Disseminator
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Presenting:

G.E.E.K.S

(Goal oriented Energy Efficient Kids for Society)

For Information concerning IMPACT II opportunities, Such as interschool visits, Adapter and Developer Grants

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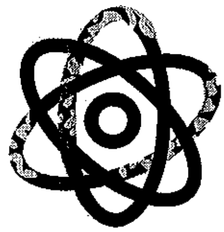
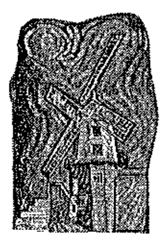


Project Description

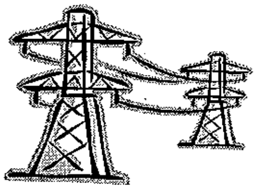
This project empowers students to become stakeholders of their own energy efficiency program. Through the use of technology and research, students learn what it takes to save energy for a realistic every day encounter with life. Students are introduced to energy through websites and simulations as they journey into an internet field trip. Upon completion of the internet field trip, students gain knowledge from perusing their utility bills. They become energy detectives as they conduct investigations that help determine where and why they are loosing energy in their home and community. The unit incorporates writing, math-both application and computation, science and language arts.



Students

This project is suitable for both classroom and school wide. The project can encompass 4-9th grades. The curriculum can be accelerated in order to benefit older students. The curriculum can simplified according to classroom based objectives.

. This project can also be altered to accommodate ESL students as well as ESE students. The activities used in this project focuses on exploration and discovery of history, math and science, with an emphasis on teamwork in a learning environment .



Staff

Mickey Santerre is in her 24th year of teaching , both in private school and public school in Dade County, Florida. She is nationally board certified. She hold's a master's degree in ESE, with an emphasis on varying exceptionalities. She hold's a specialist's degree in science education. She is currently working on her doctorate in science education. Mrs. Santerre has participated in Disseminator grants as well as Adapt- a-grant programs.

Goals and Objectives
3-5th grade

Science

The Nature of Matter

Standard 1:
The student understands that all matter has observable, measurable properties. (SC.A.1.2)

1. determines that the properties of materials (e.g., density and volume) can be compared and measured (e.g., using rulers, balances, and thermometers).
2. knows that common materials (e.g., water) can be changed from one state to another by heating and cooling.
3. knows that the weight of an object always equals the sum of its parts.
4. knows that different materials are made by physically combining substances and that different objects can be made by combining different materials.
5. knows that materials made by chemically combining two or more substances may have properties that differ from the original materials.

Energy

Standard 1:
The student recognizes that energy may be changed in form with varying efficiency. (SC.B.1.2)

1. knows how to trace the flow of energy in a system (e.g., as in an ecosystem).

2. recognizes various forms of energy (e.g., heat, light, and electricity).

3. knows that most things that emit light also emit heat.

Standard 2:

The student understands the interaction of matter and energy. (SC.B.2.2)

1. knows that some source of energy is needed for organisms to stay alive and grow.

2. recognizes the costs and risks to society and the environment posed by the use of nonrenewable energy.

3. knows that the limited supply of usable energy sources (e.g., fuels such as coal or oil) places great significance on the development of renewable energy sources.

The Nature of Science

Standard 1:

The student uses the scientific processes and habits of mind to solve problems. (SC.H.1.2)

1. knows that it is important to keep accurate records and descriptions to provide information and clues on causes of discrepancies in repeated experiments.

2. knows that a successful method to explore the natural world is to observe and record, and then analyze and communicate the results.

3. knows that to work collaboratively, all team members should be free to reach, explain, and justify their own individual conclusions.

4. knows that to compare and contrast observations and results is an essential skill in science.

5. knows that a model of something is different from the real thing, but can be used to learn something about the real thing.

Grades 6-8

Science

The Nature of Matter

Standard 1:

The student understands that all matter has observable, measurable properties. (SC.A.1.3)

1. identifies various ways in which substances differ (e.g., mass, volume, shape, density, texture, and reaction to temperature and light).

2. understands the difference between weight and mass.

3. knows that temperature measures the average energy of motion of the particles that make up the substance.

4. knows that atoms in solids are close together and do not move around easily; in liquids, atoms tend to move farther apart; in gas, atoms are quite far apart and move around freely.

5. knows the difference between a physical change in a substance (i.e., altering the shape, form, volume, or density) and a chemical change (i.e., producing new substances with different characteristics).

6. knows that equal volumes of different substances may have different masses.

Energy
Standard 1:

The student recognizes that energy may be changed in form with varying efficiency. (SC.B.1.3)

1. identifies forms of energy and explains that they can be measured and compared.

2. knows that energy cannot be created or destroyed, but only changed from one form to another.

3. knows the various forms in which energy comes to Earth from the sun (e.g., visible light, infrared, and microwave).
4. knows that energy conversions are never 100%

efficient (i.e., some energy is transformed to heat and is unavailable for further useful work).

5. knows the processes by which thermal energy tends to flow from a system of higher temperature to a system of lower temperature.

6. knows the properties of waves (e.g., frequency, wavelength, and amplitude); that each wave consists of a number of crests and troughs; and the effects of different media on waves.

Standard 2:

The student understands the interaction of matter and energy. (SC.B.2.3)

1. knows that most events in the universe (e.g., weather changes, moving cars, and the transfer of a nervous impulse in the human body) involve some form of energy transfer and that these changes almost always increase the total disorder of the system and its surroundings, reducing the amount of useful energy.

2. knows that most of the energy used today is derived from burning stored energy collected by organisms millions of years ago (i.e., nonrenewable fossil fuels).

The Nature of Science

Standard 1:
The student uses the scientific processes and habits of mind to solve problems. (SC.H.1.3)

1. knows that scientific knowledge is subject to modification as new information challenges prevailing theories and as a new theory leads to looking at old observations in a new way.

2. knows that the study of the events that led scientists to discoveries can provide information about the inquiry process and its effects.

3. knows that science disciplines differ from one another in topic, techniques, and outcomes, but that they share a common purpose, philosophy, and enterprise.

4. knows that accurate record keeping, openness, and replication are essential to maintaining an investigator's credibility with other scientists and society.

5. knows that a change in one or more variables may alter the outcome of an investigation.

6. recognizes the scientific contributions that are made by individuals of diverse backgrounds, interests, talents, and motivations.

7. knows that when similar investigations give different results, the scientific challenge is to verify whether the differences are significant by further study.

Course Outline/Overview

G.E.E.K.S. can be implemented throughout the school year or during a designated portion of the year. However, the G.E.E.K.S. project is best conducted throughout the whole year. Energy can be infused into any curriculum or content area, as well as having the benefit of being able to fit into holiday units as well.

Beginning in October:

Send home a letter to parents in order to explain and clarify the G.E.E.K. Program. Parents becomes active stakeholders as this is a family project as well.(see Appendix A)

Utilize a Bloom's Taxonomy Question Board (see Appendix D) in order for students to place their questions accordingly.

Week 1 — Introduction to unit. Divide students into groups. Conduct inquiry into prior knowledge as well as what children would like to learn. Students create time line of energy history and energy uses by research and internet field trip.(see Appendix J, K and M)

Week 2-3 — Students will conduct activities that demonstrate renewable and nonrenewable resources. Students begin Energy Hog Challenge. Conduct activities which are suggested in Energy Hog Challenge. (See Appendix I). Students work in cooperative groups. Students will evaluate their light bill. Students will create an energy savings proposal that will be evaluated by parents by parents. Parents will complete an evaluation.

Week 4 — Students will Students will conduct experiments that answer the question: Is it beneficial to breathe the air Around us ?

Week 5-6 Students will create their own future car or house(to be conducted during class) as well as their proposal for saving energy at home. (See Appendix S , 2-c and 2-d)

Week 7 Students will present their house or car project. Students will listen to the guest speaker (School's zone mechanic) and incorporate energy saving at school in a group plan. Students will reflect on the inquiry into energy.

Lesson Plans-(Time periods are determined by the teacher)

Week 1

Day 1

Students create inquiry questions. As segue into unit, watch the video at:
http://www.ase.org/content/article/detail/1010. If there is no access to internet look at story board in Appendix _B__. There is also a script that can be used (Appendix C). Hand out Energy glossary and explain that as they journey through the Energy Unit, they will become familiar with these words. During the unit, they will also be playing Energy Jepardy(see Appendix T).

Assign students to sit in groups of 4-6. This will become their groups of collaboration and learning. Have students, individually, create inquiry questions (See Appendix D).

After the students have created questions that they would like answered through this unit, each student will then share with their groups their questions. The students will then share with whole class and decide under which heading the questions fit under on the Inquiry Board. Students will observe each other's placement of question in proper column of Inquiry Board. This is a peer collaboration on part of children

Day 2

The Teacher then distributes the KWHL Charts wherein each group will answer this together. The charts will be placed on bulletin board so that the children can utilize them in order to track their learning and acquisition of knowledge. (See Appendix F)

Day 3-

Read the Energy Story (See Appendix G)

Introduce the six types of energy. Explain to students that The word energy comes from the Greek word energeia, which means in or at work. Everyday devices use energy. There are six forms of energy; electrical, chemical, nuclear, thermal, light (solar) and mechanical. Each device uses one or more of these forms of energy.

Read the Energy Story as a group (see Appendix)

1. Discuss how we have the six forms of energy everyday.

1.

chemical energy - the energy stored in the bonds between atoms in molecules.

electrical energy - the energy of moving electrons.

light or solar energy - electromagnetic radiation.

mechanical energy - the energy involved in moving objects.

nuclear energy - energy that comes from splitting or combining the nuclei of atoms.

thermal or heat energy - the energy of moving or vibrating molecules.

Day 4

Assign students to small groups and distribute the Researcher's Portfolio, Energy ABC's. (See Appendix H).

Tell the students that this activity is called "Energy ABC's", which is similar to charades. The object is to get students thinking about everyday machines or devices that use energy.

4. Each team of students will be assigned several letters of the alphabet. The object is to think of a device or machine beginning with that letter that uses or displays energy. When it is their group's turn they are to pantomime the device. The group must work together to determine the device and how best to pantomime it. For example, one or more members of the group might pantomime an air conditioner, if they selected the letter "A".

5. On small pieces of paper, write each letter of the alphabet. Fold the pieces of paper and place them in a hat or bowl. Let each student pick one of the papers. If you have more than 26 students, start with the beginning of the alphabet again.

6. As each device is done in pantomime and named, discuss with the class the form(s) of energy that it uses. For example, an air conditioner uses electrical, chemical, and mechanical energy.

7. Have students complete their Researcher Portfolio and list each device and the forms of energy it displays.

H.W: Have students read the exerpt of " What is Energy? (Taken from http://www.energyquest.ca.gov/story/chapter01.html) (See Appendix

Day 5

Explain to the students the Energy Hog Challenge. Refer to Energy History on page 7 in the teacher's guide. (See Appendix I).

Homework

illustrate a depiction of energy history. Have them read for homework A history of Transportation and environment. Explain to them that this timeline will be discussed deeper at a different time.(See Appendix J).

Week 2

Day 6

Teacher will conduct lesson of Energy Sources. Students will utilize technology, reference material and media center to obtain information (See Appendix G).). This is where teacher keeps track of sites the children have gone on.) If time runs out assign remainder of lesson for homework. Teacher can extract a grade either by observation or performance assessment

Day 7

The students will:design and construct an energy resource wheel (See Appendix L).

Procedure:
Students will create a wheel that may be used throughout the entire unit as a reference to renewable or nonrenewable energy sources. Energy resources are either renewable or nonrenewable . Some energy sources are called nonrenewable because the amount available is limited. Renewable energy sources such as solar, are relatively endless. Scientists believe the sun will be around for another 5 to 8 billion years.

1. Assign students to small groups.
2. Distribute the *Intermediate Energy Infobooks*, Researcher's Portfolio, Energy Wheel, and Energy Wheel.
3. Lead the class in the development of a rubric to assess their final product. Opportunities for self, peer, and teacher assessment should be provided.
4. Students should complete the Researcher's Portfolio, Energy Wheel and share their products with the class.

Florida Solar Energy Center
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Day 8-10

Explain to them that the Energy Hog Challenge is one in which they will be working on in and out of school. Explain to students That they will conducting some of the assignments of Energy Hog challenge at home. The first assignment will be to evaluate their power bill to compare the family energy bills to estimate how much is spent on energy each month-or year- and how it is used. Give students a few days to complete this home assignment. (See appendix N)

Homework-
Distribute " How much Energy do you use?"(See appendix O)

Direct the children that they need to visit the web site of Energy Hog at : www. Energy Hog.org.

Day 8

Students will conduct energy experiments in order to understand how energy is exchanged in everything in the world.

Homework

Energy Hog Scavenger Hunt. If students do not have a computer at home then they can do it during free time or independent time in class.(See Appendix Q).

- Students will conduct the experiment " Draft-O-Meter". They will conduct the same experiment at home. Student will write an entry in their Student Journal and Energy Hog site. (See Appendix R)

Day 9
Students will share with peers their entry in journal . Student Student Journal Wasting Energy at Home ? (Appendix P).

Day 10 Conduct experiment Crafting models of Efficiency in class (Appendix S).

Day 10-

Students will play Energy Jeopardy.(See Appendix T). Students will reflect in the journal while answering the final questions:

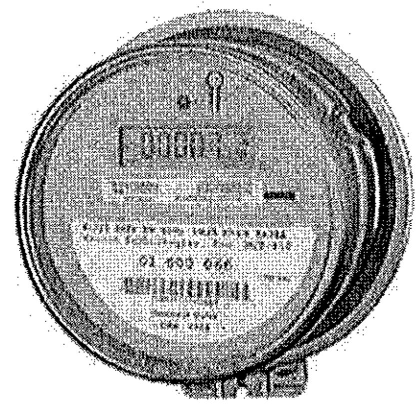
1. What did I enjoy the most this week? Why or Why not?
2. What was the most challenging for me this week ? Why?
3. What would I like to improve on in the upcoming week? Why?

Week 3

Day 11-15
Students will be introduced to how to read a meter in order to see where the money lies from Florida Power and Light. For kids. Have them click on

http://www.fplsafetyworld.com/fm_ifrm.aspx

If there is no access to computer teacher can download. Explain to students that



A residential electric meter measures how much energy you use. Energy use is calculated in kilowatt-hours or the number of kilowatts of power used times how many hours of use in a one-month billing period.

The equation for energy is:

Energy = Power x Time

It's often abbreviated like this: E = P x T

The units of the equation are:

kilowatt-hours(Energy) = kilowatts(Power) x hours(Time)

or

kWh = kW x hr

By reading the meter at the same time each day, you will get an idea of the amount of electricity you used. By writing each daily reading in an "Energy Diary," you can "chart" increases and decreases in energy use. By making notes when a particular energy activity is done like doing the laundery or cooking, you will know how your "energy dollar" is being spent.

Homework: Have students complete meter reader quiz

Day 12

Students will become aware of how saving energy at home can be beneficial, not only to their family but to them as well. This is the time that students will learn how to write an energy proposal to their parents.

(See Appendix Y)

Day 13

Students will be introduced to the Energy Surveys that will be conducted at home with their parents. (see Appendix W and X)

Day 14

The teacher will discuss that in the air there are pollutants that take energy from us. Distribute the Play " The Awful Eight". Students will perform the play in class. Discuss the eight air pollutants that were portrayed in the play. Introduce Discuss ways that society can help control the air pollutants. Conduct the lesson, " Air Pollution and Health (See Appendix V).

Day 15

The student will design and create an editorial cartoon that illustrates the effects of air pollution on select body systems.

