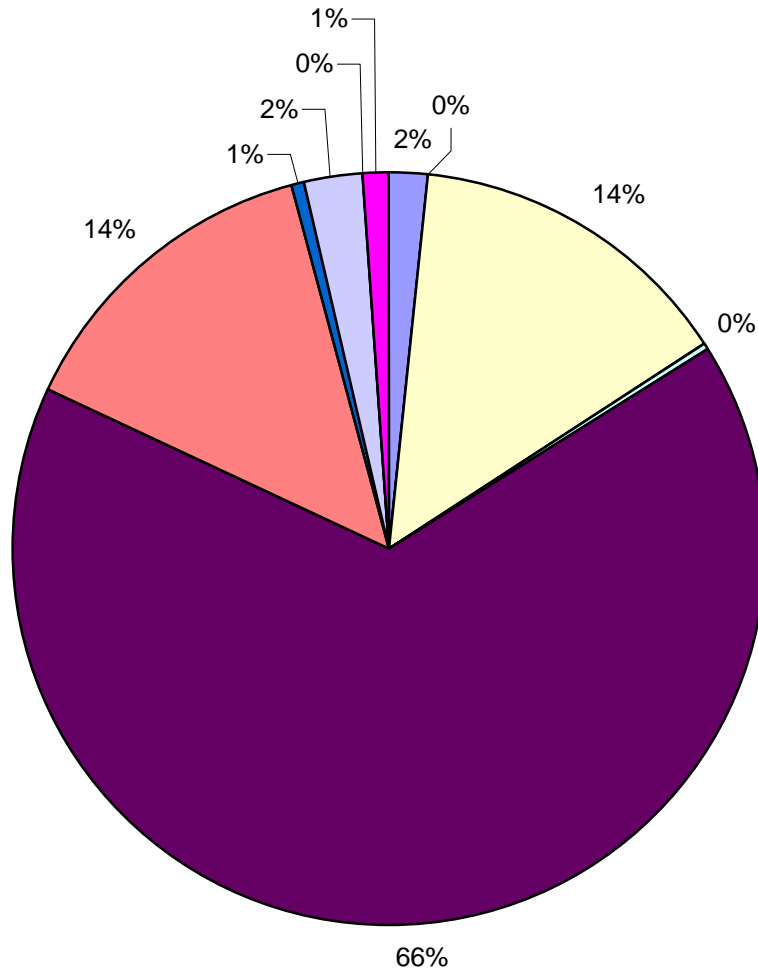
How It Works: Ocean and tidal currents can generate electricity using the same principles as wind turbines. Prototypes for tidal current and wave energy are now being piloted.

Positives: Energy production has relatively minor environmental effects. They do not produce heat, noise, or air pollution.

Negatives: Need to demonstrate economic viability and ability to integrate this resource into the power grid.

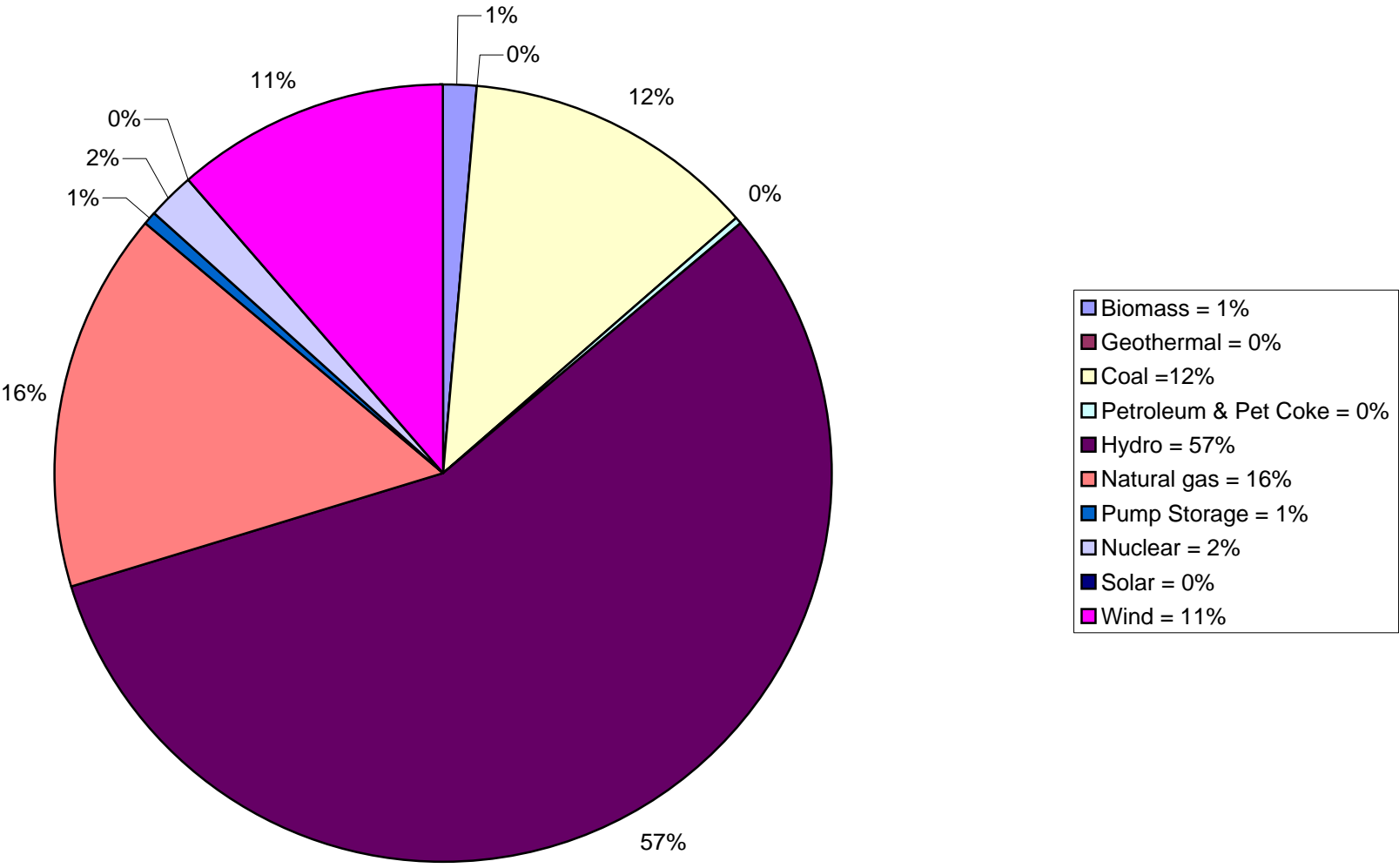
2005 Power Generation Capacity Sources 50,723 Megawatts

