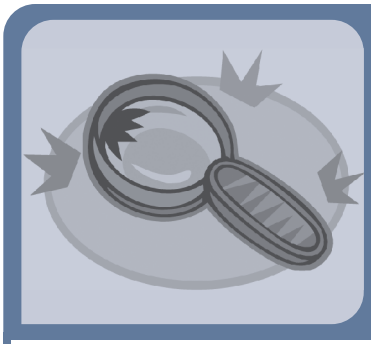

Comprehensive Theme Activity: Energy Investigations

Students investigate and develop a report on an effect of energy resource development, use, or both. The investigation and the report can be used as the performance standard for the theme Effects of Energy Resource Development.

This project can be assigned at the beginning, middle, or end of a unit related to effects of energy development and use. This project can also be the energy unit, where the investigation process is used by students to teach themselves and the class about energy-related issues. Students can be given class time to conduct research or be expected to do this on their own. In addition, students can gain knowledge and skills about effects of energy use and development through participating in class activities such as those found in other KEEP activities.

Grade Level: (5–8) 9–12

Subject Areas: Agriculture Education, Art, English Language Arts, Family and Consumer Science, Health, Mathematics, Science, Social Studies, Technology Education

Setting: Classroom, library and community

Objectives

Students will be able to

- analyze a problem or issue related to how energy development and use affects human societies and the environment; and
- develop a report that clearly and accurately presents the results of their analysis.

Rationale

Investigating an energy-related problem or issue will help students examine current energy-use practices and evaluate how they affect the quality of life.

Materials

- News reports or video recordings of energy related stories (see **Orientation**)
- Paper, writing utensils, computer/Internet and other items students need to conduct investigation
- Copies of the following:
  - ***Investigation Planning Form***
  - ***Responsibilities for the Investigation***
  - ***Directions*** (for each group member's responsibilities)
  - ***Research Question Rules***
  - ***Value Descriptors***
  - ***Investigation Report Form***
  - ***Evaluation Criteria***
  - ***Investigation Ideas for Theme III*** (optional)
- Find additional resources related to this activity on keepprogram.org > Curriculum & Resources

Time:

The time frame depends on when and how the project is implemented. The following is a possible timeline for the project.

Week One

Introduce assignment and have students plan their investigation (**Orientation** and **Steps 1–5**).

Weeks Two and Three

Students conduct research (in and out of class) and participate in class activities related to effects of energy use and development. Meet with students to discuss progress reports (**Step 6**).

Week Four

Students prepare and turn in reports (**Closure**).

Background

Most Americans are aware of the benefits that plentiful supplies of energy bring our society. We have superhighways, heating and air conditioning, and electricity to power our appliances. These benefits influence living standards, job availability, and aspects of our political structure. On the other hand, most Americans are aware of many environmental problems in our nation. Concerns such as acid rain, smog, fracking and oil spills are frequently in the news. However, not many Americans relate their energy use to these environmental problems. As much as 90 percent of our pollution can be tied to energy consumption. The purpose of the theme "Effects of Energy Resource Development" is for students to investigate the positive and negative influences energy development and use is having on our lives and on the environment.

A positive effect of energy resource development and use could be the economic benefits students receive by having a parent employed in the energy field. Nuclear waste is an example of a negative effect of energy resource development. Students may want to investigate some aspect of energy use that has both positive and negative attributes (for example, government regulations created to monitor energy-related pollution). The effects can range from the personal level (such as food consumption), to the community or regional level (a leaky fuel storage tank), to state level (transportation and tourism), to the national level (federal regulations), or international level (acid rain).

Household energy consumption is a good place to begin looking at the effects of energy development and use. End use surveys can be used to learn the contribution of energy costs to budget (see the activities "At Watt Rate?" and "The Cost of Using Energy"). These findings may lead to further investigation. For example, students could examine what people are doing to reduce energy costs.

Often, the energy effect that students investigate will involve an issue. An issue occurs when people have differing views about something. These issues dispute both positive and negative effects of energy use.

Chances are, no matter what the situation, some people will like it and others will not. Peoples' views are influenced by their differing beliefs and values. Beliefs are what people think is true. Values are the importance a person (or a group) puts on something (see ***Value Descriptors***).

People's values are developed throughout their lifetimes and are influenced by a variety of factors including their culture and environment. In Wisconsin, differing values often clash over dam building, power plant or transmission line siting, and road location. Directly or indirectly, all these issues involve energy.

Procedure

Orientation

Several weeks prior to this activity, if possible, have students collect news stories related to an effect of energy resource development. Students can use a portfolio system, such as the "Energy Learning Log" in the Appendix, to organize the news into categories (e.g. local, regional, state, national, or international; which energy resource is being used; the end use of energy; and so forth).