Share cartoon with classmates.

Key words

allergen - a substance that causes an allergic reaction in sensitive individuals.

allergy - exaggerated or pathological reaction (such as sneezing, coughing or itching) to substances.

alveoli – the tiny air sacs of the lungs.

asthma - a lung condition that make breathing difficult.

chronic - refers to an illness of long duration or recurrence.

sinusitis - inflammation of one or more of the cavities in the skull.

Week 4

Day 16

Introduction to Air pollutants

Introduction: Ask the students if they have ever blown their nose and seen black/brown stuff on the tissue(Not the green stuff from a bad cold). Discuss whqat this could be and how it got in their nose. (dust, soot. Etc.) Discuss what might happen to their respiratory tubes and their lungs if the nose didn't screen out some of these larger particles.

Pass out " Air Pollution- Should you be worried"(See Appendix Z)

Brainstorm types of possible air pollution and write them on the board/chart. Group them into five or six categories. Discuss what could people do to reduce air pollution in your community?

Day 17

This activity utilizes a scavenger hunt as a means to determine and review factors that have a positive or negative effect on air quality or that indicate air quality. The students will utilize a lits of items common to most communities each item has a connection to air (See Appendix 2-A).

Materials: Scavenger hunt list for each student team
A disposable camera for each team
Notebooks for notes and sketches

1. Brainstorm and discuss properties of air;air pollutants and examples of things that create and/or cause pollutants in the air.
2. Find an example of each item on your scavenger hunt list. Sketch the item on location and take its picture. Make a list of its traits and location . Students will have the week to locate as many items on the list as possible. Some items will require research and or

creative thinking. Students will work in small groups and this lesson will extend over the other lessons this week.

3. Students will be prepared to display photos/ sketches and discuss how each item is connected to the air around us.
4. Students can add two items not on list that fit criteria

Day 18-20

The student will conduct investigations into clean Air.

(see Appendix 2-B..)

Air Pollution

Apparatus Needed:

1. Microscope slides
2. Petroleum jelly
3. Masking tape
4. Magnifying glass or microscopes

Recommended Strategy:

Coat one side of each slide with petroleum jelly. Select several different places within your city or residential area to place the slide; e.g., inside school classroom, outside of school classroom, inside your home, outside your home, window ledges, and field. Label the location on masking tape that you attach to each slide. Each student should have three slides to look at, and these slides should have been placed in the places that I mentioned above.

Expose all slides the same length of time (6 hours, 1 day, 1 week, etc.)

After collecting the slides, place them on a sheet of white paper with coated side up. Examine under strong light with magnifying glass or microscope. Each student should have a microscope for this purpose.

Compare exposed slides with control slides that were left indoors in a closed box or drawer.

I asked the students questions about what they observed on the slides. Some of the questions are as follows:

Which of your slides had the most particles?

Where was this slide placed?
Which of your slides had the fewest particles?
Compare results with your classmates find out who had the slide with the highest particle count. Where was it placed?
What is the likely source of this pollution?
How might this pollution be reduced?
What might be done by individuals, community groups, industry, or government to help to reduced air pollution?

The above questions can also be given on paper and handed out to the students to work on in class.

How Pollution Disrupts Our Natural Environment

Materials Needed:

Experiment No. 1: Each student will participate in the following experiment. (*Note: this can also be a group activity).* The materials needed in this experiment are: 1 pair of plastic gloves, a thermometer, and 3 plastic grocery bags

Experiment No. 2: The following materials are for a group of 3 to 4 students.

2 clear plastic cups, 1 clear glass bowl, 2 thermometers, water, paper and pencil.

Strategy:

Introduction: Three major problems involved in atmospheric depletion are: 1) ozone-destroying gases, 2) acid rain, and 3) deforestation. All of these problems together cause global warming. The problem with global warming will be discussed and analyzed.

General Information:

Our atmosphere is under increasing pressure from greenhouse gases which threaten to change the climate and put holes in the ozone layer. When the atmosphere is healthy it is an efficient system able to adapt to changes. Without this ability life on Earth would be non-existent. The greenhouse gases have massively traumatized the earth's atmosphere. Chloro-fluorocarbons (CFC) from our refrigerators and fire extinguishers destroy and damage the ozone layer. The earth is acidified by sulfur and nitrogen oxides from our cars and factories. The life expectancy of our earth as we know it, today, can no longer sustain good quality air as we know it today for our future generations.

Experiment No. 1:

Note: Gloved hand represents the EARTH

The gloved hand wrapped in plastic bags represents the toxins emitted in the atmosphere.

- Students will take the temperature of the room and record its temperature (this represents the gloved hand).

- Distribute 3 plastic bags, 1 pair of rubber gloves and 1 thermometer to each student.
- Students are then to put on the rubber gloves
- Students will wrap one hand with the 3 plastic bags, leaving the other hand in the rubber glove.
- Students will slide the thermometer between the glove and the plastic bags and record the temperature in their journals
- Please note : the temperature of the gloved hand will not be recorded

The students will compare their data with one another and discuss their findings.

Experiment No. 2

The students in this experiment will show how the greenhouse effect gives off toxic gasses that are enclosed in our environment heating up the earth's atmosphere. Note: This activity should be cone on a sunny day, if this is not possible use a lamp.

- Fill each cup ¾ full of water
- Before you place the bowl over the glass of water record the temperature in the journals
- Put a glass bowl upside down over one of the cups
- (Note: both cups need to be in the sun)
- Leave the cups in the sun for about an hour before temperature is taken
- Observe the glass bowl and note the changes if any. Record data in journal
- Remove the bowl, take the temperature of the container of water, and record
- Take the temperature of the container of water that was not covered, and record
- Compare temperatures to find the difference
- Through discovery student should be able to note the differences in temperatures.

Performance Assessment:

The students will be assessed by the instructor in the following ways:

- Through their journal writing
- By their ability to execute the experiments
- Through discussions, and
- Through their written explanations on the causes and affects of Global Warming.

Week 5-6

http://www.think-energy.com/ThinkEnergy/11-14/activities/EnergyEfficient.aspx

Have students build an energy efficient home online at this website. Nest have them create a scale model.

http://www.cis.yale.edu/ynhti/curriculum/units/1981/5/81.05.06.x.html#a

Energy Efficient Architectural Design and Model Building

by
Stephen Kass

To Guide Entry

This curriculum unit is designed for middle to high school level math-science teachers with two purposes in mind The first purpose is for math teachers who want to illustrate the principles of scaling, ratio, and proportion in a concrete way through model building. Too often math is taught in isolation, divorced from any 'real life situations. This causes students much anxiety and frustration. Student's failure to connect math with subjects outside the classroom leads them throughout their math program to see any relevance or application of the math principles they have learned. This unit counteracts the irrelevance of math. It teaches hands on skills that can be continually reapplied to changing conditions throughout a student's educational career. The second purpose is intended for science teachers who want to teach practical energy efficient design principles, with particular emphasis on passive solar design.

Building a scale model house from cardboard has proven to be a very engaging activity that develops the skills of design and construction. It of also an excellent motivating factor in teaching basic math and science concepts to a large number of students. The final construction is exciting for both student and teacher. The student has the opportunity to physically and visually experience the process of creating a house, Just like an architect. All they have to do is follow the steps, 1) Preparing 2) Gathering Information 3) Designing 4) Constructing. (See the illustrations and student worksheets that are an integral part of this curriculum unit. They are available from the Yale-New Haven Teacher Institute office.)

The success of this unit depends on the ability of the teacher to be patient, flexible, and tolerant of student experimentation. The teacher must enjoy working with different types of material and the messiness involved in using these materials. The only prerequisite for the student is the ability to read a ruler.

This unit could be a course itself on architectural model building or incorporated into an existing basic math-science program. It could also be taught as an interdisciplinary unit on housing with a social studies teacher.

Major Concept, Subconcepts and Terminal Objective

Major Concept: Designing and constructing a scale model house uses critical analytical skills that apply the math principals of scaling, ratio and proportion and demonstrate the science concepts that relate to energy efficient building and alternative energy systems.

Subconcepts: I Scale drawings are similar to one view of an object. The scales give the ratio between corresponding parts of the drawing and the actual object. These corresponding ratios produce a proportion.

II. The application of science concepts that relate to energy efficient building design and alternative energy systems will be explored and evaluated.

III. Design and scale model house construction are processes that involve the collection of information, the evaluation of information, and decision-making based on that evaluation. Designing and constructing means constantly reevaluating your design and construction techniques as new ideas occur. The final product of constructing a model house involves all these processes and directly applies the ideas of scaling, ratio and proportion, and energy efficiency to a new, concrete situation.

Terminal Objective: Upon completion of this curriculum unit, students will be able to design their own floor plans (blueprints) and construct an energy-efficient scale model house from cardboard.

Instructions for Completing this Curriculum Unit

In the following two sections, each of the subconcept statements are presented individually. Each is divided into a statement of the subconcept, a performance objective, learning activities and a self-assessment activity. Read the subconcept and performance objective statements, do the learning activities as directed, and complete the self-assessment activity for each section before going on to the next subconcept section. When you have completed these two sections, in order, go on to the Final Assessment Activity and Quest sections.

I. *How to Interpret and Make Scale Drawings*

Designing your house will be easier, more thorough, and under control if you learn to make and use scale drawings.

Subconcept I: Scale drawings are similar to one view of an object. The scales give the ratio between corresponding parts of the drawing and the actual object. These corresponding ratios produce a proportion,

Performance Objective. Given a scale drawing of floor plan and the scale, the student is able to determine the actual dimensions of the lengths and widths. Also, when given the actual dimensions of the floor plan, the student is able to determine and draw the floor to different scales.

Learning Activities:

1) To the student: A picture is like a scale drawing. It shows the object as it looks, but it is usually smaller or larger. The scale on a scale drawing gives you a ratio, It compares the lengths and widths on the drawing with the lengths and widths on the actual object. Give three examples when scales are used.
2) Complete worksheets 1 and 2 on proportional drawing. Hake sure they are correct before you go on to worksheets 3-11.
3) Measure this classroom, then draw three different floor plans of it on 1/4" graph paper, using the scales 1 Q =1' (1/4'=1'), 2 Û =1' (1/2 =1'), 4 Û =1' (1 =1')—Include all doors, windows, cabinets, and desks.
4) Draw a floor plan of your room at home, including all furniture. Draw the room again, this time doubling the scale.
5) Draw a floor plan of this entire floor in the school, DON'T DISTURB OTHER CLASSES!
Self Assessment. This consists of two parts: 1) a 75% score on the worksheets completed; 2) six completed floor plans to correct scale on graph paper. Consult your teacher before you proceed.

II *Energy Use in Homes: A Question of Design*

Residential use of energy accounts for 30% of the energy pie in New England. By thermally upgrading buildings and designing all new housing to be energy efficient, significant energy savings could be achieved, As it can be seen from the chart below, the big energy uses in the home are water heating and residential space heating, totaling 72.4%. This is an area where thoughtful design techniques can be essential in saving energy.

How You Use Energy

Pennsylvania State University says this is how energy is used at home;

Heating of space	57.5$
Water heating	14.9%
Refrigeration	6.0%
Cooking	5.5%
Air Conditioning	3.7%

Lighting	3.5%
Television	3.0%
Food freezer	1.9%
Clothes drying	1.7%
Others	2.3%

A Energy Use in Architecture

Yankee ingenuity worked to keep houses warm long before oil furnaces and electric baseboard heat was used. People's lives were not oriented toward a thermostat, but revolved around the central fireplace used for cooking and heating, While the houses were drafty and cooler by present day standards, design elements were incorporated into many early buildings to minimize heat loss and maximize heat gain.

New England connected architecture allowed farmers access to their barns without having to shovel through snow, and ii the barn was connected directly to the house with no sheds in between, the body heat from the animals helped to provide a buffer of warmth against the cold. The saltbox style house allowed sunlight and heat to enter the more open south-facing front of the house while throwing a long, sloping roof into the coldest north winds. The center chimney cape allowed for ease in distributing heat, as did vents in second story floors. These architectural designs, in addition to location and different citing places, were a union of form and function that aimed to conserve heat.

The 1950's began a short-lived era of cheap and abundant fossil fuels. New houses were designed without regard to heat conservation, and consequently, when fossil fuel prices began to rise significantly in 1973, the percent of the family budget allowed to heating skyrocketed.

This dramatic price rise alerted designers and homeowners to the need for thermal efficiency in building design. It is interesting to note that as a result, many of the design elements of early American architecture have been revitalized. The south facing saltbox, the central chimney, and double airlock entry are a few energy-saving design concepts being revived.

Fuel use has influenced dwelling design since earliest people. With 72.4% of home energy used for water and residential space heating, it will be an influencing factor in the future. This figure could be significantly reduced by thermally upgrading existing houses and by designing new homes with energy consumption in mind. The era of cheap fossil fuels has passed, and architectural styles are evolving which reflect a need for thermally efficient buildings.

B. Solar Heat

There may be some confusion about the term solar heat. Solar heat can mean using ordinary building materials and techniques to maximize the extent to which a house is heated by the sun so that the load on the regular heating system will be reduced. This is *passive solar heat*, which will be the most practical approach for most people. The second kind of solar heat uses a complex system of rooftop collectors as the main heat supply. This is called an *active solar system.*

To heat a house with the sun's diffuse energy you must collect heat from a large area and concentrate it. In a typical active rooftop collector system an entire roof is oriented to face the sun and covered with a series of collectors. A collector is typically a box with a glass surface on the outside, an air cavity in the middle, and a black metal heat-absorbing surface on the inside. Like a greenhouse, the inside of the box heats up when the sun is up, even if the sky is overcast. The black inner surface maximizes this effect. Next to the metal surface is a network of pipes filled with water. The water heats up from contact with the hot black surface and is pumped to a heavily insulated storage tank. The large insulated mass of water is the heat storage mechanism. It stays warm up to a few days even when no fresh heat is coming in. (Sometimes the water mass will be combined with a masonry mass, which may be simply a tankful of rocks or a fireplace through which the water pipes flow.) The water from the colder portions of the tank is pumped up to the roof to continue the cycle. Another set of pipes reverses the collection process to heat the house. These pipes pick up the hottest water from the storage tank and circulate it to radiators distributed throughout the house.

In many systems the heat is circulated throughout the house by air instead of water by way of a system of air ducts much like the ductwork in a conventional forced air system, only larger in size. As in a conventional system, the air is forcibly circulated by a fan. A heat exchanger transfers the heat from the hot water to the air. This is essentially a coil or a network of small pipes something like a radiator, located inside the air ductwork, through which the hottest water circulates. The cool air blows across the coil or network of hot pipes, cooling the water and heating the air.

A solar collector system is at first glance tremendously attractive because it offers virtually free heat. In reality the first costs are huge, because your roof is covered with plumbing and plumbing is the most expensive part of any building. This is in addition to the cost of the storage system, the distribution system, the pumps, and installation.

C. Heating Efficiency

Though few can afford a rooftop collector system, anyone building a house can have an energy efficient house by applying a few basic heating principles thoroughly to their design. Taking pains with a hundred small details, each unimportant in itself, can result in saving about half the fuel costs. These conscientious efforts are not just for economy's sake. An efficient house is more comfortable. Being sunny, bright, relatively uniform in temperature, and relatively free of drafts, your house will have a feeling of warmth even when the room temperature is low.

1. *Weather Orientation*. Your building site should be well open to the sky on the south, east, and west, because that's where the sun shines. The southern quadrant is particularly important, since the sun is there in the winter.

The house should be protected from winter winds (though not necessarily from summer breezes) by hills and plantings because the wind-chill factor cools a house just as much as it does a person. Outdoors .

