

Electricity Unplugged

(Investigating the parts, process, and products of making electricity)

Suggested Grade Level 6-8

Overview

In this lesson, students will get acquainted (or re-acquainted) with how electricity is produced. They will have an opportunity to compare and contrast different types of electricity production systems (EP systems) and their associated parts, processes and products. As a culminating activity, students will draft a letter to the local government making recommendations about EP systems to be used in their communities. Approximately four to five 50-minute long class periods are recommended to complete this investigation.

This lesson can be implemented in a stand-alone fashion to address the basic premise of electricity production in Pennsylvania or as an introduction to a larger unit on alternative energy technology in conjunction with other lessons from the E21 website (<http://www.pspb.org/e21>). The E21 lessons, “Eat your Energy’s Worth” and “Walk a Mile for a Burger,” are complementary for study of energy basics and lessons found in the “Clean Energy” strand would be appropriate to extend an exploration of alternative energies.

Standard Statements

- 3.1.7 A Explain the parts of a simple system and their relationship to each other.
- 3.1.7 E Identify change as a variable in describing natural and physical systems.
- 3.4.7 B Relate energy sources and transfers to heat and temperature.
- 3.5.7 B Recognize earth resources and how they affect everyday life.
- 3.6.7 C Explain physical technologies of structural design, analysis and engineering, personnel relations, financial affairs, structural production, marketing, research and design.
- 4.2.7 A Know that raw materials come from natural resources.
- 4.2.7 B Examine the renewability of resources.
- 4.2.7 C Explain natural resource distribution.
- 4.8.7 B Explain how people use natural resources.

Content Objectives

Students will know that

1. Electricity can be produced from renewable and nonrenewable resources.
2. Energy resources are geographically bound.
3. Waste is produced in the production of electricity.
4. Renewable and nonrenewable resources are created on different time scales.
5. There are pros and cons to each form of electricity production.
6. EP systems have a few common components.

Process Objectives

Students will be able to

1. Identify the major components of EP systems.
2. Describe the differences between renewable and nonrenewable resources.
3. Compare and contrast different electricity production methods.
4. Describe the environmental, economic, and social implications attributed to each resource used for electricity production.

5. Evaluate EP systems used in their community/region and make a recommendation about alternative energy sources.

Assessment Strategies

1. Prior knowledge assessment
2. Small and whole group discussion
3. Completion of student handout
4. Performance in letter writing activity

Materials

Per group:

- Computer with an internet connection
- Websites:
 - Part 2
 1. Coal Plant: <http://www.its-about-time.com/investinesart/coalplantvirtualtour.swf>
 2. Nuclear:
 - a. <http://www.science.uwaterloo.ca/~cchieh/cact/nuctek/fissionreactor.html>
 - b. <http://science.howstuffworks.com/nuclear-power3.htm>
 3. Hydroelectric: <http://fwee.org/walktour>
 4. Wind: http://www1.eere.energy.gov/windandhydro/wind_how.html

Per student

- Student Handout
- Sample electricity bills (optional)

Procedures

Part 1: Student EP Systems Survey (Assessing prior knowledge) (20 minutes)

1. Explain that to explore the topic of electricity, you are going to gather information about your students' prior knowledge by having them complete the first page of the student handout.
2. Attend to any questions that students may have about the survey and reassure them that they will learn more about any items they were uncertain about in the upcoming parts of the investigation, but resist giving students direct answers.
*The survey could also be used as a homework assignment or planning tool to identify students' alternate conceptions or interests prior to beginning a study of electricity production.

Part 2: Electricity Production Systems (1, 50-minute Class Period)

1. State that there are many different types of resources to produce electricity. For this lesson, only four of them will be focused on: Coal, Nuclear, Hydroelectric, and Wind.
2. Split the students into groups of 4 or 5 to complete the web search.
3. Using the websites listed above and Question #1 of Part 2 in the Student Handout, have the students check off each component that they find being used in the production of electricity. The students should be able to see a trend in regards to common components in the production of electricity.
4. Make sure that the students also complete Question #2 of Part 2 in the Student Handout to take notes on the pros and cons of each type of electricity production.