Ask students to watch or read one or more news reports or presentations about an effect of energy use or development. Discuss why these forms of communication are effective. Mention the importance of being informed and being able to appreciate the ways that human emotion and values contribute to headline news. Have students identify the components and style of the news stories. For example, how did the reporters keep the viewers' or readers' attention? Did they tell a story or present a series of facts? Was there any mystery involved? Did they present the viewpoints of different people?

Tell students that they are going to become investigative reporters. Their mission is to seek out news related to energy development and use and to analyze how human lives, the environment, or both have been affected by energy.

Steps

1. ***Divide the class into cooperative working groups of three or four.*** See **Step 4** for information about student responsibilities. NOTE: The procedure is written for students working in groups; however, it can be adapted for a whole class or an individual project.

2. ***Outline the components of the project and discuss evaluation criteria.*** Hand out copies of and discuss the ***Investigation Planning Form***. Provide copies of and discuss the ***Evaluation Criteria*** for the project. Adapt the criteria based on the expectations of the project as needed.

3. ***Have students decide on an energy effect to***

investigate (energy effect = effect of energy development, use, or both). Students who have been keeping ***Energy Learning Logs*** of energy-related news can use these as a source for investigation ideas. ***Investigation Ideas for Theme III*** also provides students with a variety of topics. If students have several ideas and need to select just one, have students prioritize their ideas based on interest, urgency, and challenge level. Another thing to consider is whether the appealing energy effect is an issue (an issue is an effect of energy development or use about which people have differing viewpoints). Issues might be more interesting to investigate because it involves analyzing and understanding different perspectives.

Other approaches for identifying energy effects to investigate include the following:

- Use the results of an end use survey to generate ideas of energy effects to investigate (see the activities "At Watt Rate?" and "The Cost of Using Energy").
- Conduct a brainstorming session where students recall energy effects they have heard of, seen, or read about (students may be familiar with some of these energy effects if they have participated in relevant activities from this Activity Guide).
- Tell students to survey their peers or community members and ask them to state energy effects that interest or concern them.
- Assign students energy effects to investigate.

You may require students to conduct an issue analysis rather than a simple investigation. Examining an issue involves exploring diverse viewpoints, identifying problems, and drawing conclusions. These actions require higher level thinking skills, such as critical analysis and decision making. Issue analysis empowers students to be active learners, allowing them to become directly involved in the real world. However, if you or your students are hesitant to deal with the strong values that may accompany an issue, then reporting on an energy effect is a good alternative.

4. ***Identify and discuss responsibilities for the investigation.*** When students have chosen their energy effect, they should decide how they can learn more about their selection. Provide them with copies of the ***Responsibilities for the Investigation*** and the accompanying ***Directions***.

   Make sure students understand the difference between primary and secondary data. Primary data is information obtained from first hand sources, such as when students collect the information themselves by conducting inventories, taking surveys, and recording their own observations. Secondary data is information that has been obtained by someone else and presented in a book, magazine, map, or some other resource.

   Each group leader should also receive a copy of the ***Research Question Rules*** and the ***Value Descriptors*** handouts if the group is investigating an issue. It may be helpful to lead a discussion about considering and respecting differing values. Direct students to be observers and not judges.

5. ***Complete the Investigation Planning Form.*** After students complete their ***Investigation Planning Form***, arrange meetings with each group to discuss its plans and strategies. Students will add to and revise this form as they become more knowledgeable about the effect. Although it is important for them to review information from other researchers (secondary data), encourage students to develop strategies to collect data from primary sources.

6. ***Conduct the investigations.*** Chances are students will spend much time outside of class conducting the investigation. Students can also be provided with lessons and activities related to their investigations. In-class time is valuable to monitor students' progress and help with troubleshooting.

Closure

Have students use the ***Investigation Report Form*** to show the results of their investigation and analysis. You may wish to have students develop a more creative report. For example, they can pretend they are submitting an article for a popular news magazine. Students can also prepare a presentation and share their results with each other or with the public. For example, the media or utility representatives can be invited to view presentations.

Assessment

Formative

- Did students work together cooperatively in groups?
- Do they know a variety of effects related to energy development and use?
- Did they use practical decision-making strategies to select an effect or issue?
- Was information in the report/presentation

presented clearly and accurately?

Summative

- See ***Evaluation Criteria*** for investigating and reporting on an effect of energy resource development and use.
- Groups can evaluate the cooperation and responsibility of members.

Credits

Value Descriptors (p. 34) and ***Research Question Rules*** (p. 60) from Hungerford, Harold R., Ralph A. Litherland, R. Ben Peyton, John M. Ramsey, and Trudi L. Volk. in *Investigating and Evaluating Environmental Issues and Actions: Skill Development Program.* Champaign, Ill.: Stipes Publishing L.L.C., 1996. Used by permission. All rights reserved.

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Energy Learning Log

Energy Learning Logs are similar to portfolios and are used for projects within the performance standard activities. Use an Energy Learning Log throughout the entire developmental process of students' learning about energy. An Energy Learning Log can be of any type, such as an accordion folder, a spiral or loose-leaf notebook, etc. Invite students to personalize the outside of their logs with drawn or cut-and-pasted illustrations relating to energy.

