

Alternative Sources of Energy

Unit Description and Rational:

This is a unit designed using Understanding by Design, an approach developed by Wiggins and McTighe (AIM, 2005). The format follows a two page template designed by McTighe (McTighe). It is intended for implementation in a middle school science classroom when studying alternative energy sources. The unit is expected to take approximately two to three weeks and is geared to educate students about fossil fuels, the need for alternative sources of energy, the need for conservation, and global warming. Some activities are in preparation for the installation of solar panels on the school's roof. Students will develop an understanding of these topics through lab activities, videos, current events, web quests and research.

According to the *Benchmarks for Science Literacy* (AAAS, 1993), students between grades 3 and 5 should develop an understanding of the formation of fossil fuels, the fact that they cannot easily be replenished and that they need to be conserved by reducing the amount of electricity and other fuels we consume. Between grades 6 and 8, students should investigate energy transformations through experimentation with devices such as photovoltaic cells. At this age they should be able to understand that energy can be produced using a variety of methods and sources including solar energy. Some of these sources or methods have a greater impact on the environment than others and can be better utilized in some locations. Early in their education, students can appreciate the fact that all organisms, including humans, alter the environment in which they live.

What do students typically misunderstand about global warming, the greenhouse effect, and fossil fuels?

Teachers need to be aware of student misconceptions in order to develop methods and activities to help students replace their original incorrect ideas with the correct explanation. One method of uncovering these misconceptions is to directly question one's students using open-ended questions about the topic, so students will have to explain what they understand. Another

option is to research misconceptions about the topic that others have already identified. Student activities and learning experiences should be developed from these misconceptions.

Compared with other areas of science, little research has been done to identify student misconceptions in environmental science (Stamp, 2007). There are numerous misconceptions identified regarding the greenhouse effect and global warming. I have observed that students do not understand that the greenhouse effect is a naturally occurring process and is not caused solely by pollution. They think that all air pollution causes the greenhouse effect and that the hole in the ozone layer is causing the planet to warm. It has also been documented that students think that the earth is warming because of “solar radiation passing through holes in the ozone layer (Dove, 1996)” and that increased holes in the ozone layer will increase global warming. It was also observed that students picture the greenhouse effect as a barrier that surrounds the Earth and that the greenhouse effect causes skin cancer (Dove, 1996). This idea that global warming increases the risk of skin cancer was also identified by Boyes, Chickran, and Stanisstreet (1993) as well as the notion that acid rain exacerbates the greenhouse effect. Elementary students have been found to believe that heat from car exhaust causes global warming (Stanisstreet and Boyes, 1997)

Misconceptions about the “configuration or distribution of petroleum reservoirs, gasoline manufacture and storage, the origin of petroleum, the importance of petroleum in our society, petroleum prospecting and recovery; and the nature of coal and natural gas” (Rule, 2005). Rule found that there was a general lack of knowledge regarding fossil fuels and that some students thought that petroleum comes from whale blubber. Students were unaware of all of the uses for petroleum products and were most familiar with its use as a lubricant (Rule, 2005).

Pennsylvania State Standards:

3.8. Science Technology and Human Endeavors

10. A. Analyze the relationship between societal demands and scientific and technological enterprises.

- Assess the social impacts of a specific international environmental problem by designing a solution that applies the appropriate technologies and resources.
- Identify past and current tradeoffs between increased production, environmental harm and social values (e.g., increased energy needs, power plants, automobiles).

4.2. Renewable and Nonrenewable Resources

7.A. Know that raw materials come from natural resources

- Identify types of minerals and fossil fuels used by humans.

7.B. Examine the renewability of resources.

- Identify the waste derived from the use of renewable and nonrenewable resources.
- Determine how consumption may impact the availability of resources.
- Compare the time spans of renewability for fossil fuels and alternative fuels.

10. A. Explain that renewable and nonrenewable resources supply energy and materials.

- Explain that renewable and nonrenewable resources supply energy and materials.
- Identify alternative sources of energy.
- Identify and compare fuels used in industrial and agricultural societies.