The house must have sufficient window area especially to the south, to let heat in when the sun is up.

2. *Surface Area*, As important as how you heat your house is how to minimize heat loss. The heat loss of anything is proportional to its surface area. That is why radiators, which are designed to lose their heat, have fins or other irregularities to maximize their surface. In a house, you want to do the opposite, minimize the surface presented to the outside weather. The simpler the structure the more it will be heat-efficient. Many factors should influence the shape of your house. But a relatively compact shape will be easier to heat than a complex one.

3. *Insulation.* Most materials used to insulate buildings are efficient for the same reason down garments are warm. Both are fall of small cavities—dead air space—that trap air and interfere with the transfer of heat. The main idea is that heat loss is reduced by using more insulation. The effectiveness of any insulation is proportional to its thickness.

The most common and economical insulation is fiberglass. Until recently, the rule of thumb has been to use 3 inches in the walls and 6 inches in the roof and floor. Now many people are exceeding these amounts because fuel has become so expensive. For a cost of $500 for a medium-sized house you can permanently reduce your heating bill by approximately 15 percent.

4. *Window Placement and Insulation.* Windows lose heat about ten times as fast per square foot as do walls or roofs. Even a moderate window area can account for 40 percent of your total heat bill, One of the keys to heating efficiency is to minimize this avenue of heat loss. You should eliminate inefficient window areas. You need south, east, and west windows for solar heat and light. You need north windows to see outside. But you do not need entire walls of glass. Your south, east, and west walls should have enough window for solar heat but not too much more. You should give a harder look to north windows, because these give no heat back even with the sun out. North windows should therefore usually be relatively few and small.

Next, use storm windows, insulated glass (Thermopane) or some other system of double glazing. This one step will cut the heat loss through the windows in half, which means an overall savings of around 15 percent. Even with double glazing, however, windows will still pour out heat at night or on overcast days when there is no compensating solar heat gain. Heavy curtains or, even better, insulated shutters can go a long way toward solving this problem. If you use a shuttering system well, you can save another 15% on your heat bill.

5. *Infiltration*, Infiltration means the actual flow of warm air out and cool air in. This leakage can be through small cracks in the siding, or around windows and doors,

especially through cracks between the studs. It can also be simply from opening and closing doors. Infiltration can account for anywhere from 10 to about 40 percent of the total heat loss. There are several ways to keep infiltration down. Under the siding there should be some sort of continuous seal, such as plywood to keep the walls tight. Cracks around walls and windows should be caulked. Before you do finish-work you should stuff cracks with insulation. Weather stripping helps seal openings around doors and windows, A double door at an entry helps prevent large masses of cold air from coming in when people enter or leave. These precautions can save perhaps 15 percent of your total heat loss.

All of these percentages are of course approximate. What they amount to is that if you locate, design, and build your house with these features in mind, you can save tremendously on heating costs.

6. *Passive Solar Heat.* All these factors can be quantified, and there are engineering methods to compute them. When a house is engineered to maximize heating efficiency, the result is called passive solar heat A passive solar house may also include a simple system to store solar energy between sunny periods. Such a system will usually consist of a large masonry mass inside the house that is warmed up slowly by direct exposure to the sunlight. When the sun goes down, the masonry mass gradually emits heat into the surrounding room. Such a mass can be stone or concrete floor insulated underneath or a vertical mass such as an interior masonry wall or fireplace. One effective way to solar heat is to build a large stone or brick wall 4 or 5 feet inside a south wall with a large glass area.

Remember that solar efficiency, though valuable, is not your only design goal. Some people get so involved with making their house energy-efficient that they forget other equally important or more important needs. Most of the benefits of passive solar heat can be achieved by following sensible design practices. Space needs, or your own tastes should not be sacrificed for further, marginal reductions in heat loss.

Subconcept II: The application of science concepts that relate to energy efficient building design and alternative energy systems will be explored and evaluated.

Performance Objective: Students will integrate their knowledge about energy efficient and solar design principals into a proposed house design.

Learning Activities:

1) Provide students with magazines, pamphlets, advertisements, etc., which deal with alternative energy systems such as wood stoves and furnaces, solar collectors, wind mills, etc. Divide students into groups of 5 or 6 and have them make collages on poster board focusing on alternative energy.
2) Have students look through materials and identify terms which require definition clarification or concept exploration. These might include R values, specific heat, convection, B.T.U., etc, With teacher assistance, have students research these terms and make a master list on newsprint or poster board that includes the term, meaning,

use and example of usage, Leave list posted during unit. Discuss the terms listed as a class.

3) Supply students with sample house plans (Floor Plans are available in many magazines and books—see Bibliography). Select plans that represent four or five different architectural styles (ranch, saltbox, split level, contemporary, etc.). Have students select one of the designs and identity specific energy related aspects of their house plans (insulation materials, proposed heating source, window area, thermal mass, waste treatment). Once they have been identified, have students evaluate their design in terms of energy efficiency using science and math skills and knowledge gained in developing the master list of terms.

4) Construct the Model Solar House from your worksheets,

5) What solar concepts are included in this house? Which concepts are you going to use for your final house design? List 10.

III. Design and Scale Model Construction

How do you design a house? A common practice is to take an idea of a house seen in a book, in one's travels, or in one's mind eye, and just put that house on the site chosen. Another way that is different, more original, and may be better suited for you is to take the information you have about your land, your needs, and your budget, and develop a house design from that.

Begin by listing your design goals and experimenting with the items on your lists. First consider the qualities you might want your house to have: lots of privacy, skylights, a lot of sun, one or two stories, good views, high or low ceilings, fireplace, etc. Your next list should be more specific and include the actual areas you want your house to contain. This should generally not be a list of rooms, but of activities: eating, sitting, studying, reading, woodworking, wood storage, greenhouse, washing, sewing, car shelter, fixing a car, cooking, storing food, playing games, playing loud music, being alone, storage, etc. Include everything. This is not the time to be realistic. Activities can be eliminated later if necessary.

Write each activity on small, separate pieces of paper, Shuffle them around in different patterns to see which can be combined. Which functions can occupy the same or nearby space? Which must be isolated? Maybe you will discover old combinations that make more sense for you than the usual living room, dining room, kitchen, bedroom, bath arrangement. If you need both very quiet and very noisy places, you might be better off with two separate structures. You may want to save money by combining functions: eat-sit-visit or workshop-woodshed-noisy games, or greenhouse-bathroom.

Once you have developed your goals and priorities, it is time to make a scale drawing. But, making drawings is not just a way to put ideas on paper. It's a way to develop ideas and make them work for you. Basically, you make a scale drawing, such as a floor plan, and then systematically ask yourself questions about it. Is the sun orientation good? Does the layout give enough privacy? Then you revise the drawing—changing dimensions, moving rooms around, moving doors and windows—trying to solve some of the problems. You revise the second version in the same way. This process continues until you have solved as many of the problems as possible, though compromise will always be necessary. When you have finished, your space will be efficient, privacy and communication will be good, etc. If your house has one or two rooms, this drawing process may be quick and easy. But ii your house is larger, making a drawing will be a major project. The more time you spend drawing and designing, the more the house will reflect your needs and be energy efficient.

Remember, your first design will be full of defects, which is to be expected. Revise it until you have a layout that really makes sense. Later you will make a more detailed plan that will include windows, doors, and the contents of the house.

Subconcept III: Design and construction are processes that involve the collecting of information, the evaluation of information, and decision-making based on that evaluation. Designing and constructing means constantly reevaluating your design and constructing techniques as new ideas occur. The final product of constructing a model involves all these processes and directly applies the ideas of scaling, ratio and proportion to a new, concrete situation.

Performance Objective: Students will design and draw floor plans of their chosen house, using passive solar design and energy efficient principals. They will then construct a scale model house from cardboard on top of the final floor plans.

Learning Activities:

1) Complete the worksheet design with a purpose. Have your teacher correct it before you go on to the next activity.
2) Look at the housing styles worksheet. Choose a style that you like best. List five reasons why you like this style. Which housing style is the most energy-efficient? Why?
3) Complete worksheets 1-7.
4) (Optional Activity) Using the isometric dot paper grid master which is included with the student worksheets, draw a two-point perspective drawing. It is difficult at first, but follow the instructions carefully. Don't get scared' A two-point perspective drawing is a house drawing from the same angle as the drawings on the housing styles worksheets.
5) Draw a front, side, and back sketch of your newly designed house.
6) On 1/4 graph paper, sketch the floor plan for this house,
7) Make a final floor plan to perfect scale for the house you will construct.
8) Build your cardboard model on top of your final floor plan. Materials needed: cardboard or mat board, rulers, rubber cement or Elmer's glue, graph paper, paper cutter, scissors, and X-Acto knives.
9) Have students present their final design and house construction in class, explaining their choices of design and alternative systems. They should be able to use scientific data to support their choices and discuss the personal considerations that influenced their choices.

Self and Final Assessment: If your model is completed and to the correct scale as determined by your teacher, you are finished. Put the final touches to the model (landscaping). Congratulations !!!

Quest

This section will give you additional activities to extend your mastery of scaling, energy efficiency, and architectural principles.

1) Take photographs or make drawings of older houses in your neighborhood for an album; talk to the owner and collect information regarding the house—its style, date, location and changes made to the house,
2) Look through magazines and find a photo of each basic house style. Mount the pictures on illustration board for display.
3) Visit a contractor or architectural firm and ask for prints of the basic house styles. Bring these to class and discuss the advantages and disadvantages of each in respect to the families of different members of the class.
4) Using the New Haven papers, read through the "houses for sale section and make a list of the styles advertised. See if there seems to be a trend toward a particular basic style.
5) Redesign any space or object that you want to see changed.
6) Draw a scale model of anything that interests you.
7) Study the architecture in your town. Have students design an evaluation form to be used for analyzing buildings. Questions that might be included: What direction is the house facing? How many windows are on the north side? South side? Does the land scaping help to minimize heat loss? Is there an "airlock" entryway? Does the roof shed winds? What type of heat source originally kept the house warm? Compile data and discuss factors influencing architecture,
8) Have students prepare a slide show on the buildings they study. The energy conserving features and energy wasting features should be highlighted.
9) Have students do a survey of the public buildings in town. They should find out how they are heated, and how much it. costs annually to heat them. Discuss what could be done to lower these heating costs, and invite town officers to the class to talk about potential energy savings.

Energy and Cars: What Does the Future Hold?

LENGTH OF LESSON:
Two to three class periods

GRADE LEVEL:
5-9

SUBJECT AREA:
Earth Science

CREDIT:
Betsy Hedberg, freelance curriculum writer and teacher.

OBJECTIVES:
Students will understand:

1. The reasons why attitudes toward fossil fuel use and alternative energy sources may change over the next 50 years.

2. How changing attitudes toward fossil fuel use and alternative energy sources may affect car technology.

3. The types of alternative energy sources that are currently under research, particularly for use in cars.

MATERIALS:
For this lesson, you will need:

Pens or pencils and paper

Poster board or construction paper (for group presentations)

Markers or crayons

Computers with Internet access (optional for research)

PROCEDURE:

1. Ask students to discuss what they already know about fuel efficiency in cars. Pose the following questions:

- Which types of cars are the most fuel efficient and why?
- What factors might contribute to a desire for increased fuel efficiency in cars?
- How fuel-efficient are cars today compared to 50 years ago?

2. Divide the class into small groups of approximately four students each. Read the following scenario to the class:Pretend that you live in the year 3000. Your group is a team of archaeologists who have been studying the very interesting time period of A.D. 2000-2050. You've just excavated a site that reveals a great deal about transportation during this time period. At this site, you've found dozens of old cars and car pieces. You've also found an old sign that says "Joe's Junkyard, Established 2015." Therefore, you assume the oldest cars in this junkyard are from about the year 2000. You know that in 2050, a catastrophic earthquake leveled this part of town and all businesses ceased to operate. You can assume that cars in this junkyard are models from about 2000 to 2050. Your assignment is to present a report to the country's leading archaeologists explaining the following things:

- The ways in which attitudes toward fossil fuel use and the use of alternative energy sources changed between 2000 and 2050, and the reasons for these changes.
- Changes to automobile technology and power sources between 2000 (the year when the oldest cars junked in 2015 would probably have been built) and 2050, and the ways in which these changes reflected changing attitudes toward fossil fuel use and alternative energy sources.

3. When students take themselves out of this futuristic scenario and into the present time, they will therefore need to make predictions about the following things:

- How and why (or whether) attitudes toward fossil fuel use will change over the next 50 years.
- The reasons why we might see changes in the way cars are powered.
- The changes that will occur in car technology in order to accommodate changing attitudes toward fuel efficiency and energy sources.

4. Ask groups to use the Internet, the library, and any other relevant resources they can find to answer the following questions:

- How do present-day internal-combustion car engines work? How is fuel processed in the engine in order to make the car operate?
- What can be done to increase a car's fuel efficiency?
- What types of alternative energy sources are being developed for future cars? How do these energy sources power the car? What are the advantages and disadvantages of each type of energy source? Which energy sources seem most likely to be commonly used in cars of the future?
- What environmental, political, and cultural factors might contribute to a desire for cars with higher fuel efficiency or cars that use alternative energy sources?
- What factors might detract from creating cars with higher fuel efficiency or cars that use alternative energy sources?

The following Web sites will be helpful in students' research:
Energy Quest
Fuel Economy Site
Alternative Fuels Data Center

5. Once they've finished their research, have groups prepare their reports. The reports should have two components:

- Oral presentation: Have groups make oral presentations to a panel of archaeologists (i.e., the rest of the class) describing the things that their team has found in Joe's Junkyard and the conclusions it has reached concerning changes in automobile energy sources and attitudes toward energy use from 2000 to 2050. Their presentations should address the questions they investigated in step 4 of this lesson and should include visual aids when appropriate. For example, they can include diagrams of car engines that use different energy sources (traditional versus hybrid, for example) or charts showing the projected supply of fossil fuels or smog reduction goals for a particular city.

- Written paper: Have each student individually write a two- to three-page paper describing the conclusions his or her group has drawn from Joe's Junkyard and summarizing the group's predictions for the ways in which energy sources and attitudes toward energy sources will change over the next 50 years (2000-2050).

Note: It's entirely possible that students will conclude that the public is not likely to change its attitudes toward fossil fuel use, that car companies will not follow through with plans to create cars powered by alternative energy sources, and that things won't be all that different 50 years from now. It's fine for them to draw this conclusion, but they must support their argument with detailed evidence from their research. They can claim that the cars in Joe's Junkyard didn't change much during this 50-year period (or that they became less fuel efficient), but they must justify their reasoning by showing evidence from current trends and predictions they've found in their research.

ADAPTATIONS:

Have younger students research alternative energy sources for cars and predict which energy sources currently under research today are the most likely to be used in the next 50 years. Have them report on the archaeological dig by explaining which alternative energy source became the most widely used and describing the reasons why this energy source was selected to replace or be used in conjunction with fossil fuels. Students will not need to describe the technological details of the engines or the political processes by which attitudes toward fossil fuels might change. They'll instead keep their research focused on the types of energy that might be used in cars and the reasons why these types of energy might be practical.

DISCUSSION QUESTIONS:

1. Hypothesize the design features that could increase a car's fuel efficiency. Discuss how aspects of the engine, body, and other components of the car could be modified to minimize the amount of fuel the car requires.

2. Explain why you think there are many more sport utility vehicles on the road today than there were 10 years ago. Compare the design features of a sport utility vehicle with those of a car in terms of their fuel efficiency.