Energy Learning Logs Can Be Used...

...as a Vehicle for Pre-assessment

Prior to any instruction on energy, invite students to write about energy for 15 minutes or so. Emphasize that this is not a formal writing task. They should write down anything that comes to mind, keeping their pen or pencil to the paper at all times. If their mind is blank, suggest they write the word energy over and over again until they think of something related to energy, or they can write about why they can't think of anything related to energy. After students are done writing, ask them to summarize what they wrote by writing down three statements that they think they know about energy, and three questions that they have about energy. These questions can be discussed as a class, shared with the teacher on an individual basis, or kept private. At the end of the energy unit, have students revisit these questions and statements and answer or rewrite them as needed.

...to Help Organize and Plan a Project

After students have been introduced to the purpose of a project, encourage them to use the Energy Learning Log as a planning and organizing tool. They can outline their objectives and identify what they need to acquire. The log can be used to collect background information and reference materials such as journal articles and interview results. This is one reason why a large three-ring binder or accordion folder serves as a good log.

The system students use to organize the information they collect provides insights into their thought processes. Have students construct outlines or concept maps that diagram their arrangements. This allows you a good opportunity to evaluate their work in progress. Assist them by identifying new categories or suggesting ways they can narrow their scope.

...as a Reflective Tool and to Monitor Progress

Use the Energy Learning Log to link different energy concepts students have learned. When students are learning new concepts, encourage them to refer to previous information.

Allow time at the end of each energy education activity for students to summarize and interpret what they experienced. They should view these writing opportunities as a means to express their personal insights. They are striving to make the energy activity meaningful and to apply it to their own lives. By relating what they have observed in their own words, students will discover gaps that need to be filled, make connections among existing thoughts, and raise questions that require further exploration.

Students may wish to use parts of the log as a diary. They can record their personal reflections, wishes, and frustrations in a special section of the log, in code, or in a separate journal. In some cases, this section will be designated as writing not to be viewed by the teacher.

Energy Learning Log

...to Report and Evaluate Results

An Energy Learning Log can be used to document the results of a project or activity, or it can be the project. Actual samples of student work can be part of the log. Samples include artwork, videos, poetry, draft writings, calculations, and test results. One strategy involves having students use the log to show what they think is their best work. Reflective questions should accompany this presentation. For example, students can be asked to explain why they think this is their best work, what they did to make the project successful, what they would do differently, and how this applies to their overall development as a current and future energy consumer.

If the log itself is graded, one or more of the following criteria can be used: accuracy of content, creativity, originality, evidence of increased knowledge about energy, thorough expression of attitudes toward energy, completeness, etc. It is best to present these criteria to students before they initiate their log work; then they will know what they should achieve. These criteria can be adapted into a rubric evaluation form (see Converting KEEP's Assessment Ideas into Rubrics).

Resources

Barrow, Lloyd. "A Portfolio of Learning." *Science and Children* 31, no. 3 (1993):38-39.

Belanoff, Pat, and Marcia Dickson, editors. *Portfolios: Process and Product*. Portsmouth, N.H.: Boynton/

Cook Publishers, Inc., 1991.

Benjamin, Carol Lea. *Writing for Kids*. New York: T. Y. Crowell, 1985.

Cole, Donna J., Charles W. Ryan, and Fran Kick. *Portfolios across the Curriculum and Beyond*. Thousand Oaks, Calif.: Corwin Press, Inc., 1995.

The Watercourse and Western Regional Environmental Education Council. "Water Log" pp. 19–22 in *Project WET Curriculum and Activity Guide*. Bozeman, Mont.: The Watercourse and the Western Regional Environmental Education Council (WREEC), 1995.

Investigation Planning Form

Group Members' Names	Responsibility

What effect of energy development (or energy use or both) are you going to investigate?

Is this effect an issue? Explain why or why not. (NOTE: It may be recommended or required that you investigate an issue.)

Write the research question(s) that will guide your investigation.

Before you begin your investigation, summarize what you currently know about this effect and indicate if any of this information comes from class activities.

If it is an issue, summarize what you think are the differing viewpoints.

How do you plan to conduct the investigation? (Describe strategies you plan to use, such as library searches, Internet searches, letters to professionals, interviews, and surveys.)

Responsibilities for the Investigation

Purpose

To investigate an effect of energy resource development, use, or both (subsequently shortened to the term energy effect). Investigations entail looking into the history of the energy effect (what contributed to its existence), observing and recording current characteristics of the energy effect, and—for issue analysis—identifying and analyzing how people view the energy effect.

Responsibilities Involved in Completing an Investigation

These are possible jobs related to an investigation. Your group or teacher may have variations to these tasks. One or more students can be responsible for each of the following roles.

Leader: The leader directs the group and makes sure the tasks are completed. Specific responsibilities include development of research questions, interpreting facts and data, drawing conclusions, and preparing the final report. All these responsibilities are accomplished with the assistance of other group members.