4.3 Environmental Health

A. Identify how human actions affect environmental health.

- Identify pollutants.
- Identify sources of pollution.
- Describe how people can reduce pollution.

4.6 Ecosystems and Their Interactions

C. Explain how ecosystems change over time.

- Explain how ecosystems change.
- Explain a change in an ecosystem that relates to humans.

Stage 1: Identifying Desired Results:

Unit Enduring Understandings:

1. Organisms depend on their environment for resources they need to survive. These organisms interact with their environment and as a result cause changes, which can be beneficial or detrimental to themselves and other living organisms.

2. Renewable and nonrenewable resources depend on the both the process and the time needed to create energy sources. Nonrenewable and many renewable resources are being consumed at far faster rates than their geological or biological formation rates (Partnership for Student Success in Science, 2007).
3. There are alternative sources of energy that can be used to produce energy, reduce dependence on fossil fuels and reduce the amount of carbon dioxide and other pollutants that are released into the atmosphere, slowing the process of global warming.

Unit Essential Questions:

1. What is the difference between renewable and nonrenewable resources?
2. Where do fossil fuels come from?
3. Where does our electricity come from?
4. What is the greenhouse effect?
5. What is global warming and what causes it?
6. What are the benefits of energy conservation?
7. What are alternative sources of energy?

What students will need to know and be able to do (knowledge and skills):

1. Explain the difference between renewable and nonrenewable resources and give examples of each.
2. Explain how a renewable resource could be used up or become scarce.
3. Explain how fossil fuels such as coal form.
4. Discuss problems associated with our dependence on fossil fuels (environmental, social, political, etc).
5. Explain why fossil fuels are considered a nonrenewable resource if they form naturally.
6. The greenhouse effect is a naturally occurring process that is necessary for life on Earth.
7. Define greenhouse gases and give some examples of greenhouse gases and their sources.
8. Explain how conservation can slow the process of global warming.
9. Describe the effects of global warming – known and predicted.
10. Describe ways to conserve energy and identify devices or practices that waste energy.

11. Give examples of alternative sources of energy and describe how they produce electricity.
12. Describe under what conditions a photovoltaic cell functions best.

Stage 2: Assessment Evidence

Performance Task 1: The Story of Coal

Goal: The goal of the performance is for students to communicate the “story” of the formation of coal.

Role: The students are authors of a children's book, comic strip, producers of a video, or some other method of illustrating the formation of coal.

Audience: Children ages 7-10

Situation: The students will be given the following instructions:

You have been commissioned by a science textbook company to create a resource for children that explains the formation of coal deposits in Pennsylvania. You are allowed to write it as an adventure, a straightforward non-fiction book, or any other method you think of to convey the “story”. You can check in with your "editor" from time to time to see if you're on the right track.

Product: An illustrated children's book, comic strip, video, etc.

Standards:

- A. Required Elements: An accurate description of the formation of coal, including:
 - conditions that existed that created the raw materials
 - what it was formed from (not dinosaurs)
 - geologic processes that created it
 - how it is extracted
 - what it is used for
 - how much is used
 - how coal extraction and uses can be detrimental to the environment
- B. Writing Mechanics: Your writing should be clear with correct grammar, punctuation, and spelling.

- C. Creative Elements: The children's story should be creative, neat, well planned, colorful, and appealing to children.
- D. Use of Class Time and Cooperation: You will be given class time to work on this project with a partner(s), be sure to use it effectively. It is not time for socializing, working on other assignments, or napping-use your time to work as a group!

Helpful websites about coal:

<http://lsa.colorado.edu/summarystreet/texts/coal.htm>

<http://kids.rrc.state.tx.us/school/classroom/coal/coalfrom.html>

Performance Task 2: Alternative Energy Sources Displays and Presentations

Goal: Create a display about an alternative energy source that will be set up in the school lobby to provide visitors and community members about alternatives to fossil fuels and present it to the class.

Role: The students will become “experts” in a form of alternative energy.

Audience: Fellow students, members of the community, and visitors to the school district

Situation: The district will be putting its solar panels on-line and these displays will be placed in the lobby where the meter showing electricity production from the solar panels will be located.

Product: Tri-fold display board about their energy source.