Part 3: The Environmental, Economic, Social Products of Electricity Production (30 minutes and Homework)

1. Allow students to work in teams to ponder the questions in Part 3 of the Student Handout.
2. Discuss their responses as a large group to try to identify the major products or impacts of producing electricity and what that means for their communities.
3. Ask students if they know how much their family pays for electricity per month and ask them if they think that is reasonable.
4. Assign students a short homework assignment to find out more about where their family's power comes from using the following website:
<http://www.epa.gov/cleanenergy/powpro/screen1.html>.

Part 4: Electric Choice in Pennsylvania (20 minutes)

1. Review students homework assignment to find out who distributes their electricity, what type of resource is used as fuel and the emission amounts from its production.
2. Give students a short lecture on the deregulation of electricity in Pennsylvania.
3. Discuss the role of choice in influencing the future of electricity production and introduce the task for Part 5.

Part 5: Take Action-Write Your Recommendation to the Town Council (1-2, 50 minute Class Periods)

1. Drawing on their previous experiences in the lesson and daily lives, students will draft a letter to a town council person making recommendations for the electricity production system fuel of choice.
2. Students will utilize the lessons learned from Parts 2 and 3 to support their recommendation.
3. Students may proceed with this action step, as appropriate. Some performance tasks include presenting their work publicly, mailing their letters to the local government agency, hosting a forum for peers, etc.

Electricity Unplugged (Teacher Notes)

(Investigating the Parts, Process, and Products of Making Electricity)

Part 1 Notes

- **Prior Knowledge Assessment.**

This assessment tool is not meant to be graded; it may prove to be useful as students transition into learning about electricity production systems and is a way for teachers to find out what initial conceptions students hold before diving into any activities. The questions have been written to be both straight-forward and also discussion-stimulating. When using this assessment, you are encouraged to allow students to grapple with misconceptions or pose questions, but refrain from correcting students until they have had an opportunity to struggle with the concepts individually and collaboratively.

Part 2 Notes

- **Electricity Production Systems Website Links.**

- Coal Plant: <http://www.its-about-time.com/investinesart/coalplantvirtualtour.swf>
- Nuclear:
 - <http://www.science.uwaterloo.ca/~cchieh/cact/nuctek/fissionreactor.html>
 - <http://science.howstuffworks.com/nuclear-power3.htm>
- Hydroelectric: <http://fwee.org/walktour>
- Wind: http://www1.eere.energy.gov/windandhydro/wind_how.html

Part 3 Notes

- **Environmental, Economic, and Social Products**

One thing to make sure that your students understand is that the variety of fuels used to generate electricity all have some type of impact on the environment. Fossil fuel power plants release air pollution, require large amounts of cooling water, and can mar large tracts of land during the mining process. Nuclear power plants are generating and accumulating large quantities of radioactive waste that currently lack any repository. Even renewable energy facilities can affect wildlife (fish and birds), involve hazardous wastes, or require cooling water.¹

The following Power Scorecard website is a great resource for specific information on specific air, water and land use impacts: <http://www.powerscorecard.org/issues.cfm>. Students are also guided to this site for reference in the student handout. A synopsis of environmental products students may generate is included below (Each underlined phrase links directly to the associated Power Scorecard site.)

Air impacts	Water impacts	Land use impacts
Climate change Acid rain Ozone (smog) and fine particulates Air toxics (mercury)	Consumption of water resources Pollution of water bodies	On-site land impacts Off-site land impacts

Part 4 Notes

¹ <<http://www.powerscorecard.org/issues.cfm>>

- **Electric Choice in Pennsylvania.** In this section, students should have completed the homework assignment from Part 3, which asked them to search their zip code at the EPA's website to find out the electricity that is being used in their area and the amount of emissions being produced. Students will benefit from a short lecture on the deregulation of electricity providers in PA. The Clean Air.org site is a great source for deregulation information: <http://www.cleanair.org/Energy/deregulation.html>.

Part 5 Notes

- **Social Action: Writing a recommendation for an EP system to an agency of local government.** From the knowledge gained from the previous parts of the lesson, students will be able to write an informed letter to a town council person recommending the selected electricity production system choice. By addressing the positive and negative implications of the different electricity production methods, students should gain an understanding of the implications of their actions. However, by completing the social action step, students will also understand that they have the power of choice. Empowerment through social action can produce change.

Notes on Additional References

Electricity Basics. Websites.