Manager: The manager is responsible for organizing the researched information (such as maintaining the Energy Learning Log). The manager works closely with other group members to keep track of what has been and needs to be learned.

Researchers: The researchers help develop the research question(s) and work with the leader and manager to decide what information is needed. They plan strategies for gathering facts and data. They should collect data that is both primary (firsthand) and secondary (obtained from other resources). Depending on the needs of the project, they might conduct inventories, organize environmental monitoring tests, or design questionnaires. They work closely with the leader and manager to interpret the data. They design graphic representations of the results and meet with the manager to decide how to arrange the information.

Directions

Leader of the Investigation

Developing Research Questions

A research question is important because it provides direction and boundaries to your investigation. You may need only one question for your investigation or you may need a few. Limit your questions to five. See ***Research Question Rules*** to help you design your question(s). Before you develop your research question(s), it may be helpful to read a few articles or talk with some experts to gain a basic knowledge of the energy effect.

Special Considerations When Also Conducting an Issue Analysis

Identifying different viewpoints is an important step. Make sure your investigation considers as many viewpoints as possible. See the Value Descriptors handout for lists and descriptions of values.

Drawing Conclusions

The conclusion summarizes what you discovered during the investigation. The conclusion should provide answers or responses to each of the research questions. Try to avoid expressing opinions here; allow the person who reads or hears your report to form his or her own view. In many cases, the data you present will speak for itself. If you analyzed an issue and have any suggestions for resolving the issue, you can describe your recommendations here, but your teacher may instruct you not to include them in the report.

Preparing the Final Report

See Investigation Report Form for contents of the report. The report should be very neat, well-written, organized, and pleasing to the eye. Your teacher may also require a presentation.

Directions

Manager of the Investigation

You need to be able to quickly find what you have learned so you can reference or cite the information. Keeping track of what you know and don't know avoids repetition of tasks and helps guide the project.

Develop a portfolio such as an ***Energy Learning Log*** or a catalog system to record and arrange your notes. There are many approaches to arranging your portfolio. You can have a section for each research question, with each section having subsections such as Background, Methods of Research, Results, and Conclusions. There can also be pages for keeping notes, progress reports, letters, illustrations, charts, and so forth. Eventually, essential information will be organized into a report.

Special Considerations for Issue Analysis

If you are analyzing an issue, the researchers will be collecting information about people's viewpoints. You may want to develop a classification system for categorizing the different viewpoints (see table below). Narrow the viewpoints to five or less to make the project more manageable (see ***Value Descriptors***).

Person or Group	Viewpoint or Position	Value

Directions

Researchers of the Investigation

The following are several approaches to getting background information on an energy effect or issue. Always keep your research question in mind as you work. Continually ask yourself, Will this information help answer the research question? What else do I need to know to answer the research question?

Class Activities

Your teacher may have you participate in class activities that are relevant to the energy effect or issue you are investigating.

Literature Review (Secondary Data)

You can get background information about the effect from reading printed materials such as encyclopedias, text- books, reference books, magazines, and newspapers. The Internet often has information about energy-related topics. Continually summarize what you read to determine how it applies to what you already know. Remember to stay focused and limit your search to facts and data relevant to your research question. Try to find similarities and common themes among your readings. See if you can identify three to five main points for each article. If you are studying an issue, analyze what you read to see if there is a viewpoint expressed. Use the ***Value Descriptors*** to categorize these viewpoints.

Firsthand Data (Primary Data)

Whether you are investigating an energy effect or analyzing an issue, it is interesting to find out information first hand, especially if you are studying a local effect or issue. Your teacher may have copies of surveys or survey ideas you can use to collect data. Other contacts include the local utility, Focus on Energy, the Wisconsin Office of Energy Innovation, and the Department of Energy. Your teacher may provide a list of other resources.

Research Question Rules

There are several important rules for writing research questions for investigations.

Research questions...

- are always stated in question form.
- avoid simple yes or no responses by beginning with phrases such as “To what extent” and “In what ways.” For example: To what extent are people willing to spend extra money for compact fluorescent light bulbs? In what ways has the vegetation around the student parking lot been affected by automobile air emissions?
- always indicate a population or area. The population refers to a group on which the research question is focused (high school students, power plant employees, snail darters, etc.). The area refers to the geographic area in which the data will be collected (the city of Eagle River, Southeastern Wisconsin, Green Bay West High School, etc.). for this project are always derived from and related to an effect of energy development or use.
- specify the variables to be measured when possible. A variable is a given factor or condition (e.g., number of cars, location, number of people in a car, time, etc.). The following research question specifies the variable to be measured: How many cars traveling through the intersection of Main Street and Michigan Avenue in the city of Stevens Point in Wisconsin have more than one person in them during morning and evening rush hour traffic?
- specify a relationship between two variables if possible. The following question seeks to find the extent that one variable (such as gender) affects or relates to another variable (amount of time spent in the shower): Do male or female high school students spend more time in the shower?
- for this project are important in a social and environmental sense. For example, they contribute to an understanding of how energy resource development and use affects our lives, financial security, culture, government, and environment.