3. Describe the reasons why car manufacturers dramatically increased their cars' fuel efficiency over the past 50 years.

4. Explain the environmental effects that a large number of cars might have on a city like Los Angeles, which is very spread out and surrounded by mountains.

5. Describe the reasons why people might be reluctant to abandon their sport utility vehicles and trucks in favor of more fuel efficient cars or to give up their traditional cars for electric vehicles or other alternative energy cars.

6. Discuss what events could cause car manufacturers to drastically change the fuel efficiency or energy sources of their cars.

EVALUATION:

Evaluate students' oral presentations with a rubric that addresses the following questions:

- Did the group present its information in a serious and mature manner?

- Did the group provide clear details from its research to illustrate its points?
- Did the group provide interesting and easy-to-understand visual aids?

Evaluate students' papers with a rubric that addresses the following questions:

- Did the student do a good job of explaining what his or her group found and the conclusions that the group drew?
- Did the student use examples and details from the group's research to illustrate his or her points?
- Did the student write in a clear and convincing manner?

EXTENSION:

Car Advertising

Have students look through car magazines and/or brochures and identify design features that are more and less fuel efficient. Ask them to figure out which cars are being marketed as fuel efficient and which are not.

Changing Attitudes

Have students interview their parents, grandparents, and teachers to find out how they think attitudes toward fossil fuel use and alternative energy sources have changed in their lifetime. Have they noticed significant changes? If so, have they noticed these changing attitudes reflected in car design? Have these changes affected their behavior as consumers? For example, do they take fuel efficiency into consideration when purchasing a vehicle? Why or why not?

SUGGESTED READINGS:

Great Automakers and Their Cars

Robert Italia. Oliver Press, 1993.

Nine of the most influential automobile designers and manufacturers from around the world are profiled in this book. Biographical information is included about Americans like Henry Ford and the Dodge brothers, Europeans like Ferruccio Lamborghini, and Japanese like Soichiro Honda, as well as the history of the company that each founded.

"Your Next Car?"

Jim Motavalli. Sierra, July/August, 1999.
This article discusses the pros and cons of three types of alternative-fuel cars that are in various stages of development – one type powered solely by electricity, hybrid vehicles that use both gasoline and electricity, and cars that have fuel-cells powered by hydrogen. Also discussed are the economic forces within the auto industry that are driving the developments.

Forward Drive: The Race to Build "Clean" Cars for the Future
Jim Motavalli. Sierra Club Books, 2000.
New methods of powering automobiles are being developed to reduce the global-warming and fossil-fuel depleting effects of today's gasoline-powered cars. This book is an in-depth examination of the history of automobile development including early electric vehicles and an exploration of the new technologies that will be used to create "clean" cars.

WEB LINKS:

Automotive Learning Online
Animations and clickable diagrams of your automobiles inner parts will help you to know everything you ever wanted to know about your family car.
http://www.innerauto.com/innerauto/htm/auto.html

DOE's Hybrid Electric Vehicle Program
HEV's are Hybrid Electric Vehicles that combine electrical power with some other power source. Learn all about HEV's here and download free software that allows you to design your own HEV.
http://www.ott.doe.gov/hev/

Celebrating 100 Years

Celebrate 100 years of the automobile and learn about its history with timelines, historical photographs and essays, and a virtual field trip to "Carhenge."
http://www.azstarnet.com/auto100

CREATING THE INTERSTATE SYSTEM

A fascinating history of the greatest engineering undertaking of the 20th century, the construction of America's Interstate Highway System. Learn how this achievement has unified our Country and assured the defense of our national interests?
http://www.tfhrc.gov/pubrds/summer96/p96su10.htm

An Introduction to Building a Model Solar Car

Future automotive engineers will want to practice their skills by building their very own solar powered model car. Complete project plans are available at this website.
http://freenet.msp.mn.us/org/mres/carmanual/top.html

VOCABULARY:

emissions
The output of a car's engine (the car's exhaust).
Context:
Stricter governmental emissions standards have forced car companies to produce more fuel efficient cars.

ethanol
Grain alcohol, commonly produced from corn.
Context:
Ethanol can be blended with gasoline to create a cleaner-burning fuel than gasoline alone.

hybrid
Something of mixed origin or composition.
Context:
Car manufacturers may soon introduce hybrid vehicles, which will still use gasoline but will also have batteries to store energy and thus increase the car's fuel efficiency.

internal combustion
An engine that produces power by burning fuel within the engine.
Context:
Most cars today still have internal combustion engines rather than batteries, solar panels, or other alternative power capabilities.

natural gas
A mixture of hydrocarbons commonly produced along with crude oil.
Context:
Natural gas is a fossil fuel that is distributed through all 50 states and burns more cleanly than gasoline.

OPEC
Organization of Petroleum Exporting Countries. A consortium of oil-producing countries, mainly in the Middle East.
Context:
OPEC's oil embargo of the 1970s led the United States into a nationwide energy scare, skyrocketing oil prices, and rationing of gasoline.

ACADEMIC STANDARDS:

Grade Level:
5-9
Subject Area:
Science: Earth and Space

Standard:
Understands basic features of the Earth.

Benchmarks:
Knows the major external and internal sources of energy on Earth (e.g., the sun is the major external source of energy; the decay of radioactive isotopes and gravitational energy from the Earth's original formation are primary sources of internal energy).

Grade Level:
5-9

Subject Area:
Geography

Standard:
Understands how human actions modify the physical environment.

Benchmarks:
Understands the global impacts of human changes in the physical environment (e.g., increases in runoff and sediment, tropical soil degradation, habitat destruction, air pollution; alterations in the hydrologic cycle; increases in world temperatures; groundwater reduction).

Grade Level:
5-9
Subject Area:
Geography

Standard:
Understands how human actions modify the physical environment.

Benchmarks:
Knows how people's changing attitudes toward the environment have led to landscape changes (e.g., pressure to replace farmlands with wetlands in flood plain areas, interest in preserving wilderness areas, support for the concept of historic preservation).

Grade Level:
5-9
Subject Area:
Geography

Standard:
Understands the changes that occur in the meaning, use, distribution, and importance of resources

Benchmarks:
Understands programs and positions related to the use of resources on a local to global scale (e.g., community regulations for water usage during

drought periods; local recycling programs for glass, metal, plastic, and paper products; different points of view regarding uses of the Malaysian rain forests).

DiscoverySchool.com
http://www.discoveryschool.com

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Appendices

Dear Parents,

In class we are studying, " Energy and Energy Efficiency. During the next 6 weeks your child will be interviewing you as stakeholders of energy efficiency in your home. They will be conducting energy efficiency tests and will be researching what the best ways to save energy in your home are. Please take time to work with your child, allow them to give their knowledge of what they are learning in order to help your household be more efficient. Just think of it conserving energy is like a light bulb turning on to savings for your family.

The culminating activity will be a proposal for energy savings. This project will be due at the end of the unit. The proposal will consist of :

1. An introduction to the energy efficiency program for your house designed by your child.

2. A Literature Review – research that your child has explored with appropriate documentation.

3. An Action Plan that is realistic.

4. Conclusion.

Your child represents our future. Therefore, please help them by being an active participant. Together we will see the benefits.

Sincerely,

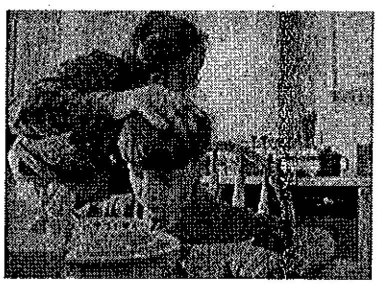
Taken From http://www.ase.org/content/article/detail/1010

Alliance To Save Energy

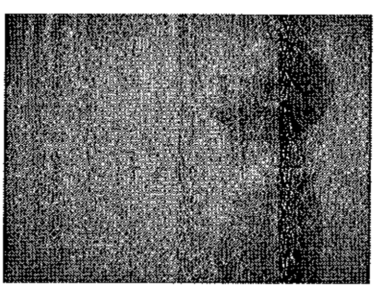
(FATHER)

"We're at a crucial stage with energy usage. Prices are just too high."

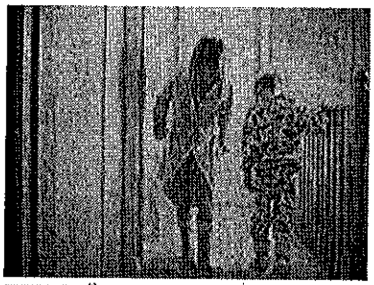
"We need to cut consumption and we need alternatives."



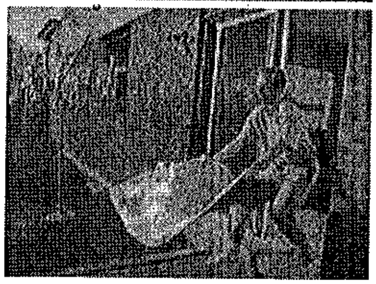
"...That's what drove us to attempt the first static-electricity powered home."



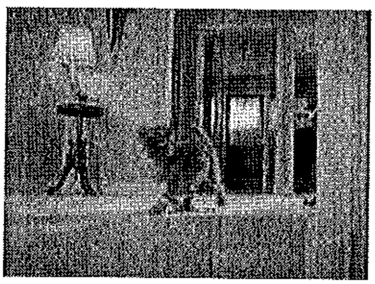
"Faster, faster..."



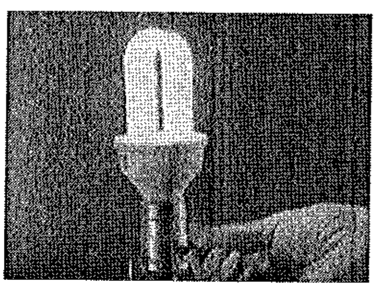
"...water's getting cold!"



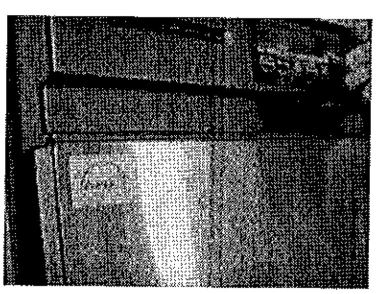
"Success has been...elusive..."



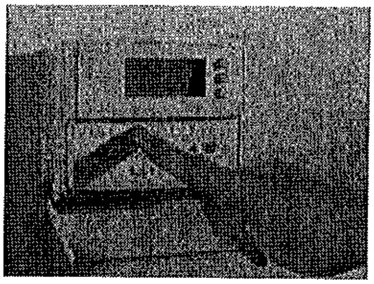
"...it hasn't been everything we'd hoped..."



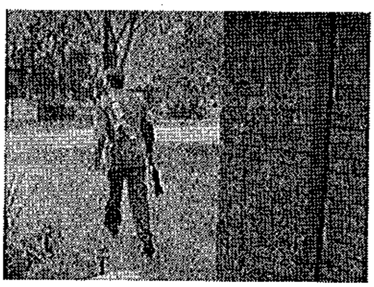
"...the smartest thing we did, the bright spot, if you will...



" ...is that we equipped the house with Energy Star products..."

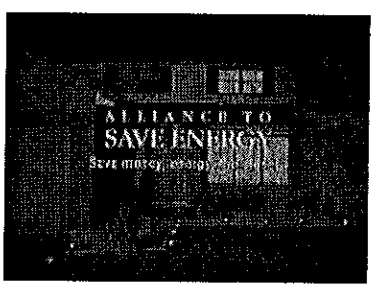


"... which use less juice and save money."



"We've taken a step toward the future..."

"...our future."



"Anyone can make their home more energy efficient

'Static Electricity House' Script **Appendix C**

:60

Ext: *Average suburban home on average suburban street.*

Cut to interior of home.

CU of Father, speaks to film-makers off camera.

Father: We're at a crucial stage with energy usage. Prices are just too high. We need to cut consumption and we need alternatives.

Scene: Mother sets table behind him while shuffling around in wool socks.

Father VO: ...That's what drove us to attempt the first static-electricity powered home.

Scene: Son shuffling across the carpet in wool socks.

Father VO: Static cells under the carpet collect energy and transfer it as needed throughout the house.

Scene: Daughter reading by lamplight. Lamp begins to dim. She quickly rubs her feet on the floor until the light begins to brighten.

Cut to son eating breakfast while father rubs his head to turn on blender behind him.

Cut to daughter & son shuffling outside bathroom door while father yells from within, "Faster, faster...water's getting cold!"

Father VO : Success has been...elusive...

Scene: Father taking out flaming rug while fire alarm sounds.

Father VO : ...it hasn't been everything we'd hoped...

Scene: Three quick cuts of family members getting static shocks by touching doorknob.

Cut to dog trotting through house in small wool socks.

Father VO : ...But, besides making the house itself more energy efficient, the smartest thing we did, the bright spot, if you will...

Scenes making house more energy efficient:

Hand screws in fluorescent bulb

Caulking a new window with Energy Star label

Scenes using Energy Star appliances:

Placing dish in dishwasher

Adjusting a programmable Honeywell thermostat

Father VO : ...is that we equipped the house with Energy Star products, which use less juice and save money.

Father: Static electricity may not be viable. (Cut to scene of father leaving house for work with sock stuck to the back of his suit.) But hey, we've taken a step toward the future. Our future.

Scene: Whole family on couch with hair standing on end.

Cut to exterior of house.

Supers: Alliance to Save Energy

Save money, energy, the planet.

VO: Anyone can make their home more energy efficient.

Super: For a free Power$mart® booklet visit
www.ase.org

MomVO: Goodnight sweetie.

Child VO: Goodnight mommy. *(makes an "mmm" sound as before a kiss)*

Child's bedroom window flashes with a static electricity spark.

SFX: Static shock.

Appendix D

Blooms Taxonomy Wall Chart

Dalton, J. & Smith, D. (1986) "Extending Children's Special Abilities – Strategies for primary classrooms" pp36-7

Knowledge

Useful Verbs	Sample Question Stems	Potential activities and products
Tell list describe relate locate write find state name	What happened after...? How many...? Who was it that...? Can you name the...? Describe what happened at...? Who spoke to...? Can you tell why...? Find the meaning of...? What is...? Which is true or false...?	Make a list of the main events.. Make a timeline of events. Make a facts chart. Write a list of any pieces of information you can remember. List all the .... in the story. Make a chart showing... Make an acrostic. Recite a poem.

Comprehension

Explain interpret outline discuss distinguish predict restate translate compare describe	Can you write in your own words...? Can you write a brief outline...? What do you think could of happened next...? Who do you think...? What was the main idea...? Who was the key character...? Can you distinguish between...? What differences exist between...? Can you provide an example of what you mean...?	Cut out or draw pictures to show a particular event. Illustrate what you think the main idea was. Make a cartoon strip showing the sequence of events. Write and perform a play based on the story. Retell the story in your words. Paint a picture of some aspect you like. Write a summary report of an event. Prepare a flow chart to illustrate the sequence of events. Make a coloring book.

Application

Useful Verbs	Sample Question Stems	Potential activities and products
solve show use illustrate construct complete examine classify	Do you know another instance where...? Could this have happened in...? Can you group by characteristics such as...? What factors would you change if...? Can you apply the method used to some experience of your own...? What questions would you ask of...? From the information given, can you develop a set of instructions about...? Would this information be useful if you had a ...?	Construct a model to demonstrate how it will work. Make a diorama to illustrate an important event. Make a scrapbook about the areas of study. Make a paper-mache map to include relevant information about an event. Take a collection of photographs to demonstrate a particular point. Make up a puzzle game suing the ideas from the study area. Make a clay model of an item in the material. Design a market strategy for your product using a known strategy as a model. Dress a doll in national costume. Paint a mural using the same materials. Write a textbook about... for others.