How electricity works

<http://science.howstuffworks.com/electricity.htm>

Power distribution grid

<http://science.howstuffworks.com/power.htm>

How power works and US power production map

<http://science.howstuffworks.com/power1.htm>

Nice diagram of turbine and generator - oh the magic!

<http://www.eia.doe.gov/kids/energyfacts/sources/electricity.html#Generation>

Parts, Process, and Production of electricity production Websites.

How nuclear power works

<http://science.howstuffworks.com/nuclear-power3.htm>

How hydropower plants work

<http://people.howstuffworks.com/hydropower-plant1.htm>

Simplified model of hydropower plant

<http://www.eia.doe.gov/kids/energyfacts/sources/renewable/water.html>

Advantages and disadvantages of all power sources. Website.

Electricity resources listed with their advantages and disadvantages

<http://www.nucleartourist.com/basics/why.htm>

Pennsylvania Electricity Production Websites.

Pennsylvania wind and solar potential

http://www.eere.energy.gov/states/alternatives/resources_pa.cfm

Pennsylvania wind map

http://www.eere.energy.gov/windandhydro/windpoweringamerica/maps_template.asp?stateab=pa

Nice diagram of electricity distribution

http://www.eia.doe.gov/basics/electricity_basics.html

Name: _____

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Overview

This survey asks you to think about how electricity is produced. The questions will challenge you to explore what you know and hopefully get you to ask questions about the things that you do not know!





Part 1: Student Electricity Production Systems Survey (Assessing prior knowledge)

- 1) Circle whether each of the following statements is True or False.
- a) True or False All electricity production has an impact on the environment.
 - b) True or False To date, all commercial nuclear power plants use energy from fission to produce electricity.
 - c) True or False The way in which electricity is delivered to our homes depends upon the fuel used to make it.
 - d) True or False Electricity production systems have a few common components.
 - e) True or False Where you live determines how your electricity is produced.
 - f) True or False In Pennsylvania, consumers choose their own electricity supplier.
 - g) True or False Using coal to produce electricity is a sustainable process.
 - h) True or False Some non-renewable resources can take a million years to be created.
 - i) True or False The choices and decisions made by consumers have no impact on how electricity is produced.

Please note any other questions or interests you have about electricity production below.





Part 2 (Electricity Production Systems)

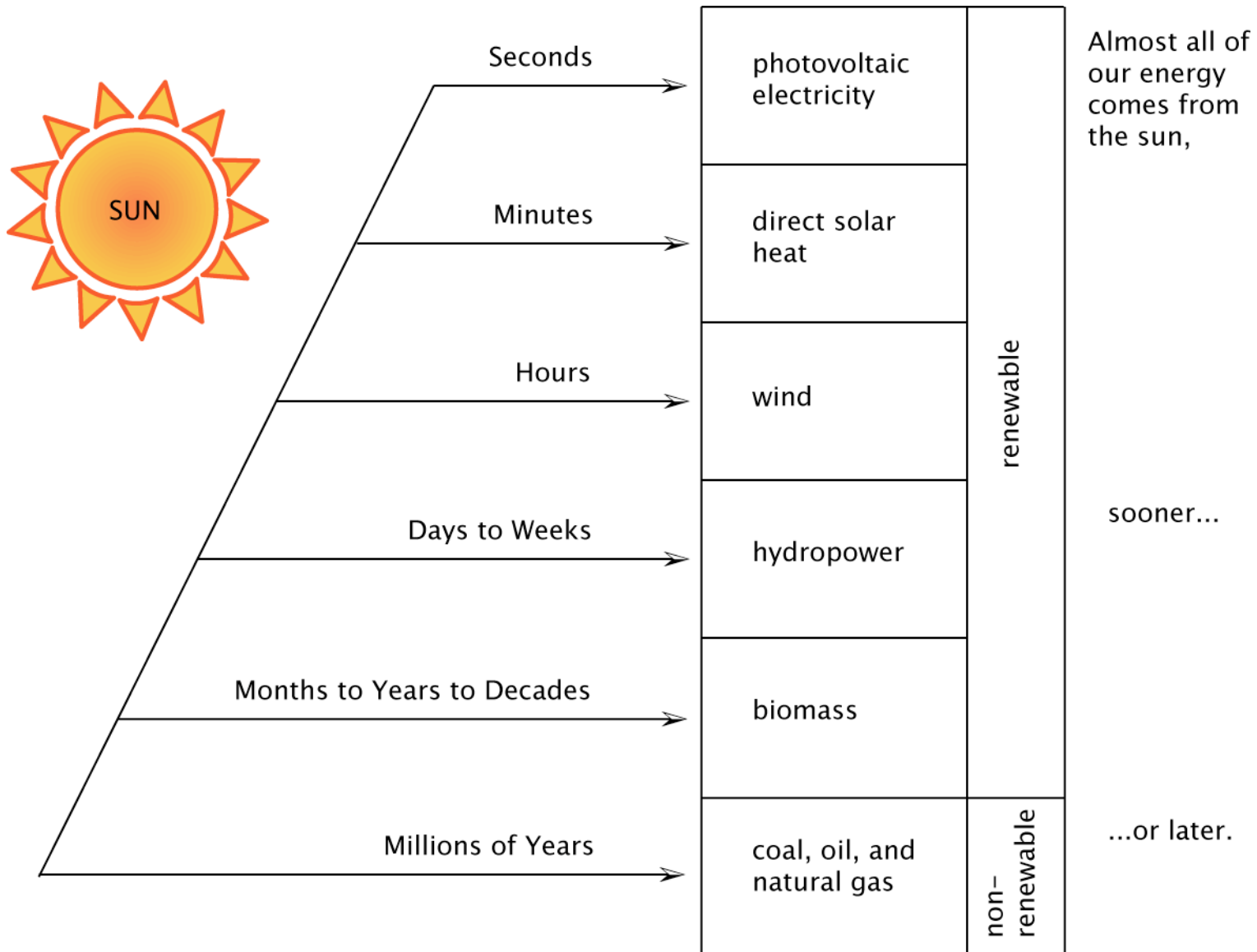
1) For each resource, check off which components are being used in the production of electricity.