Value Descriptors

The purpose of an issue analysis is to identify values and analyze how they contribute to the issue. There are many reasons people think and feel the way they do. One factor is their personal values. Values are the worth or importance someone attributes to something or someone else.

The descriptors listed below may be helpful as you analyze issues. These statements attempt to name and define values that might be held by individuals. The definitions, as well as the list itself, should not be considered complete. They are simply tools to help you in the complex task of identifying values.

Value	Description: The appreciation of, or focus upon...
Aesthetic	form, composition, and color through human senses.
Economic	the use and exchange of money, materials, and/or services.
Ecological	natural biological systems and principles.
Educational	the accumulation, use, and communication of knowledge.
Egocentric	self-centered needs and fulfillment.
Ethical/Moral	present and future human responsibilities, rights and wrongs, and ethical standards.
Ethnocentric	the fulfillment of ethic/cultural goals.
Health & Safety	the maintenance of positive human physical conditions.
Legal	national, state, or local laws; law enforcement; law suits.
Political	the activities, functions, and policies of governments and their agents.
Recreational	human leisure activities.
Religious	the use of belief systems based on faith or dogma.
Scientific	the process of empirical research; knowledge gained by systematic study.
Social	shared human empathy, feelings, and status.
Technological	the use of technology for human/societal goals.

Investigation Report Form

Group Members' Names	Responsibility

Title of Your Investigation _____

Research Question(s)

Background Information (Attach additional pages as needed. Describe key points based on your literature review and other research strategies.)

If you conducted an issue analysis, complete Table below.

Person or Group	Viewpoint or Position	Value

Methods for Obtaining Firsthand Data (Describe how you obtained data, such as interviews, surveys, opinionnaires, etc.)

Results (Describe what you learned from your firsthand data)

Conclusions

Evaluation Criteria

Investigating and Reporting on an Effect of Energy Resource Development and Use

Investigation and Report Title _____

Group Members' Names	Responsibility

Planning the Investigation				
Topic of investigation is an effect of energy development, use, or both.	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**
The research question(s) provided guidance to the investigation.	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**
Research Process				
Approaches used to collect background information were effective.	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**
Practical strategies were used to collect first-hand data.	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**
A systematic approach was used to organize the researched information.	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**
Final Report				
Background information is well written, thorough, and accurate.	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**
The results of the investigation were clearly written and well organized.	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**
Accurate and logical conclusions that addressed the research questions were made.	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**

Investigation Ideas for Theme III

Lifestyles

Consumption Patterns

There are many ways to analyze how we use energy. One way is to conduct a home energy end use survey to find out how much energy you use. Doing a cost analysis on the results of your survey shows you what your energy practices cost. If you think your family is using energy wisely, find out what promotes this behavior. If you find that your home is wasting energy and money, survey family members to determine what they think about their current practices and what changes they would be willing to make.

Research how people in your community try to reduce their waste production. Observe if energy conservation is one reason why they do this.

Consumer Power

Create a cartoon strip that highlights the adventures of an energy-saving teenager. One of the hero's experiences can involve learning how conscientious shopping contributes to energy conservation. Every product uses energy during its manufacturing process. For example, illustrate how buying a durable product that is more expensive saves more energy than purchasing something that may break easily and has to be replaced.

Rank advertisements based on how well they influence or discourage energy conservation. Develop a chart or scale that shows the results of your ranking and the criteria you used. For example, do the ads promote impulsive shopping? Do they highlight energy-saving efforts such as reduced packaging?

Consumption Trends

Research consumption trends in the United States for major products like automobiles, televisions, home computers, and appliances. Increased consumption of these products typically leads to increased energy consumption. Compare the consumption trends and energy production and consumption of the United States and another location such as Europe, Russia, China, or a developing nation.

Energy and Shopping Costs

Energy plays a role in the production, manufacturing, and sale of everything we buy. Below are some topics to investigate to understand the relationship between shopping costs (consumerism) and energy.

- Compare natural raw materials to artificial materials. Which cost more to produce? Which cost more to dispose of or recycle?
- What kinds of product packaging are cost effective and nonpolluting? What is wrong with the packaging of many products today? Describe how the cost of packaging a product affects the cost of the product.
- There are hidden costs involved in many products. Describe all the costs, including energy, used in producing goods. What tips should consumers consider when purchasing products? What kinds of products and packaging should be avoided? How does the consumption of goods relate to economic issues?

Fueling Our Entertainment

Design a survey related to energy use and entertainment. For example, you can determine the amount of television watched by teenagers in your school. How many of your friends use renewable batteries to power their computer games? What modes of travel do people use when on vacation?

