Computer-Based Energy Projects (Four Activities)

Grades: 5-8, 9-12

Topic: Energy Basics

Owner: National Renewable Energy Laboratory

This educational material is brought to you by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy.

Computer-Based Energy Projects

For the Teacher

Although these are science fair projects, all three are easily adaptable to the regular classroom, provided you have computer access. If possible, it would be optimal to team-teach with the computer science teacher at your school as part of a unit on renewable energy. Students can work in groups for any of these projects. In fact, for class work groups would be preferable. When working in groups, it may be more effective to assign different aspects of the project (to be turned in) to each member of the group.

Project 1: This project lends itself well to a renewable energy unit. While learning about what these energy sources are, students can gain an understanding of their availability throughout the country and, more importantly, which renewable resources can be harnessed in their area. This can also correlate to an analysis of locations in the country where renewables are already being used. The ultimate message for students might be that we have a vast and virtually untapped resource that would provide clean power. This lesson is highly relevant across the curriculum, particularly in today's political climate due to our country's reliance on foreign oil.

Project 2: With the recent advances in transportation technology, a project that incorporates an investigation of hybrid vehicles is useful for informing students about the latest discoveries and will likely be in line with student interests. This project also continues the theme from project three: energy use. Students will gain a valuable understanding of the magnitude of fossil fuel use and how it can be decreased, even *without* buying new technology cars.

Project 3: No unit on energy use and renewable resources is complete without an analysis of the distribution of energy consumption around the world. The best way to adapt this project would be to have one class period of data compilation (from the included Web sites), and another of discussion.

Project 4: Computer modeling need not be confined to the realm of engineers and programmers. NREL has developed a modeling program, HOMER, which can be simplified enough so that even middle school students can use it. HOMER models renewable, hybrid, or stand-alone systems to allow the user to construct the most economically feasible power system. The Web site where HOMER can be downloaded also provides tutorials that could be used in the middle school classroom. For high school students, a project in which they model their own homes powered by renewable energy resources would send a very important message about the feasibility (depending on what resources are available in your area) of employing renewable power in small-scale, domestic situations.

National Science Education Standards by the National Academy of Sciences

Science Content Standards: 9-12

Science As Inquiry

– **Content Standard A**:

"Abilities necessary to do scientific inquiry"

"Understanding about scientific inquiry"

Physical Science

- Content Standard B:

"Conservation of energy and increase in disorder"

"Interactions of energy and matter"

Earth and Space Science

- Content Standard D:

"Geochemical cycles"

Science and Technology

- Content Standard E:

"Abilities of technological design"

"Understandings about science and technology"

Science in Personal and Social Perspectives

- Content Standard F:

"Population growth"

"Natural resources"

"Environmental quality"

"Natural and human-induced hazards"

"Science and technology in local, national, and global changes"

Science Content Standards 5-8

Science as Inquiry

- Content Standard A:

"Abilities necessary to do scientific inquiry"

"Understanding about scientific inquiry"

Physical Science

- Content Standard B:

"Transfer of energy"

Science and Technology

- Content Standard E:

"Abilities of technological design"

"Understandings about science and technology"

Science in Personal and Social Perspectives

- Content Standard F:

"Populations, resources and environments"

"Natural hazards"

"Risks and benefits"

"Science and technology in society"

Technology Description

In a society where an increasing amount of our information comes from the Internet, students (and teachers) need more exposure to using the Internet as a research and learning tool. Also, as we become more technology-dependent we need to provide computer-based learning for students so that they may be better prepared for their academic life and beyond. Finally, renewable energy technology is evolving at a pace that could bring it into common households within the lifetime of our students. This set of projects seeks to combine technology-based learning with the study of renewable energy. Our goal is to provide a learning experience in which students gain a deeper understanding of energy use and renewable energy availability, as well as an appreciation for the feasibility of renewable energy in our society.

References

P. Gilman, T. Lambert, P. Lilienthal; HOMER: The Optimization Model for Distributed Power, July 2003. [Online]. Available http://www.nrel.gov/homer/

RETScreen International, July 2003. [Online] Available http://www.retscreen.net

Carleton College, "Using Data in the Classroom: Community and Educational Issues," July 2003. [Online] Available http://serc.carleton.edu/research_education/usingdata/index.html

Project Ideas

1 Where are the best renewable and non-renewable energy resources in the US? In the World?

Learning Objective: Students will become familiar with using the Internet as a research tool. Students will learn the best locations for each of the renewable resources.