Standards: The boards will be graded for:

- accuracy of information
- use of visuals
- description of energy production
- neatness
- clarity
- organization
- Students will also be assessed on presentations and cooperation.

Performance Task 3: Investigating Photovoltaic Cells

Goal: Determine the optimal conditions for the functioning of photovoltaic cells.

Role: The students will be given the job of determining the best conditions for the placement and function of the photovoltaic cells that will be placed on the roof of the school. They will have to

determine the effect of angle of incidence, light intensity, wavelength of light, temperature, etc. on the electricity production of photovoltaic cells. They will be divided into research teams and each team will investigate a different variable.

Audience: Each group will write a formal lab report to communicate their findings to the company that is going to install the panels.

Situation: The students will be told that there are questions about the placement of the panels and that some people think that a mistake could have been made. It is their job to determine the optimal conditions for photovoltaic cell functioning.

Product: Formal lab report.

Standards: The lab reports will be graded for

- Clear statement of the problem being investigated
- Clear statement of the hypothesis
- Complete materials list
- Detailed procedure with evidence of a control
- Accurate display of results including a data table and graph
- Accurate discussion of results, including possible sources of error, and what the results mean

Stage 3: Learning Plan

1. Modeling the Greenhouse Effect in a Bottle

- Students will model the greenhouse effect by measuring temperature change in a bottle of air and in a bottle filled with carbon dioxide when it is exposed to light.

2. Alternative Energy Webquest

- Students will go to various websites that include information and activities that deal with various alternative sources of energy. These websites include:
 - An introduction to electricity production that includes information about energy production in the United States and how hydroelectric power plants, nuclear power plants, and coal and gas power plants produce electricity.

http://www.southernco.com/learningpower/powerinfo_1.asp

<http://www.southerncompany.com/learningpower/howplants.asp>

- Crash Course in Wind Energy: This is an interactive activity that explains how wind is used to produce electricity using a wind turbine.

<http://www.windpower.org/en/kids/intro/index.htm>

- Sunsite Funsite: This interactive website introduces students to solar energy, including how the Sun's energy is produced, how it travels to Earth, and how it can be utilized on Earth including photosynthesis, solar thermal energy and photovoltaics.

<http://www.tucsonelectric.com/Community/EducationalServices/solar/frameset.htm>

3. How Much Energy Do You Use?

- Students will investigate how much energy their family uses by surveying the appliances in their house and how often they are used.
- Survey can be found at:

http://www.ase.org/uploaded_files/educatorlessonplans/howmuch.pdf

4. Energy Hogs Game

- Students play the game to find appliances, conditions, behaviors, etc in a home that waste energy.
- Game can be found at: <http://www.energyhog.org/childrens.htm>

5. Investigating Lightbulbs

- One easy way to conserve energy is to use compact fluorescent lightbulbs (CFLs) instead of traditional incandescent bulbs. In this activity students investigate why the CFLs conserve energy compared to a traditional bulb.
- The activity can be found at:

<http://www.learningtogive.org/lessons/unit384/lesson2.html> (see attachment 1)

6. *An Inconvenient Truth* – Students will watch segments of the video to develop an understanding of the relationship between carbon dioxide levels and global temperatures as well as sources of these emissions, the changes that global warming is causing as well as what it may do in the future.

7. Modeling the Photoelectric Effect in Photovoltaic Cells

- Students will act out the photoelectric effect as it occurs in a photovoltaic cell.

- The activity can be found at:

http://www.powernaturally.org/Programs/pdfs_docs/29_Photocells_II.pdf

8. Socratic Seminar – “Greenmark” by Robb Mandelbaum from *Discover* June 2004

- This article describes what residents on the Danish island of Samsø have done to give up fossil fuels by 2008, by using renewable energy sources such as solar energy, wind energy, biological gases and wood.

- Students will read the article “Greenmark” and discuss the pros and cons of what was done and if it could be accomplished in the United States. They will then write a brief summary of the class discussion and explain whether or not they think that a similar change could be implemented in our school district.

- Electronic version can be found at

<http://discovermagazine.com/2004/jun/greenmark/?searchterm=greenmark>

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