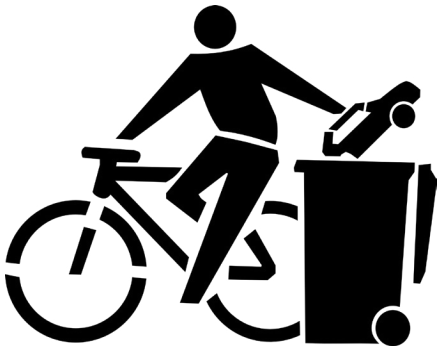
Energy and Transportation

Transportation has played an important role in the economic development of societies. Following are some topics to investigate to learn more about the relationship between energy and transportation.

- Explain how energy is important in the development of new modes of transportation.
- Describe the history of transportation, focusing on how energy relates to the design of new modes of transportation.
- Compare a variety of modes of transportation.
- Describe and contrast methods of traveling that are energy expensive and energy economical.
- What are the costs of gasoline today? What were the costs in the 1960s, 1970s, 1980s, and 1990s? How and why have the prices changed? What was the energy crisis of the 1970s? What impact did this event have on American society?
- Why do car designers consider energy costs when designing new methods of transportation? Explore the idea of energy efficiency in the auto industry.

Traveling to and from School

Does your school have a parking problem? What about traffic congestion on streets near your school? Perhaps you want to learn about the potential for carpooling. There are many different investigations related to transportation. Simple tests, such as setting pieces of paper coated with petroleum jelly around your parking lot, provide insight into potential air pollution. Surveying students about how they get to school lets you know who uses cars, buses, and bicycles.



Energy and Health and Safety

Research ways in which energy development and use positively and negatively affect human health and safety. There are some issues:

- Accidents and exposure associated with mining coal and uranium, drilling for oil and natural gas, building dams to harness hydroelectric power, and harvesting wood and biomass fuels
- Food preservation and nutritional health
- Exposure to air emissions from burning fossil fuels, biomass fuels, and wood
- Accidents related to transporting energy resources such as coal, oil, natural gas, and propane
- Benefits of home heating and cooling
- Safety issues associated with electricity and natural gas use
- Exposure to radiation from nuclear sources
- Advances in medicine, such as Xrays, ultrasound, and use of plastics

Compare and discuss the development and use of energy resources in terms of health and safety.

Energy and the Environment

Air Pollution

Conduct experiments to investigate various air pollutants or their sources. Some common activities are listed below. If you have an air quality monitoring station nearby, learn what tests they conduct.

- Put a white sock on exhaust pipes of different cars and compare emissions by looking at the gray scale of the socks. **Caution: Make sure the car is cooled down before the sock is put on and removed. This activity should be conducted in an open area, and students should not stand near the car when it is running. When finished, place socks in plastic bags and dispose of properly.**
- Compare the density of particulate matter as it comes out of different smokestacks. (Simple scales that classify the concentration of pollutants emitted from smokestacks can be purchased or designed.)
- Collect and compare particulate matter from different locations (such as a parking lot, windowsill, and kitchen counter) using a thin layer of petroleum jelly smeared onto a piece of white cardboard.
- Buy a carbon monoxide detector and test the air inside the school.

Warm Water

Power plants use water from lakes and rivers to remove the excess heat produced when the power plants generate electricity. Research how the warmed water released by power plants affects a lake or river. What does it do to fish and other aquatic life? Could power plants be built near small lakes? How many power plants could one river or lake have next to it? Might the distance between power plants along a river be important?

Oil Spills

Simulate cleaning up an oil spill. First, pour a small amount of oil into a bowl of water. Add rocks to demonstrate oil coating land surfaces. Provide samples of feathers and animal fur to show how oil affects marine life. Then find the most efficient way to contain and remove the oil. Some items that can be used include cotton, eyedroppers, baking soda, kitty litter, and detergent.

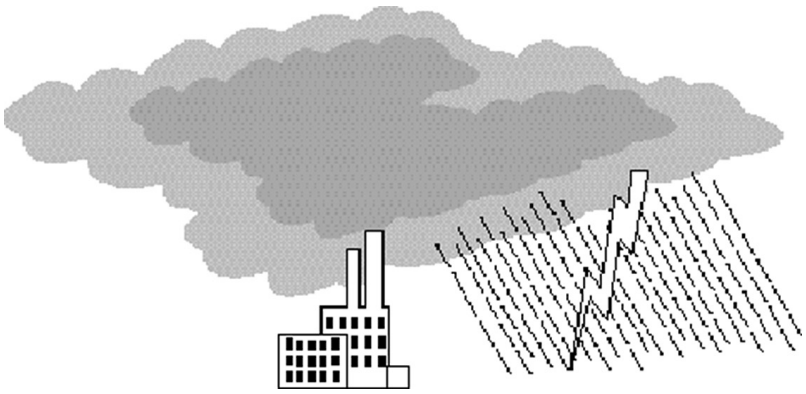
Ozone Detection through Milkweed Bio-Monitoring