Electricity Production Component	Electricity Production Resource			
	Coal 	Nuclear 	Hydroelectric 	Wind 
Boiler				
Reactor				
Reservoir				
Stack				
Steam generator				
Pennstock				
Rotor blades				
Turbine				
Gearbox				
Condenser				
Generator				
Transformer				
Cooling water condenser				
Cooling tower				
Transmission lines				

Additional Notes:

2) List the pros and cons for each form of electricity production, be sure to include whether they are renewable or nonrenewable. Use the chart provided below to record your answers.

	Electricity Production Resource			
	Coal 	Nuclear 	Hydroelectric 	Wind 
Environmental Implications				
pros				
cons				



Adapted from http://www.ase.org/uploaded_files/educatorlessonplans/fossil.pdf by E. Diefendorf

Part 3: The Environmental, Economic, Social Products of Electricity Production

Overview

In this section, you will work with a team to think deeply about producing electricity. You will need to think about how making electricity affects the natural world (ENVIRONMENTAL), how money cycles through your community (ECONOMIC), and what role electricity plays for your community (SOCIAL). Please work with your team to answer the following questions and be prepared to share your ideas with the rest of the class.

[Hint: You may want to make some visuals if you think it might be helpful for you to explain or for others to understand.]

1) Analyzing Environmental Products

- a) Think back to Part 2...What are some environmental products of producing electricity?

Choose two (2) of the environmental products you named and describe the reason why they may be good or bad for the environment. If you more information, take a peek at the Powerscorecard website: <http://www.powerscorecard.org/issues.cfm>.

- b)

2) It's time to think a little bit about **economics**. Brainstorm some ideas about how you think producing electricity might affect the way that money cycles in your community.

<p><u>Brainstorming Area</u></p>

Additional Resources: Energy Glossaries

For definitions of the following words and more...

Renewable resource
Nonrenewable resource
Electricity
Coal
Nuclear
Hydroelectric
Wind
Environmental
Social
Economic

...take a look at the links below.

Energy Glossary

http://www.eia.doe.gov/glossary/glossary_main_page.htm

Source: Department of Energy

Solar Glossary

http://www.eere.energy.gov/solar/solar_glossary.html

Source: Department of Energy

Wind Glossary

<http://www.otherpower.com/glossary.html>

Source: ForceField, a small business in Colorado