Analysis

Useful Verbs	Sample Question Stems	Potential activities and products
analyse distinguish examine compare contrast investigate categorise identify explain separate advertise	Which events could have happened...? I ... happened, what might the ending have been? How was this similar to...? What was the underlying theme of...? What do you see as other possible outcomes? Why did ... changes occur? Can you compare your ... with that presented in...? Can you explain what must have happened when...? How is ... similar to ...? What are some of the problems of...? Can you distinguish between...? What were some of the motives behind...? What was the turning point in the game? What was the problem with...?	Design a questionnaire to gather information. Write a commercial to sell a new product. Conduct an investigation to produce information to support a view. Make a flow chart to show the critical stages. Construct a graph to illustrate selected information. Make a jigsaw puzzle. Make a family tree showing relationships. Put on a play about the study area. Write a biography of the study person. Prepare a report about the area of study. Arrange a party. Make all the arrangements and record the steps needed. Review a work of art in terms of

Synthesis

Useful Verbs	Sample Question Stems	Potential activities and products
create invent compose predict plan construct design imagine propose devise formulate	Can you design a ... to ...? Why not compose a song about...? Can you see a possible solution to...? If you had access to all resources how would you deal with...? Why don't you devise your own way to deal with...? What would happen if...? How many ways can you...? Can you create new and unusual uses for...? Can you write a new recipe for a tasty dish? can you develop a proposal which would...	Invent a machine to do a specific task. Design a building to house your study. Create a new product. Give it a name and plan a marketing campaign. Write about your feelings in relation to... Write a TV show, play, puppet show, role play, song or pantomime about...? Design a record, book, or magazine cover for...? Make up a new language code and write material suing it. Sell an idea. Devise a way to... Compose a rhythm or put new words to a known melody.

Evaluation

Useful Verbs	Sample Question Stems	Potential activities and products
Judge select choose decide justify debate verify argue recommend assess discuss rate prioritise determine	Is there a better solution to... Judge the value of... Can you defend your position about...? Do you think ... is a good or a bad thing? How would you have handled...? What changes to ... would you recommend? Do you believe? Are you a ... person? How would you feel if...? How effective are...? What do you think about...?	Prepare a list of criteria to judge a ... show. Indicate priority and ratings. Conduct a debate about an issue of special interest. Make a booklet about 5 rules you see as important. Convince others. Form a panel to discuss views, eg "Learning at School." Write a letter to ... advising on changes needed at... Write a half yearly report. Prepare a case to present your view about...

Name____________ Date___________

Blooms Taxonomy Chart

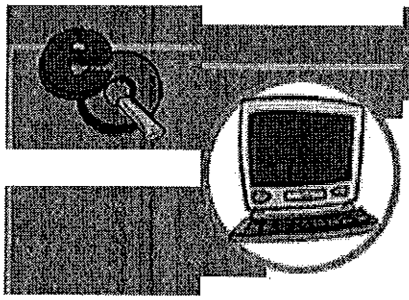
Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation
How many types of popcorn are there?	Who do you think discovered popcorn?	Why did changes of popcorn packages occur?			

These are just examples of questions. After you teach the children what each dimension is and what questions are to go in each dimension, the chart becomes easier. Remember that the questions are student driven. As a manager of their thinking, you defer judgement as to where each question should go. The students will suggest to each other the right dimension, if there is question as to location of their created inquiry.

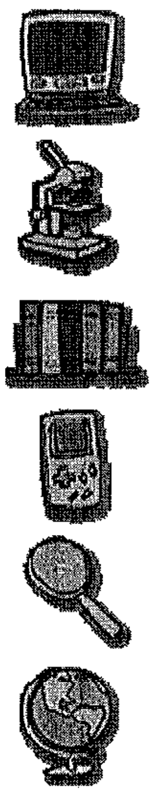
Appendix F

Name____________________________Date__________________________

K	W	H	L
What I know	What I Want to Know	How will I find my answers?	What I learned



ENERGY STORY



Introduction

Energy is one of the most fundamental parts of our universe.

Photo credit: corbisimages.com

We use energy to do work. Energy lights our cities. Energy powers our vehicles, trains, planes and rockets. Energy warms our homes, cooks our food, plays our music, gives us pictures on television. Energy powers machinery in factories and tractors on a farm.

Energy from the sun gives us light during the day. It dries our clothes when they're hanging outside on a clothes line. It helps plants grow. Energy stored in plants is eaten by animals, giving them energy. And predator animals eat their prey, which gives the predator animal energy.

Everything we do is connected to energy in one form or another.

Energy is defined as:

"the ability to do work."

Photo credit: corbisimages.com

When we eat, our bodies transform the energy stored in the food into energy to do work. When we run or walk, we "burn" food energy in our bodies. When we think or read or write, we are also doing work. Many times it's really **hard** work!

Photo credit: corbisimages.com

Cars, planes, light bulbs, boats and machinery also transform energy into work.

Work means moving something, lifting something, warming something, lighting something. All these are a few of the various types of work. But where does energy come from?

There are many sources of energy. In **The Energy Story,** we will look at the energy that makes our world work. Energy is an important part of our daily lives.

The forms of energy we will look at include:

- Electricity
- Biomass Energy - energy from plants
- Geothermal Energy
- Fossil Fuels - Coal, Oil and Natural Gas
- Hydro Power and Ocean Energy
- Nuclear Energy
- Solar Energy
- Wind Energy
- Transportation Energy

We will also look at turbines and generators, at what electricity is, how energy is s to users, and how we can decrease or conserve the energy we use. Finally, we'll loc at the "newer" forms of energy...and take a look at energy in the future.

You can start with **Chapter 1: Energy - What Is It?** by clicking the link below. O you can go to any of the other chapters.

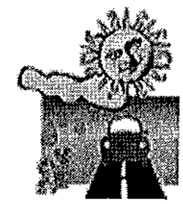
The Energy Story - Table of Contents

Energy Story Section Updated: April 22, 2002

Appendix H

Name____________
Date______________

ALTERNATIVE FUEL MATTERS



Researcher's Portfolio

Energy ABCs - Activity 2

1. List the letters of the alphabet you were assigned.

2. For each letter of the alphabet you have been assigned, list several devices or machines that begin with that letter. For each device or machine list the types of energy it uses or displays.

Letter	Machine	Energy

3. Decide which machine is your group's favorite representative for each letter. You will have to pantomime these machines to the class. They will have to guess what type of machine you are imitating or trying to depict.

4. Write your results for each letter of the alphabet below:

Letter	Machine	Energy
A		
B		
C		
D		
E		

F		
G		
H		
I		
J		
K		
L		
M		
N		
O		
P		
Q		
R		
S		
T		
U		
V		
W		
X		
Y		
Z		

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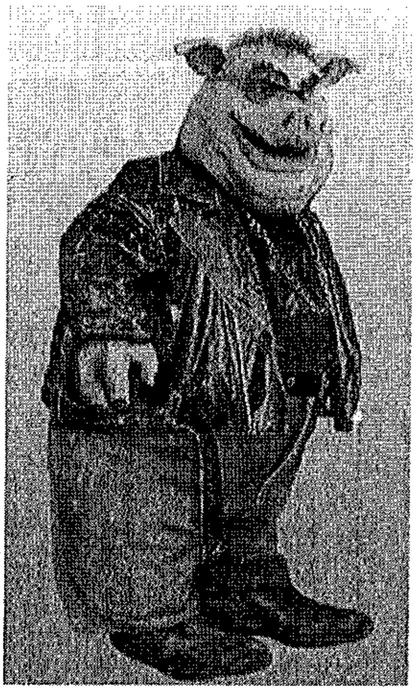
Appendix I

BewARE - Energy Hogs Last Seen Headed Your Way!

New energy education materials available for educators



Do you have energy hogs in YOUR home? If your home is wasting energy, chances are you do – and you've got to get them out. That's the message students get when they take the *Energy Hog Challenge* – a new, free set of classroom activities created for grades 3-6. At a time when energy prices are rising and putting **additional** stresses on the family budget, now is a good time to teach your students the importance of saving energy.

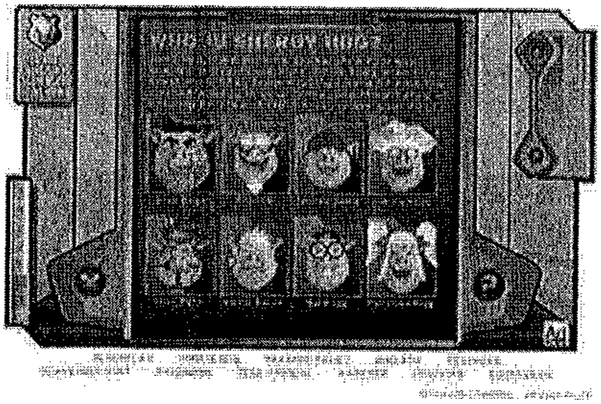
The Alliance to Save Energy's Energy Hog campaign was created by the Ad Council, creator of Smokey Bear, "Friends Don't Let Friends Drive Drunk," and other famous public service advertising (PSA) campaigns. This PSA campaign features a dastardly character, the Energy Hog, who puts an engaging face to the invisible concept of wasting energy. He takes a topic of low interest and makes it fun for children, while empowering them to inspire their parents to make smart energy choices.

To download the free classroom activities, go to www.energyhog.org and click on the Teachers button. A Teacher's Guide takes teachers through the lessons, and a Student's Guide can be printed out for each student. The Student's Guide includes a take-home Energy Hog Scavenger Hunt that kids can do with their parents to evaluate the energy efficiency of their own home.

In addition to the classroom activities, the campaign includes TV, radio, and Internet PSAs directing people to the campaign website, www.energyhog.org. Here, children "train" to become Official Energy Hog Busters by successfully completing five fun games that also teach them how to save energy. Kids who win all five games and become Official Energy Hog Busters can print out a certificate.

Americans use more energy with each successive year. The Energy Hog campaign strives to *decelerate* this trend by raising public awareness about the benefits of saving energy at home.By practicing simple efficiency measures, families can build strong energy-saving habits, reduce their own energy bills, and help their communities by reducing energy-related pollution.

The Alliance to Save Energy is the nonprofit sponsor of the Energy Hog campaign. Partners in the effort include the U.S. Department of Energy, the Home Depot, the North American Insulation Manufacturers Association, 18 state energy offices, and one utility company.



On www.EnergyHog.org, several different Energy Hogs are found. Each loves to waste energy in a different way, and there are different ways to stop each of them, as kids learn to save energy at home.

Maria Ellingson is the campaign director at the Alliance to Save Energy. She can be contacted at *mellingson@ase.org*, or (202) 530-2247. More information on the Energy Hog campaign can be found at ww.energyhog.org.

Current Issue | Archives | NCSTA

The Science Reflector
Newsletter of the North Carolina Science Teachers Association
PO Box 1783, Salisbury, NC 28145
Elizabeth Snoke Harris, Editor

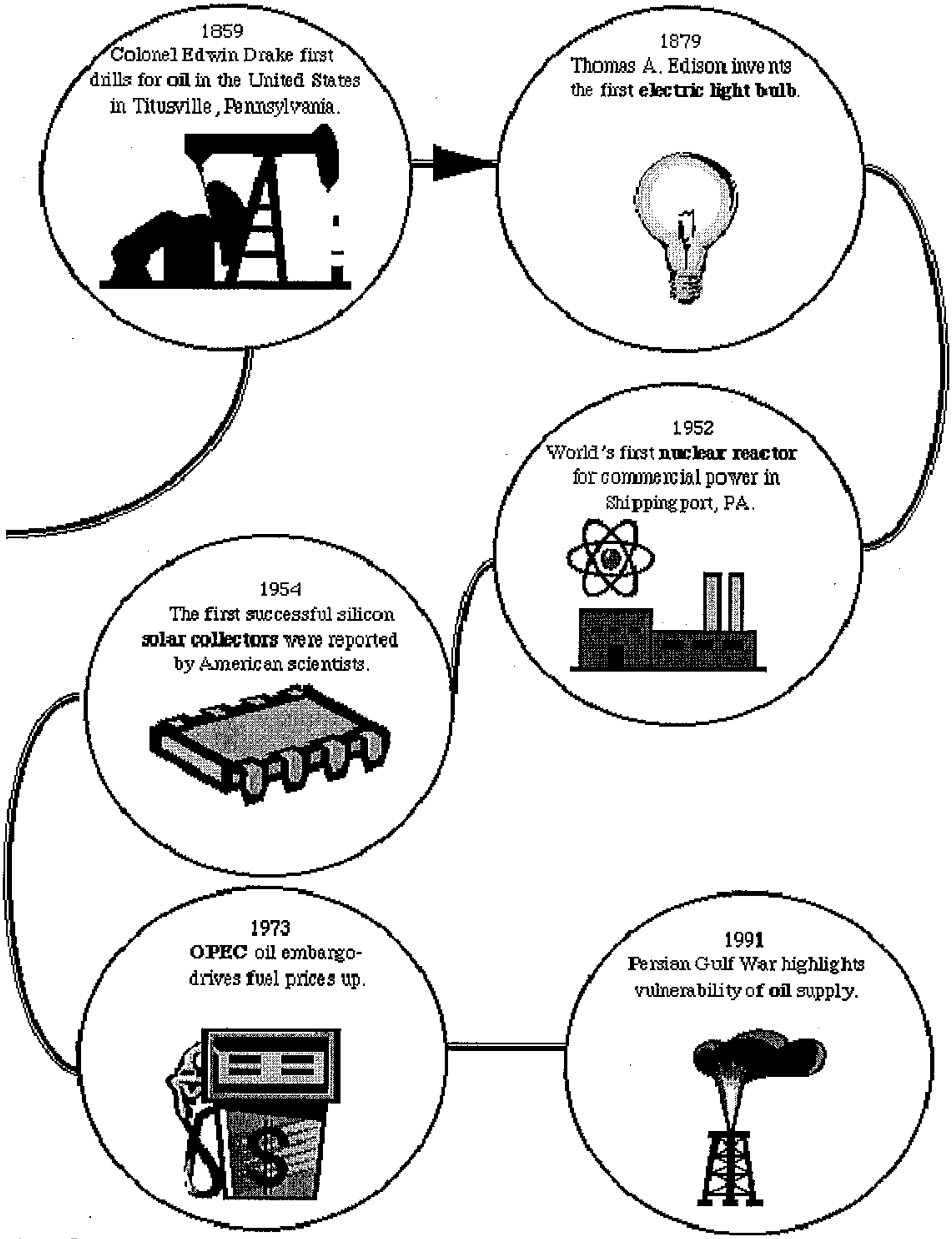
Appendix J

Refer to these web pages for further historical **tim**e lines for energy

http://www.energyquest.ca.gov/time_machine/700000bce-1000bce.html

http://www.cfo.doe.gov/me70/history/links.htm

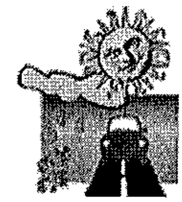
Appendix K



Taken from MAST Home Page

Appendix L

ALTERNATIVE FUEL MATTERS



Energy Wheel - Activity 1

Time: 1 - 1.5 hours

Student Objective
The student will:

- design and construct an energy resource wheel.
- use the wheel as a reference device.
- share and compare information on the resource wheel.