Source: Northwest Power and Conservation Council



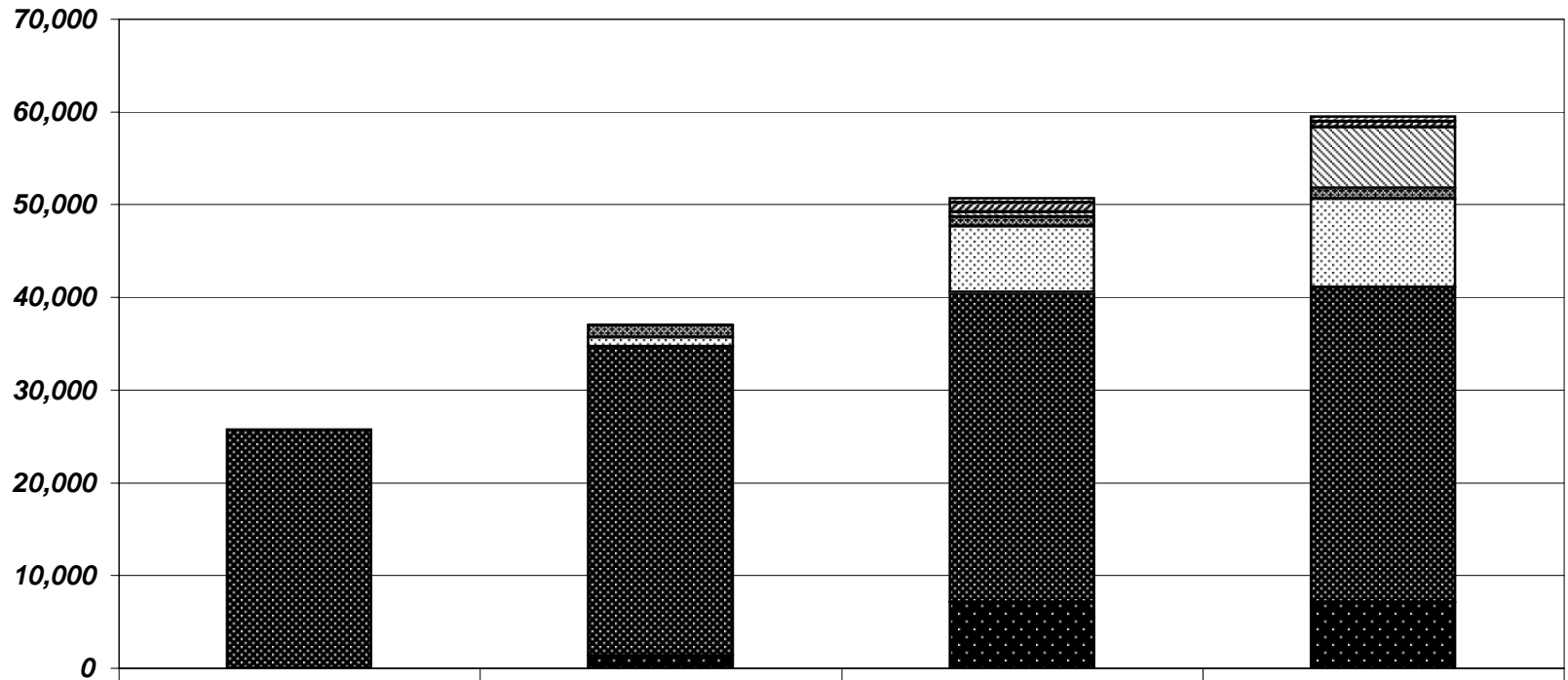
2025 Power Generation Capacity Forecast
59,541 Megawatts

Source: Northwest Power and Conservation Council



Changing Pacific Northwest Power Sources

Source: Northwest Power and Conservation Council



	1960	1980	2005	2025
Other	0	30	0	0
Petroleum & Pet Coke	0	0	0	0
Pumped Storage	0	0	507	595
Biomass	0	0	1,014	595
Wind	0	0	507	6550
Solar	0		0	0
Nuclear	0	1,280	1,014	1191
Natural Gas	0	1,000	7,101	9527
Hydro	25,781	33,400	33,477	33938
Geothermal	0	0	0	0
Coal	0	1,320	7,101	7,145