Check the ozone in your area by participating in a bio-monitoring project. This type of study involves growing or locating milkweed plants and collecting data about their health. Through careful planting and placement of ozone-sensitive plants such as milkweed, you can determine if unhealthy levels of ozone are present. Look for milkweed plants that are at least 50 feet from the road, and won't be mowed or walked on. Your study site should have at least 30 milkweed plants. (If you don't know what milkweed looks like, use a plant identification book or ask someone who knows.) It is often found in fields, meadows, and along roadsides. A mature

Ozone damaged milkweed leaf

plant is about a foot and a half tall with hairy leaves that are between two and ten inches long. If you pick a leaf from a milkweed plant, you will see a thick white sap ooze from the stem. Ozone damage can be seen by looking at the leaves. Injured leaves will have small dots or lesions, called stipples, on their upper surface. The amount of damage depends on the quantity of ozone in the air and the age and health of the plant. The Wisconsin Department of Natural Resources sponsors a milkweed bio-monitoring project.

Acid Rain



Test the pH of water in your area. Obtain some litmus paper or a pH monitor. Collect rainwater at different times of the year and keep a log of the pH. Contact another school from a different part of the state and have students do a similar study. Compare your results.

Investigate the effect of acid water on plants. Make "acid rain" by adding vinegar or lemon juice to distilled water. Prepare solutions with different pH levels (e.g., 6, 5, 4). Sprout some fast-growing plants, such as alfalfa, and then water different plants with acid water. Make careful observations. Compare the condition of the plants to a control that is watered with plain distilled water.

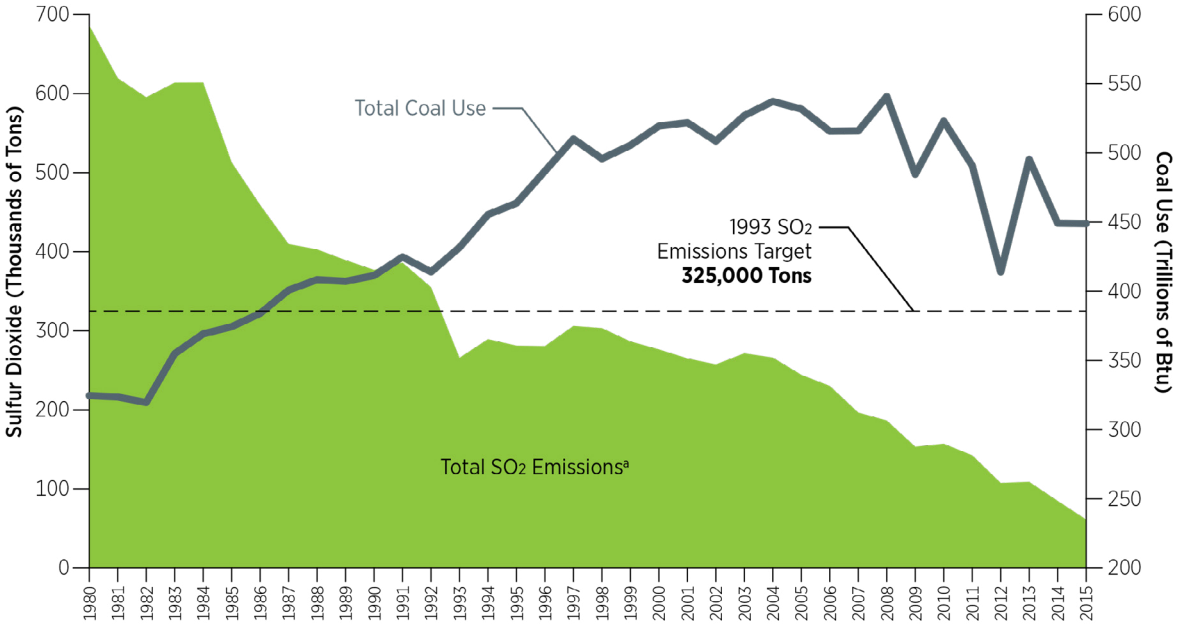
Pollution Regulations I

Find out what Wisconsin is doing to prevent air pollution. Invite a local government agent to discuss Wisconsin laws and policies about air pollution. Ask a representative from a local utility or industry to discuss the methods they use to monitor and control emissions.

Pollution Regulations II

Find out how successfully Wisconsin has reduced air pollution by analyzing changes in sulfur dioxide (SO2) emissions by the state's major electric utilities since 1980. Sulfur dioxide, one of the pollutants associated with the formation of acid rain, is produced by burning fossil fuels, especially coal. In an effort to address the problem of acid rain, the Wisconsin state legislature passed a law (1985 Wisconsin Act 296) in 1985. The law set a goal of 325,000 tons of sulfur dioxide emissions (from major electric utilities and other sources) by 1993. A graph showing Wisconsin coal use and sulfur dioxide emissions from 1980 to 2012 is shown on the next page.