Key Words:

- biomass
- coal
- electricity
- fossil fuel
- geothermal
- hydrogen
- hydropower
- natural gas
- nonrenewable
- nuclear (uranium)
- petroleum
- propane
- renewable
- solar
- wind

Materials:

- *Intermediate Energy Infobooks*
- Researcher's Portfolio, Energy Wheel
- Poster board
- Markers
- Fasteners
- Scissors
- Rulers
- Template

Internet sites:

Renewable energy education module
NEED Project (National Energy Education Development Project)
National Renewable Energy Lab's Education Office

Procedure:
Students will create a wheel that may be used throughout the entire unit as a reference to renewable or nonrenewable energy sources. Energy resources are either renewable or nonrenewable (see *Intermediate Energy Infobook*). Some energy sources are called nonrenewable because the amount available is limited. Renewable energy sources such as solar, are relatively endless. Scientists believe the sun will be around for another 5 to 8 billion years.

1. Assign students to small groups.

2. Distribute the *Intermediate Energy Infobooks*, Researcher's Portfolio, Energy Wheel, and Energy Wheel.
3. Lead the class in the development of a rubric to assess their final product. Opportunities for self, peer, and teacher assessment should be provided.
4. Students should complete the Researcher's Portfolio, Energy Wheel and share their products with the class.

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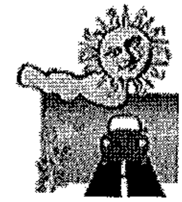
ALTERNATIVE FUEL MATTERS



Researcher's Portfolio **Energy Wheel - Activity 1**

You will be using classroom materials to produce an energy wheel to represent the most common forms of energy.

1. With your team members, review the information in the *Energy Infobooks*.
2. Discuss the various energy resources.
3. Create a symbol to represent each of the twelve energy sources listed below.

Nonrenewable	Renewable
Coal	Solar
Propane	Wind
Natural gas	Geothermal
Petroleum	Hydropower
Nuclear	Hydrogen
Electricity	Biomass

Note: *Electricity is a secondary energy source and can be considered renewable or non-renewable. Because it is most often generated through the use of non-renewables, list it with the non-renewable energy sources.*

4. Trace and cut out form A (viewer) on poster board or a file folder.
5. Trace and cut out form B (wheel) and form C on poster board or a file folder.
6. Using form C, trace six wedges onto each side of the wheel (form B).
7. Design your wheel to have renewable energy forms on one side and non-renewable energy forms on the other side.
8. On the outer edge of each pie section, print the name of the energy source.
9. Under the names (but within the pie lines), draw the energy symbol you selected to represent that energy source, followed by an interesting fact. Do this on both sides of the wheel.
10. Fold the viewer (form A) on indicated fold line.
11. Punch a hole in your wheel and viewer where indicated. Place the wheel between the folded sides of the viewer.
12. Fasten the two forms together using a duo-tong fastener. The wheel should turn freely to reveal information through the window.
13. Decorate your viewer.

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ALTERNATIVE FUEL MATTERS

Researcher's Portfolio **Energy Wheel - Activity 1**

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Petroleum	Hydropower
Nuclear	Hydrogen
Electricity	Biomass

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9. Under the names (but within the pie lines), draw the energy symbol you selected to represent that energy source, followed by an interesting fact. Do this on both sides of the wheel.
10. Fold the viewer (form A) on indicated fold line.
11. Punch a hole in your wheel and viewer where indicated. Place the wheel between the folded sides of the viewer.
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13. Decorate your viewer.

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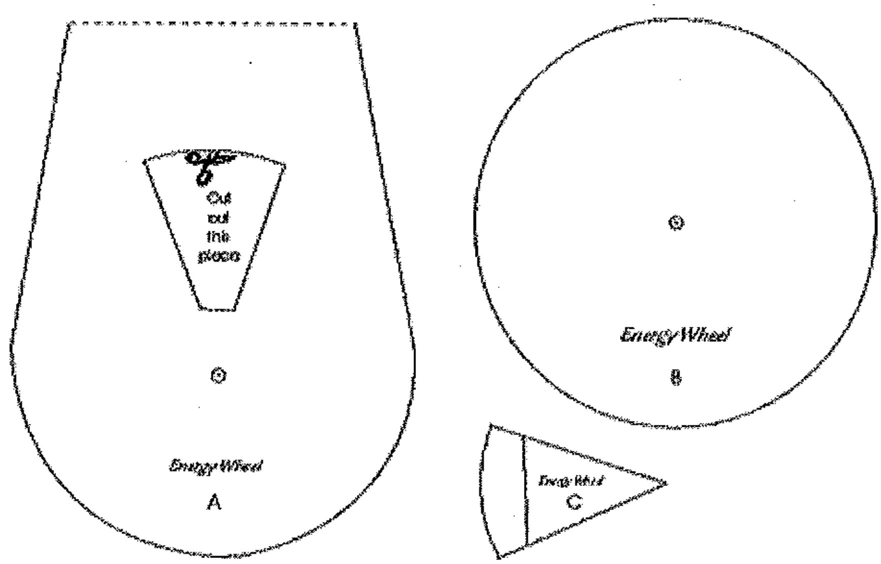
Activities

ALTERNATIVE FUEL MATTERS

Work Page

Energy Wheel - Activity 1

You will be using classroom materials to produce an energy wheel to represent the most common forms of energy using templates like these.



Get Acrobat Reader These templates are not to scale. Click on the above drawings to download the PDF file.

The templates to scale are available in PDF format. To view it you must have Adobe Reader. Click on the icon to download the software.

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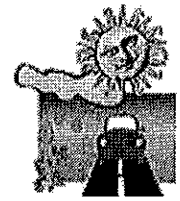
ALTERNATIVE FUEL MATTERS



Self/Group Assessment **Energy Wheel - Activity 1**

1. Answer the following questions about yourself:

a. The part I liked best about this project was...

b. If we did this project again I would like to try .

c. I helped move my group forward when I.

2. Answer the following questions about each of the other members of your group:

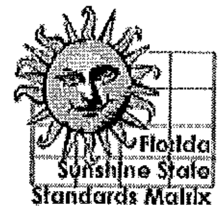
a. The part I liked best about working with you .

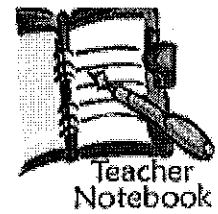
b. If we did this project again you may want to try .

c. It was especially helpful to me when you.

d. You helped move the group forward when you.

Share your answers in the second section with each member of your group.





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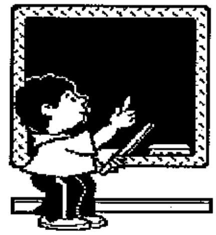


Name:______________________________
Date:_______________________________

Name:____________________________________ **Date:**____________
Internet Field Trip

Trip Log

GRADE ________________________

UNIT TITLE ____________________________________

I am studying ____________________________________in my science class.

WHAT I ALREADY KNOW ABOUT THIS SUBJECT

____

____

OTHER THINGS I WANT TO KNOW ABOUT THIS SUBJECT

____
____
____
____
____
____

WEB SITE
I visited this Web site:

____

WHAT I LEARNED ON MY INTERNET FIELD TRIP

1. ____
____

2. ____
____

NEW WORDS

I learned these new words on my Internet Field Trip. Here are the words and their meanings.

WORD	MEANING

WHAT I SAW ON MY INTERNET FIELD TRIP

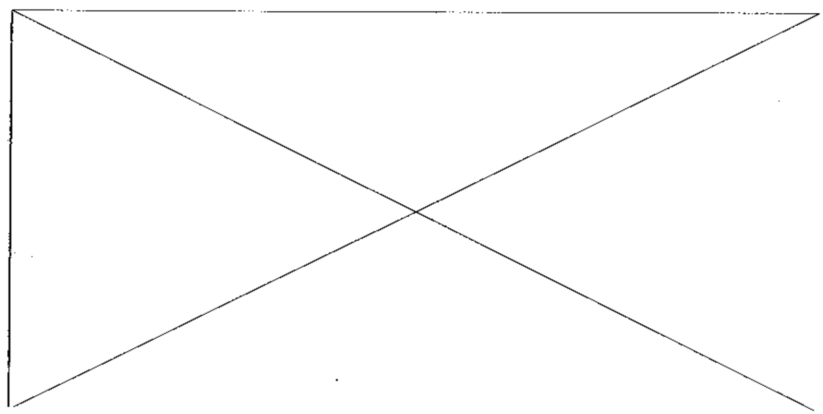
This is a drawing of ______________________________.

Appendix N

Energy and Electricity

Objectives

- Students will gain an understanding of the terms "volt," "amp," "watt," "watt-hour," and "kilowatt-hour."
- Students will collect data about electricity consumption.



- Students will work with equations.
- Students will report findings to the class.

Materials

- Student Assignment Sheet
- Data Collection Sheet

Procedures

1. Come to class prepared with some data from appliances in your own home, or in the school. Use this information to create problems that can be solved with the equation W = V x A.
2. Explain the terms "volt," "amp," "watt," "watt-hour," and "kilowatt-hour." This is not for high-school physics, so the technical aspects of electricity need not be covered; students are simply told that electricity has strength, or power, that is measured in amps, and that it is "pushed" into their homes by a force that is measured in volts. The amount of work that electricity does is measured in watts, and the amount of work done in an hour is measured in watt-hours. One thousand watt-hours equals one kilowatt-hour. Consumers are charged for their electricity by the kilowatt-hour.
3. Introduce students to the equation W = V x A (watts = volts x amps), and work some problem examples on the board.

Notes:
It is assumed that students participating in this project have a basic understanding of equations and related sentences. In other words, they should know that:

if $W = V \times A$

then $V = W/A$

and $A = W/V$

This is important because they should be able to find data for any two variables and calculate an answer for the third (for a particular electrical appliance or tool). An additional hour should be provided if students need work on solving equations.

4. Give students the Student Assignment Sheet and the Data Collection Sheet and discuss proper ways of finding information about appliances, and recording it on the data sheet.
5. Show students how to calculate watt-hours per week, watt-hours per month, watt-hours per year, and kilowatt-hours.
6. Their assignment is to take the data sheets home and complete the required research for at least six appliances or tools.
7. Students should be required to find out how much one kilowatt-hour of electricity costs from the local utility company.
   They can obtain this information from a family electricity bill or from a phone call to the power company. A figure for cost per kilowatt-hour is necessary so students can calculate how expensive certain appliances or tools are to operate per day, week, month, or year.
8. After they have completed their assignments at home, have them use their research findings to discuss the energy consumption of various appliances.
9. A discussion about energy conservation and production would be an obvious addition to this hour's lesson.
10. Ask students how they would react if a situation arose in which electricity had to be rationed.
    - Which appliances or tools could they live without and which would be essential?
    - What electrical machines, other than household appliances, are crucial to the quality of our modern life?
11. At the end of the hour, students turn in their homework.

Extension Activities

- An additional hour may be needed if time is to be spent in class calculating how much it costs to operate each student's list of appliances and tools.
- The project can be expanded to include increased emphasis on the data that students bring in. For example, charts can be made to compare the amount of electricity consumed by certain appliances, or a composite "household" can be developed to illustrate electricity consumption throughout a home. There are many directions this project can go once basic data collection has been completed.

Excerpted from *Science Projects*.

Energy and Electricity Student Assignment Sheet

Electricity is a basic source of energy available to most people in America. It is so basic, in fact, that we take it for granted and just assume it will always be there. Yet somebody has to provide electricity, and it has a cost. If the bills aren't paid, lights go dark, stereos stop playing, refrigerators stop cooling, televisions lose sight and sound, computers shut down – things aren't the same without electricity. For this project you will examine a number of appliances, machines, and tools in your home to see how much electricity they use and how much it costs to operate them. This activity should provide some insight into the importance of electricity in your life (just add up the number of electricity-consuming items in your house), and into the mathematics involved in making calculations about electricity consumption and cost. Electricity is an important area in the study of physics, so you are also being introduced to that branch of science.

Here is your assignment.

I. On the energy and electricity Data Sheet:
   A. List at least six items in your home that run on electricity.
   B. Under the appropriate heading, record pertinent information you find at home about each item. You are looking for volts, amps, or watts. Find two of these, and then use the equation "watts = volts x amps" from the data sheet to calculate the third. Write "given" in the box with each piece of information that you find written on an appliance. An appliance example is done for you on the data sheet handout. The voltage and wattage information was found written on the cassette tape deck, so the word "given" is recorded next to these entries. Then the equation A = W/V was used to calculate amps for this item.
   C. Estimate and record how many hours each item is used in a typical day.
   D. Also calculate and record for each item:
      1. Watt-hours per day
      2. Watt-hours per year
      3. Kilowatt-hours per year
      4. Cost per year for the electricity used (you will need to find out how much one kilowatt of electricity costs).

II. On a separate math worksheet show all the calculations for your data sheet entries in an orderly way. The answers should be labeled with units.

III. Be prepared to present your work to the class if called upon.

IV. Turn in your completed energy and electricity Data Sheet and the math worksheet that shows all of your calculations.

Excerpted from *Science Projects*

Name ______________________ Date ______________________

ENERGY AND ELECTRICITY DATA SHEET

VOLTS: The "force" that pushes electricity through a wire.

AMPS: The "strength" of an electric current; the amount of current being pushed through a wire.

WATTS: Unit of electric power or energy.

WATT-HOUR: The amount of work one watt of electricity can do in one hour.

COST PER KILOWATT-HOUR: This is how you are billed for the electricity you use at home. In your area cost per kilowatt hour = ________.

KILOWATT-HOURS: $\frac{\text{watt-hours}}{1000}$

1. WATTS = VOLTS × AMPS
   W = V × A
2. WATT HOURS = W × T (timed used)
3. Most things that plug into a wall socket use 110 volts.
4. Some large appliances and motors use 220 volts.

APPLIANCE OR TOOL	VOLTS $V = \frac{W}{A}$	AMPS $A = \frac{W}{V}$	WATTS $W = V \times A$	HOURS OF USE/DAY ESTIMATED	WATT-HOURS/ DAY	WATT-HOURS/ YEAR	KILOWATT-HOURS/YEAR	COST/YEAR
CASSETTE TAPE DECK	GIVEN: 120	CALCULATED: .075	GIVEN: 9	3	27	9855	9.855	$0.70
1.								
2.								
3.								
4.								
5.								
6.								
			TOTALS:					

4. How Much Energy Do You Use?

Subjects:
Science, Math, Social Studies, Home Economics

Process Skills:
Counting, multiplication, use of calculators, comparing, data gathering

Grades:
3—6

Cognitive Task Level:
Average to difficult

Time for Activity:
15 minutes preparation, one day's homework, 20 minutes classwork

Intended Learning Outcomes:
Completing this activity will allow students to:
- Observe the items that use energy in their own homes
- Calculate the energy cost for their own homes
- Compare this cost with others in their class and with the national average.

Background
U.S. residents use more energy now than we ever have in the past. There are many reasons for this. As more people populate the country, energy needs rise. Technology advances, such as industrial processes, sophisticated machinery and computers also require increased energy. Our everyday lives are filled with electrical appliances that our grandparents never used.
Why is our energy bill so high? This activity gives your students a chance to work on some real-life math problems. This activity bases its numbers on cost figures from one utility. Energy figures in your area may be different. Your local energy utility can give you figures that show the average expenditure per household in your community.

Materials
Calculators
Handout

- *Energy Home Survey* worksheet

Procedure
1. Start by asking your students if they ever heard their parents complain about the cost of energy. Explain that the monthly utility bill is directly related to the amount of energy the household uses, and that this activity will help them find the "energy-eaters" in the house.
2. Distribute the Energy Home Survey worksheet and assign the homework.
3. When students have completed the homework assignment, assist them in answering the questions and completing the math.
4. Ask them if they found appliances in their homes they think they could live without, such as an electric can opener or an electric plate warmer.