Controls and Variables: None

Materials and Equipment:
Computer with Internet access
Poster-making supplies

Safety and Environmental Requirements: None

Suggestions:

- Create a map showing the locations of the three best energy resources in a region. The map can be on the scale of county, state, country, continent or world.
- Create a series of maps showing the distribution of several energy resources in a region, with one energy resource depicted in each map.
- If you could power an entire region solely on renewable energy, how would you distribute wind farms, geothermal plants, hydroelectric power, biomass and solar utilities across the region? Create a map showing your plan.

Resources:

1. http://rredc.nrel.gov/solar/
2. http://www.eia.doe.gov/
3. http://serc.carleton.edu/research_education/usingdata/index.html
4. http://www.wattsun.com/resources.html
5. http://waterdata.usgs.gov/nwis/rt
6. http://www.ussdams.org/
7. http://energy.er.usgs.gov/products/databases/USCoal/index.htm
8. http://www.epa.gov/enviro/html/em/index.html
9. Biomass Resource Information Clearinghouse (see www.nrel.gov) Hint: Use information about US Agriculture production to map the location of the best biomass resources.

2 How much energy do we consume while driving?

Learning Objective:

Students will learn about how much energy we consume for transportation.

Students will analyze which technological advancements can help reduce energy consumption.

Controls and Variables: none

Materials and Equipment:
Computer with Internet access
Poster-making supplies

Safety and Environmental Requirements: None

Suggestions:

- Analyze the performance of four cars from an environmental perspective. Create a poster that compares the following features for four different cars: miles per gallon, annual fuel expense, greenhouse gas emissions, nitrogen and sulfur emissions, and other features that affect fuel economy and pollution.
- Considering our current oil consumption, how much could we decrease consumption by if everyone drove hybrid-electric cars? How could we further reduce oil through public transportation and carpooling? Show this information on another poster.

Resources:

1. http://www.fueleconomy.gov/
2. http://www.epa.gov/autoemissions/
3. http://www.glencoe.com/sec/science/webquest/content/altfuels.shtml
4. http://www.glencoe.com/sec/science/webquest/content/hybrid.shtml
5. http://www.eere.energy.gov/afdc/

3 How much energy do we use?

Learning Objective:

Students will understand how energy is used.

Students will understand their own contribution to energy use.

Students will learn about energy-saving technologies.

Controls and Variables: None

Materials and Equipment:
Computer with Internet access
Poster-making supplies

Safety and Environmental Requirements: None

Suggestions:

- Create a series of maps showing energy usage in a region (county, state, country, etc). Indicate what sector (domestic, industrial, agricultural) uses what fraction of energy in the area you are mapping. How can this region reduce its energy use?
- For a more advanced project, compare energy usage between three regions, indicating the distribution of energy use as described above.
- Most advanced: compare resource availability (fossil fuels, agriculture, renewable energy, if used in that region) in the region with that region's energy use. Refer to project number one in this chapter for additional Web sites to use in your research.
- Discuss orally or in writing: Why do some countries use more energy per capita than others? How could these countries decrease their energy consumption?

Resources

1. http://eia.doe.gov/mer/contents.html

2. http://www.eia.doe.gov/emeu/consumption/

4 Are renewable energy resources economically feasible on a small scale?

Learning Objective:

Students will learn how to use a computer program which models small-scale renewable energy system.

Students will analyze the costs associated with powering their own home from renewable sources.

Controls and Variables:

Control: Current energy usage and cost

Variable: Energy-saving practices, costs associated with renewables, availability of renewable resources, metering options

Materials and Equipment: Computer with Internet access and HOMER version 2.0 (or higher) installed on the hard drive. (HOMER can be obtained from the following Web site. Be sure to download version 2.0 or higher.

http://www.nrel.gov/homer/)

Safety and Environmental Requirements: None

Suggestions:

- Use the computer program HOMER to answer the following questions.
- How much money would you save if your house, which is connected to the utility grid, had renewable power sources as well?
- If you had to choose between connecting your house to the grid or using only renewables, which would be cheaper?
- Use the additional suggestions below to gather all of the necessary data for your project.
- Call your local utility company to find out about net metering options and the sellback pricing of domestic watts produced.
- Go through the HOMER tutorials before attempting to set up this project. Tutorials can be accessed on the HOMER website. (http://www.nrel.gov/homer/).
- Download resource data files from the HOMER Web site. Contact NREL with any questions about HOMER.

OPTIONAL: Use RETScreen software for your simulations. The site listed contains a training manual. (http://www.retscreen.net/ang/menu.php)

Compare the results from HOMER with the results you obtained from RETScreen.