Sulfur Dioxide Emissions and Coal Use 1980-2015 (Thousands of Tons and Trillions of Btu)



Source: Wisconsin Office of Energy Innovation. Wisconsin Energy Statistics Book, 2018.

Questions

1. How many tons of sulfur dioxide were produced in 1980?

2. How many tons of sulfur dioxide were produced in 2015?

3. What is the percent change in sulfur dioxide emissions from 1980 to 2015?

4. Did Wisconsin meet its sulfur dioxide emission goal for 1993? Has it been maintained since then?

5. By how many trillion Btus did coal use change from 1980 to 1993? Did coal use increase after 1993?

6. Comment on how changes in coal deliveries to Wisconsin power plants from different regions of the United States may be related to the decrease in sulfur dioxide emissions. Below is a table showing where Wisconsin got its coal between 1980 and 2010.

Coal Deliveries to Wisconsin (Thousands of Tons)

Region of United States	1980	1990	2000	2010
Eastern	4,056	2,151	969	678
Midwestern	3,842	3,029	221	186
Western	6,617	12,631	20,975	22,400
Total	14,515	17,811	22,165	22,263

Energy and Economics

State Energy Budgets
Wisconsin imports all the fossil fuels it uses. Find out the yearly cost of importing fossil fuels. Does a significant part of the state budget go toward paying for energy? Where exactly does this money go?

Externalities
Should the price of energy include the cost of environmental and health effects? Identify possible environmental and health effects of fossil fuel combustion. Who pays to fix or address these problems?

Sociopolitical Issues

Environmental Justice
"Energy for Everyone." Is this true? Does everyone in your community get the energy they need? What programs does your community have to help low-income residents? Are these programs effective? Interview government agencies to find out what they're doing to help. Talk to people who use these programs to learn what they think.

The History of Hydropower in Wisconsin
Write a creative story about issues related to hydropower in Wisconsin's past. For example, you could investigate how hydropower helped industrialize the state. Another option is to dramatize some of the political debates surrounding the ownership and development of various hydropower plants.

The Energy Crisis
Search for and compare energy-related advertisements that appeared in magazines and newspapers during the energy crisis (1973 to 1980) to those that appear today.

Energy and Culture

Energy and the Rise and Fall of Ancient Civilizations
Choose an ancient civilization from the list below and become an expert on that culture's society and their use of energy. Remember to keep a running list of resources you use and create a bibliography.

Ancient Sumerians	Ancient Atlantians	Ancient Aztecs
Ancient Mesopotamians	Ancient Greeks	Ancient Mayans
Ancient Egyptians	Ancient Romans	Ancient Incas
	Ancient Celts	

Following are just a few research topics you can explore to learn the role that energy played in the success or downfall of these civilizations.

- What was the primary energy source of the society? All ancient civilizations used various forms of alternative energy, from biomass to solar energy to wind. List and describe the various forms of alternative energy used.
- What type of heat was most commonly used to keep the members of your civilization warm? Why? Be descriptive!
- What other ways did the civilization use energy (cooking, transportation, agriculture, warfare)? To what extent did energy resources influence the economy of the society?

Material World

Check your local library for a copy of Material World by Peter Menzel or search for his images online. This book includes photographs of families around the world with their household possessions. Compare the types and amounts of items in their households. Using energy as your focus, write a paper that expresses your impressions of the different photographs.

Create your own version of Material World, using stories, posters, or drawings. Compare energy use in the United States to that in a developing nation. Contact the National Peace Corps Office and ask for the name of a volunteer. Write that volunteer and ask what the energy use practices are like in their location. Better yet, try to make contact with a youth of your own age.

The Use of Lights During Holiday Festivals

Design a calendar that identifies different cultural holidays that use light in their celebrations. An alternative is to research one event and demonstrate how light is used. For example, candles are important symbols of Christmas (tree lights), Hanukkah (candles in the Menorah), and Kwanzaa (a candle representing different values is lit each day). These celebrations all take place during winter, but light is used in celebrations throughout the year. In November, during a celebration called Loy Krathong, people in Thailand send candles and incense out onto the river on floats made out of banana leaves. Before sending the boats afloat they make a wish. Clay lamps are lit during the Hindu feast of Diwali in October to show the way to Lakshmi, the goddess of propriety. Can you discover other examples?

Communicating Energy Ideas Using Art and Music

Develop ways to portray energy ideas using drawings, paintings, and music. Energy-related ideas you may want to communicate visually include the following:

- Objects moving fast or slowly
- Hot, warm, and cold
- The energy contained in an energy source (like batteries, the sun, a piece of wood)
- How people use energy

Analyze famous paintings to see the influence of energy. For example, how did Van Gogh paint the sun? How do impressionists use light and dark to create images? Use some of these same techniques in your own artwork.

Compose a musical piece that focuses on the variety of sounds emitted from different instruments. These instruments can be of your own design or from different cultures.