Extensions/Modifications
A good introduction to this activity is to encourage students to ask a grandparent, or older relative or neighbor about what life was like when they were children. Many grandparents grew up before television, commuter flights and digital clocks. The student could interview the senior and write a report comparing an aspect of energy use "then" vs. "now."

Appendix P

Energy Home Survey

Do this survey twice: once in the morning before school, and once just before dinner. It will help you determine
how much energy you use.

Appliance Multiply by Subtotal Total per day

Electrical Appliances

Incandescent Lights:
Number of lights on = 1 cent per hour
Fluorescent lights:
Number of lights on = 1 cent per every 4 hours
Television:
Number of sets on = 4 cents per hour
Radio:
Number of sets on = 1 cent per hour
Stereo:
Number of sets on = 2 cents per hour
Microwave oven:
Number of ovens on 15 cents per hour
Computer:
Number of computers on = 1 cent per hour
Vacuum cleaner:
Number on 9 cent per hour
Portable heater:
Number on = 15 cents per hour
Air conditioner:
Number on = 55 cents per hour
Total for all subtotal usage
Total usage in one day

Add up all the numbers in the Subtotal column. This subtotal is the total cost for these appliances in one hour.

Some of these appliances will be on for more than one hour, some less. Based on what you know about your
household, write the total number of hours and the total cost in one day for these appliances in the Total per
day columns above.

(Example 1: If two stereos are on for eight hours a day, you multiply 2 (stereos) x 2 cents per hour x
8 hours = 32 cents per day. Example 2: If you vacuum for 1/2 hour, multiply by 9 cents per hour x .5
hours = 4.5 cents per day.

Periodic Appliances

Some items are not used all the time. They create a cost only when they are used.

Periodic Appliances

Appliance and loads per month Multiply by Total per month

Dishwasher:
Loads = 10¢ per load
Washing machine:
Loads = 5¢ per load
Electric clothes dryer:
Loads = 67¢ per load
Gas clothes dryer:
Loads = 16¢ per load
Total usage for one month

These answers give you the total cost per month, based on how much your family uses these appliances.

Periodic Appliances:

Appliance and average use per month Total per month

Gas water heater: $13.00
Electric water heater: $45.00
Refrigerator: $16.00
Extra freezer: $18.00
Electric heating system:
Small home: $85.00
Large home: $250.00
Gas heating system:
Small home: $28.00
Large home: $120.00
Total for 1 month

With your teacher's help, try to figure out your home energy costs for one month. Compare it to the bill that
your parents receive each month. How do they compare?

My estimate: _______________
My parent's bill: _____________

Did your estimate come close to the actual cost? If not, why do you think they differ?

Credit: The National Wildlife Federation's Animal Tracks Activity Guide for Educators.

Appendix Q

Energy Scavenger Hunt

Your mission – if you accept the challenge – is to use the following web sites to answer the corresponding questions which deal with traditional energy sources and alternative sources.

http://www.energyquest.ca.gov/story/index.html

1. What are the three major forms of fossil fuels?
2. Coal is a hard substance made up of

   a.

   b.

   c.

   d.

   e.
3. How is coal mining performed?
4. Coal is used in what ways?
5. Where can you find oil and natural gas deposits?
6. What % of the oil we use in the Unites States comes from the Middle East?
7. What are three examples of products made from oil?
8. Natural gas is also known as, __________________?

9. What is the difference between "natural gas" and "gasoline."

10. What is natural gas used for?

11. Why do some people feel natural gas is a good choice for fueling automobiles?

12. What is biomass?

13. How can biomass be used as an energy source?

14. Does biomass effect global warming?

15. What does the term "geothermal" mean?

16. Geothermal energy in California is being used in what way?

17. What can geothermal also be used to create in factories?

18. What amount of geothermal energy is being produced in California power plants?

19. The term hydro means ______________________________?

20. How is hydroelectric power used?

21. What % of electricity used in the United States is supplied by hydroelectric power?

22. How does a hydro dam work?

23. A nuclear power plant is fueled by ______________________.

24. Describe the reaction that takes place in a nuclear reaction.

25. Why do some scientists believe nuclear fusion is better than fission in a reaction?

26. Name three basic ways to tap the ocean for energy?

27. What is wave energy?

28. What is tidal energy?

29. How could power plants benefit from the use of ocean thermal energy conversion?

30. Solar water heaters date back to ________________?

31. How are solar water heaters used today?

32. What is solar thermal electricity?

33. Describe photovoltaic energy.

34. What experimental item is using photovoltaic cells today?

35. Describe the process of wind energy.

36. What speed of wind is required for a wind turbine to generate electricity?

37. When looking at the differences between renewable energy and fossil fuels, which state has enough wind gusts to produce 11% of the world's wind electricity?

38. How much money did the U.S. spend for oil from foreign countries in 2000?

39. List three drawbacks to using renewable energy sources.

40. One future energy source is hydrogen. How is NASA currently using hydrogen in the space program?

http://www.eren.doe.gov/pv/pvenv.html

41. List four positive aspects for the environment from the use of photovoltaic energy.

http://www.zebu.uoregon.edu/1996/ph162/review.html

42. Why do we need to look for alternate energy sources?

http://www.nei.org

43. What pollutants are emitted into the air during the production of nuclear energy?

44. The experts tell us … where and when was the first commercial nuclear energy power plant built?

http://www.eren.doe.gov/geothermal

45. Describe the environmental and economic impact of using geothermal energy.

http://www.eren.doe.gov/biopower/main.html

46. Is biomass harmful to the environment and if so, what are the effects?

http://www.usbr.gov/power/edu/hydrole.htm

47. Compare the cost of generating hydropower to other sources of electricity.

48. According to the chart showing hydroelectric generating capacity, what is the total number of plants in the state of Illinois?

http://www.energy.ca.gov/development/oceanenergy

49. Tidal power requires large large tidal differences. These occur off only two states in the U.S. which are ______________________?

50. Name three environmental concerns that relate to the use of wind energy.

DRAFT-O-METER

Linda Gregory
Urbita Elementary School, San Bernardino, CA
Adapted from the Tennessee Valley Authority

Linda Gregory
Urbita Elementary School, San Bernardino, CA
Adapted from the Tennessee Valley Authority

Objective: Students will:

1. Learn an easy technique to measure the presence of drafts in their homes and classrooms.
2. In a follow-up exercise, students can create draft guards (see Worm Warmers lesson).

Materials: Pencil, tape, plastic food wrap

PROCEDURE

1. Cut a 12cm by 25cm strip of plastic wrap.
2. Tape the shorter edge of the wrap to a pencil and let the rest hang freely.

3. Blow plastic wrap gently and note how sensitive the wrap is to air movement. Drafts mean that air is leaking into or out of a building. This means either a loss of f heat in winter or a loss of air conditioning in summer. Alliance to Save Energy's Green Schools Program 1 of 2 **FOLL**

OW UP A. dents can complete the following "Home Draft Checklist" to assess where drafts are in their homes. B. Have students complete the "Worm Warmers" activity to guard against the drafts they detected in this exercise.

HOME DRAFT CHECKLIST Check each of the locations where drafts are likely. Where your draft-o-meter detects drafts, rate them by checking the right column. Rate drafts as 1 (strong), 2 (moderate), or 3 (weak). If there is no draft, check the "no draft" column. If your home does not have a listed location, just draw a line through that location. **DRAFT RATINGS**

DRAFT LOCATIONS NO DRAFT 1 2 3 1. Exhaust fans in bathrooms and kitchens 2. Dampers in fireplaces and woodstoves 3. Doors 4. Windows 5. Light fixtures attached to walls and ceilings 6. Attic door 7. Window air-conditioning units left in place in winter 8. Mail chutes or slots in walls or doors 9. Cracks in the foundation of the house or holes where pipes pass through 10. Where porches and steps meet the house Alliance to Save Energy's Green Schools Program 2 of 2

WORM WARMERS (DRAFT GUARDS)

Linda Gregory

Urbita Elementary School, San Bernardino, CA

Overview: Creation of draft guards to help reduce energy waste. (This lesson follows the Draft-O-Meter lesson in which drafts are detected.)

Objective: Students follow directions to make a draft guard.

Subjects: Language Arts, Science (Earth and Physical Science)

Suggested Grade Level: K-6

California Standards addressed:

- Language Arts – Listening and Speaking Grade 1 #1.1, 1.3, Listening and Speaking Grade 2 #1.1, 1.2, 1.4
- Science – Investigation & Experimentation Grade 1 #4b, Earth Science Grade 2 #3e, Physical Science Grade 3 #1c, 1d, Physical Science Grade 4 #1g

Materials:

- dry rice or lentils (each draft guard needs at least 2 pounds of rice)
- plastic wiggly eyes (2 per student)
- fabric glue
- pre-sewn fabric sacks
- one finished draft guard (1 per student)
- small cups for scooping (1 per student)

BACKGROUND INFORMATION

This is a follow up lesson to the Green Schools lesson on making draft detectors. After students have made the detectors and used them to find areas in the school or home where there are drafts they make draft guards to solve the problem.

PROCEDURE

I. Setting the stage

A. The fabric sacks for the guards should be pre-made as they require a sewing machine. Each sack uses 6 inches by 38 inches of material. The sacks are sewn up the bottom and the sides, leaving the top open for filling.

B. Ask students if they remember why they made draft guards in the previous activity. Remind them that these were made so they could find places in their homes or classrooms where drafts allow air to leak in or out of the room causing higher energy costs.

C. Hold up the finished draft guard and tell them that this is our new classroom "Worm Warmer" and he can help us to cut down on drafts. Ask students how they think he can help and demonstrate laying the worm warmer on a windowsill or below a door where it can block a draft. Ask students to think of one place where they think a worm warmer would be helpful and share their answers.

D. Explain that they are going to make a worm warmer too. Take the class outside to an area where spilled rice will not be a problem. This is very messy indoors.

II. Activity

A. Open up the bags of rice and show how to hold the open end of the sack wide to pour in a cup of rice.

B. Explain that when they are done they use the fabric glue to add the eyes and to close the top of the worm warmer.

C. Students will take about 15 to 20 minutes to fill the worm warmer, add eyes, and close the top, depending on their age. They should hold the end shut for one or two minutes to seal the glue.

FOLLOW UP

A. Ask students to take their worm warmers home to guard against drafts or to place them in their classroom to help cut energy costs.

B. The worm warmers make excellent gifts as well.

EXTENSIONS

Use the thermometer gun in the Green Schools kit to measure the temperature near a draft before and after the draft guard is in place.

CRAFTING MODELS OF EFFICIENCY

Laura Honda, Manor School
Ross Valley School District, California

Overview: Allowing students to use their knowledge on energy and creativity to build energy efficient and non-energy efficient cardboard classroom models. Thus, providing a visual comparison between energy efficient and non-energy efficient classroom models.

Objectives:

1. Encourage students to apply their background knowledge of energy with creativity
2. Entice curriculum by integrating art and energy efficiency/conservation subjects together
3. Demonstrate a creative way to utilize recycled items

Subjects: Energy Efficiency/Conservation and Art

Suggested Grade Level: 3rd, 4th, and 5th grades

California Standards Addressed:

- 3rd grade:
  - Science: Investigation and Experimentation 5.c. Students use numerical data in describing and comparing objects, events, and measurements.
  - Science: Investigation and Experimentation 5.e. Students collect data in an investigation and analyze those data to develop a logical conclusion.
- 4th grade:
  - Science: Investigation and Experimentation 6.a. Students differentiate observation from inference (interpretation) and know scientists' explanations come partly from what they observe and partly from how they interpret their observations.
- 5th grade:

- Science: Investigation and Experimentation 6.f.

Funding for this lesson plan is provided by California utility ratepayers under the auspices of the California Public Utilities Commission.

Students select appropriate tools (e.g. thermometers, meter sticks, balances, and graduated cylinders) and make quantitative observations.

- Science: Investigation and Experimentation 6.h.
  Students draw conclusions from scientific evidence and indicate whether further information is needed to support a specific conclusion.

Time: 4-6 one-hour class periods
Materials:

- Solar-House Kit
- Recycled Items: Pizza boxes, paper & plastic scraps, T.P. rolls etc.
- Art Materials: Paint, scissors, glue etc.
- Green Schools Materials

PREPARATION AND BACKGROUND: The objective of the lesson is to allow students to apply their energy knowledge to a hands-on project. Students will then learn the differences between energy efficient homes and non-energy efficient homes visually.
Procedure/Activities:

1. Lead a discussion with student about what to include in the energy efficient classroom and the energy inefficient classroom.
2. Record their responses on board.
3. Instruct the students that two of them together will develop their own models. Tell them they have the following recycled materials to use: pizza boxes, paint, paper and plastic scraps, T.P. rolls and mini solar cells with fans.
4. Once the models are constructed, have the students take them outside to see if the solar fan works
5. Temperature Experiment - have students place a thermometer inside the efficient model (with light colored roof) and the inefficient model to see if there is a temperature difference.

6. Students share their models with other classes and explain why having insulation, thermal reflective barrier, double paned windows, shade trees, etc. save energy.

Funding for this lesson plan is provided by California utility ratepayers under the auspices of the California Public Utilities Commission.

7. Make presentation about models for PTA and at staff meeting

For Discussion:

1. The initial discussion is important because it helps students remember and review what they learned about energy efficiency.
2. After the students test out their models, have them discuss what they found when they took the models out into the sun. If the fan turned, why did that happen?

Extensions/Evaluations: Students can explain about every detail of our energy efficient and non-energy efficient models. Have them present their models to the PTA, to the School Board, to other classes in the school.

Resources:

1. Solar House Kit - mini photovoltaic cell with solar powered ceiling fan, light bulb, and principle of sun heated water from NEED
2. Energy Color Experiment from Green Schools

Appendix T

Welcome to Jeopardy!
<u>Energy Unit</u>
Test Review: Chapter 16 & 24 (parts)

100 points
■The main purpose of this type of food is to provide "quick energy."
■What is a carbohydrate?

200 points
■This type of food provides the most Calories (energy) per gram.
■What is a fat?

300 points
■The FDA recommends that only 10% of our Caloric intake come from this type of food.
■What is protein?

400 points
■The number of Calories in a food that contains, 25 grams of Carbohydrate, 3 grams of Fat, and 8 grams of Protein.
■What is 159 Calories?

500 points
■The amount of Fat (in grams) it would take to make 810 Calories.
■What is 90 grams?

100 points
■$Q = mDT\ C_p$
■What is the equation to calculate thermal heat?

200 points
■1.0 cal/g°C and 4.184 j/g°C are both values for this constant.
■What is the specific heat of water?

300 points
■A Food Calorie is actually equal to 1000 of these.
■What is a small "little bitty" calorie?

400 points
■This is the Calories per gram (Cal/g) of a certain food with a 38 gram serving size containing 300 Calories? (with sig figs of course)
■What is 8 Cal/g?

500 points
■The enthalpy of fusion deals with the boundary between these two states of matter and is usually expressed in kj/mol.
■What is the solid/liquid boundary?

100 points
■The process in which a gas changes to a liquid.
■What is condensing?

200 points
■At the solid/liquid boundary, this is the change of state that would be exothermic.
■What is freezing?

300 points

■The process in which a solid changes to a gas.

■What is sublimation?

400 points

■At the liquid/gas boundary, this is the process that would be endothermic.

■What is boiling?

500 points

■The process in which a gas changes to a solid.

■What is deposition?

100 points

■The ability to produce heat or do work.

■What is Energy?

200 points

■The energy of motion.

■What is Kinetic Energy (KE)?

300 points

■The Law that states energy can't be created or destroyed.

■What is the Law of Conservation of Energy?

400 points

■This is defined as the flow of energy from hot to cold.

■What is heat?

500 points

■The measure of disorder.

■What is Entropy?

100 points

■Plants are the main source for this type of fat.

■What is unsaturated fat?

200 points

■In this type of fat, all the carbon to carbon bonds are single bonds

■What is saturated fat?

300 points

■One reason we need fat is that it's required for the formation of this part of the cell.

■What is the cell membrane?

? Points (Daily Double)

■This is the type of fat that is liquid at room temperature

■What is unsaturated fat?

500 points

■These are the three elements that make up a fat.

■What are Carbon, Hydrogen, and Oxygen?

100 points

■When Gibb's free energy is negative, the reaction is said to be this.

■What is spontaneous?

200 points

■Usually, these type of reactions are spontaneous.
■What are exothermic reactions?

300 points

■If the number of gas molecules on the reactant side is greater than the number of gas molecules on the product side, the reaction is classified as this.
■What is non-spontaneous.

400 points

■Between $H_2O(l)$ and $CO_2(s)$, this is the one with the greater Entropy.
■What is H2O?

500 points

■If the value for Entropy (S) is positive, the reaction will most likely be this.
■What is spontaneous?

Appendix U

Meter Reader Quiz found at

http://www.fplsafetyworld.com/fm_ifrm.aspx

The Awful 8: The Play

Purpose:

To become aware of different air pollutants and their causes and effects.

Grade Level:

Sixth to eighth grade

Essential Elements:

Sixth grade science 3B, 4B; seventh grade science 3B, 9C, 1.3, 1.6; social studies 5D, 7C; eighth grade science 3B, 9C, 9F, 1.3.

Objective:

The students will be able to list major air pollutants, what causes them, and their effects on people and the environment.

Focus:

After studying air pollution, students will present a play about the different pollutants.

Materials:

Markers, yardsticks, large pieces of poster board, background information on air pollution, library books that cover air pollutants, materials for "costumes" copies of play for each student, video camera.

Background:

The U.S. Environmental Protection Agency (EPA) has established national ambient air quality standards for six air pollutants - ozone, carbon monoxide, sulphur dioxide, nitrogen dioxide, respirable particulate matter, and lead.

Volatile organic compounds (VOCs) are emitted from sources as diverse as automobiles, refineries, chemical manufacturing, dry cleaners, paint shops, and other sources using solvents. VOCs are precursors to ground-level ozone, and some of the VOCs are toxic.

Chlorofluorocarbons (CFCs) are a family of chemicals commonly used in air conditioners and refrigerators as coolants and also as solvents and aerosol propellants. CFCs drift into the upper atmosphere where their chlorine components destroy upper-level ozone. CFCs are thought to be a major cause of the ozone hole over Antarctica.

The main man-made source of carbon dioxide emissions is fossil fuel combustion for energy-use and transportation. Methane comes from landfills, cud-chewing livestock, coal mines, and rice paddies. The extent of the effects of climate change - or the "greenhouse effect" on human health and the environment is still uncertain, but could include increased global temperature, increased severity and frequency of storms and other "weather extremes," melting of the polar ice cap, and sea-level rise.

Ground-level ozone is a photochemical oxidant and the major component of smog. Ground-level ozone is not emitted directly into the air but is formed through chemical reactions between natural and man-made emissions of VOCs and oxides of nitrogen in the presence of sunlight. Since the reactions are stimulated by temperature, peak ground-level ozone concentrations occur in the summer months. Elevated levels above the national standard may cause lung and respiratory disorders. Short-term exposure can result in shortness of breath, coughing, chest tightness, or irritation of nose and throat. Individuals exercising outdoors, children, the elderly, and people with pre-existing respiratory illnesses are particularly susceptible.

Nitrogen dioxide is formed both by the combustion of nitrogen and the reaction of nitric oxide with oxygen in the atmosphere. Nitrogen dioxide emissions result almost entirely from fuel combustion by industry, energy producers, and motor vehicles. In addition to being a precursor to ground-level ozone, oxides of nitrogen react chemically in the atmosphere to form nitrates. These pollutants can be transported long distances from the source and can contribute to acid rain and impair visibility. Nitrogen dioxide can harm humans at elevated levels above the national standard. In particular, may cause increased respiratory illness such as chest colds and coughing with phlegm in children. For asthmatics, can cause increased breathing difficulty.

Carbon monoxide is produced by incomplete combustion of carbon in fuels. The majority of carbon monoxide emissions come from transportation sources, principally from highway motor vehicles. Carbon monoxide reduces blood's ability to deliver oxygen to vital tissues, affecting primarily the cardiovascular and nervous systems. Lower concentrations have been shown to adversely affect individuals with heart disease and to decrease maximal exercise performance in young. Higher concentrations above the national standard can cause symptoms such as dizziness, headaches, and fatigue.

Sulphur dioxide results primarily from combustion of sulphur-bearing fuels, smelting of sulphur-bearing metal ores, and industrial processes. Major sulphur dioxide emission sources are power plants, refineries, some types of chemical plants, primary metal smelters, and cement plants. These pollutants can be transported long distances from the source and can contribute to acid rain and visibility impairment. Sulphur dioxide becomes sulfuric acid once it comes in contact with moist mucous membranes. At elevated levels above the national standard, it irritates the respiratory tract, causing restricted air flow and breathing difficulty. Individuals with pre-existing pulmonary disease are particularly susceptible to these effects.

Respirable particulate matter includes dust, dirt, soot, smoke, and aerosols emitted into the air by various sources. Major sources of particulate pollution are factories, power plants, refuse incinerators, motor vehicles, construction activity, fires, and natural windblown dust. These microscopic particles can be inhaled and deposited deep in the lungs where they can be trapped on membranes. If trapped, they can cause excessive growth of fibrous lung tissue, which leads to permanent injury. Children, the elderly, and people suffering from heart or lung disease are especially at risk.

The primary sources of lead in the atmosphere are lead-containing gasoline additives, nonferrous smelters, and battery plants. There has been a steady decline in lead levels in the air as a result of the phase out of leaded gasoline and pollution control programs. Elevated levels above the national standard can adversely affect mental development and performance, kidney function, and blood chemistry. Young children are particularly at risk due to their increased sensitivity of young tissues and organs.

Your group can learn about some of the major air pollutants by putting on a play called The Awful 8. By performing the play, they can teach other people about the pollution problems in our atmosphere.

Assign each part under the "Cast of Characters" and pass out copies of the play. Give the kids time to learn their lines, design costumes, and plan any special effects they might want to add.

After the group performs the play, review the eight major air pollutants by having each "pollutant" come out and take a bow. The Pollutants should state their name; what causes them; how they affect people, wildlife and the environment; and what people can do to help reduce this type of pollution. Or you can have the audience supply this information to see how much they learned from watching The Awful 8.

Procedure:

1. Distribute copies of the play to each student.
2. Have class read play aloud, following seating arrangement for each part.
3. Assign students to different roles; for homework practice lines and bring own props.
4. Next 3 days - practice play.
5. Present and/or video record play when students are ready.

Closure:

List ways we can prevent or reduce the types of air pollution mentioned in the play.

Enrichment:

1. Put a Sock On It Activity - place a white sock over a car's tailpipe; have adult start engine and let run for a few minutes; inspect sock and compare with a clean sock.
2. Brainstorm solutions to air pollution problems - be creative.

The Awful Eight Play

A play about eight major air pollutants

Cast of Characters:

The number of characters and some suggestions for props and costumes are in parentheses.

- **Connie Lung, reporter** (1; props: microphone, notebook)
- **Harry Wheezer, reporter** (1; props: microphone, notebook)
- **The Particulates** (3; prop: dirt; costume: dirty jeans and brown t-shirts, smear dirt on face)
- **Carbon Monoxide** (1; costume: sneakers, hat, trench coat, and sunglasses)
- **The Toxins** (5; props: gasoline cans made from cardboard; costume: black clothing)
- **Sulfur Dioxide** (1; prop: water gun or spray bottle filled with water; costume: torn tshirt, yellow and white streamers attached to clothing)
- **Nitrogen Oxides (Nitros)** (5; props: dead branches; costume: each Nitro can wear one of the letters in "nitro")
- **Bad Ozone** (1; costume: sunglasses, sophisticated clothing for a "big city look")
- **Good Ozone** (1; costume: sunglasses and light-colored clothing with bits of cotton attached to represent clouds)
- **Chlorofluorocarbons (CFCs)** (4; costume: heavy coats and jackets with the initials "CFC" stapled to the lapel and on the back, gloves and scarves)
- **EPA Scientists** (2; prop: notebooks; costume: lab coats)
- **Carbon Dioxide** (2; costume: t-shirts and shorts, black costume makeup wiped on clothing, legs, and faces)

Tips for Putting on the Play:

- Have the Pollutants make picket signs by taping large pieces of poster board to yardsticks and writing slogans on the poster board. (See slogan suggestions in description of the play's setting.)
- If some students prefer non-speaking roles, you can let them carry picket signs or be camera people filming the report. They could also take on the responsibilities of stage manager, costume designer, or set designer.
- Go over these pronunciations with the students playing the Toxins: benzene (BEN-zeen), xylene (ZI-leen), toluene (TOL-you-een).
- If your audience is small, have Harry and Connie come up with some ways that people can help reduce air pollution at the end of the play.

Setting

In front of the Environmental Protection Agency (EPA) building, the air Pollutants are picketing the EPA. Some carry picket signs with phrases such as "Dirty Air! Let's Keep It That Way," "Down with the Clean Air Act," and so on. TV reporters Connie Lung and Harry Wheezer are at center stage. In turn, each Pollutant comes over to be interviewed, while the other Pollutants continue to picket in the background.

Dialogue

Connie: Hi! I'm Connie Lung.

Harry: And I'm Harry Wheezer. We're here at the Environmental Protection Agency to cover a late-breaking story. Eight of the world's worst air pollutants are picketing the EPA to protest clean-air legislation.

Connie: In tonight's special report, we'll give you the scoop on where these pollutants come from and the ways they can hurt people and other living things.

Harry: Our first interview is with the Particulates. (Particulates walk over, carrying signs and chanting.)

Particulates: Dust, soot, and grime. Pollution's not a crime. Soot, grime, and dust. The EPA's unjust!

Connie: (coughs) So—you're the Particulates.

Particulates 1 (Soot): Yeah—I'm Soot. This is Grime, and this is Dust.

Harry: You guys are those tiny bits of pollution that make the air look really dirty?
Particulates 2 (Grime): Yeah! Some of us are stirred up during construction, mining, and farming. (throws some dirt in air)
Soot: But most of us get into the air when stuff is burned—like gasoline in cars and trucks or coal in a power plant and even wood in a wood-burning stove!
Particulates 3 (Dust): And we just love to get into your eyes and make them itch and make your throat hurt and...
Grime: (interrupts) Come on, Dust, quit bragging! We gotta get back to the picket line. (Particulates return to picket line. Carbon Monoxide sneaks up behind Harry.)
Harry: Let's introduce the folks at home to our next pollutant, Carbon Monoxide. Hey, where did he go? Oh, there you are! Pretty sneaky, Carbon Monoxide!
Carbon Monoxide: Yeah, sneaking up on people is what I do best. I get into the air when cars and trucks burn fuel inefficiently—but you can't see or smell me.
Connie: Then how can we tell when you're around?
Carbon Monoxide: You'll find out when you breathe me in! I can give you a bad headache and make you really tired. (gives an evil laugh)
Harry: (yawns) Oh—I see what you mean. Thanks for talking with us, Carbon Monoxide. (yawns again) (Carbon Monoxide returns to picket line.)
Connie: (checking notes) Next we'd like you to meet some of the most dangerous air pollutants—the Toxins. (Toxins walk over, carrying signs and chanting.)
Harry: You Toxins are made up of all kinds of poisons. How do you get into the air?
Toxins 1: Hey, man, we come from just about everywhere. Chemical plants, dry cleaners, oil refineries, hazardous-waste sites, paint factories...
Toxins 2: Yeah, and cars and trucks dump a lot of us into the air too. You probably don't know it, but gasoline is loaded with us toxins.
Toxins 3: Wow, that's for sure. There's benzene, toluene—all kinds of great stuff in gas.
Connie: Scientists say you cause cancer and other kinds of diseases. What do you think of that?
Toxins 4: They can't prove a thing!
Toxins 5: That's why we're here—to make sure you people don't pass any more laws that might keep us out of the air. C'mon, Toxins—we're outta here! (Toxins return to picket line. Sulfur Dioxide walks over.)
Connie: Next we'd like you to meet Sulfur Dioxide. (turns to face Sulfur Dioxide) I understand you just blew in from the Midwest.
Sulfur: Hey, I wouldn't miss this for all the pollution in New York City!
Harry: I'm sure the folks at home would like to know how you get into our air.
Sulfur: Well, heck, don't they read the newspapers? I've been making the front page at least once a week! Most of the time, I shoot out of smokestacks when power plants burn coal to make electricity.
Connie: And what kinds of nasty things do you do?
Sulfur: Nasty—that's me! (snickers) I think it's cool to make it hard for some people to breathe. And I can make trees and other plants grow more slowly. But here's the most rotten thing I do: when I get way up into the air, I react with oxygen in water in the sky, and presto! You get acid rain! (sprays water at audience)
Harry: Acid rain is a big problem. It can hurt or kill fish and other animals that live in lakes and rivers, and some scientists think it makes trees sick. Acid rain can even eat away at statues and buildings.
Sulfur: (proudly) That's right. Hey, I can even travel a long way to do my dirty work. If I get pumped out of a smokestack in Ohio, I can ride the wind for hundreds of miles and turn up as acid rain in Vermont!
Connie: I sure hope we can get rid of you soon, Sulfur Dioxide!
Sulfur: Good luck, guys! I gotta do some more picketing before I catch the next east wind! (Sulfur Dioxide returns to picket line. Nitros walk over.)
Harry: (to the audience) He's really rotten!

Nitros: (all together) You think Sulfur Dioxide is rotten? You haven't met us!
Connie: You must be the Nitrogen Oxides.
Nitro 1: Just call us the Nitros for short. (turns to audience) Give me an "N"!
Audience and other Nitros respond: "N"!
Nitro 2: Give me an "I"!
Audience and other Nitros respond: "I"!
Nitro 3: Give me a "T"!
Audience and other Nitros respond: "T"!
Nitro 4: Give me an "R"!
Audience and other Nitros respond: "R"!
Nitro 5: Give me an "O"!
Audience and other Nitros respond: "O"!
Nitro 1: What's that spell?
Audience and other Nitros: NITRO!
Nitro 2: What's that mean?
Other Nitros: DIRTY AIR!
Harry: Hey, I didn't know pollutants could spell.
Nitro 4: Very funny, Harry.
Connie: So, how do you Nitros get into the air?
Nitro 5: We get airborne when cars, planes, trucks, and power plants burn fuel.
Harry: And what happens once you're in the air?
Nitro 1: We can make people's lungs hurt when they breathe—especially people who already have asthma.
Nitro 2: And, like Sulfur Dioxide, we react with water in the air and form acid rain.
Nitro 3: But we also make another form of pollution. And here she is—BAD OZONE! (Bad Ozone waves and walks over. Nitros return to picket line.)
Bad Ozone: Well, my friends the Nitros pour into the air. They get together with some other pollutants. As the sun shines on all these lovely pollutants, it heats them up—and creates me, Bad Ozone. And where there's ozone, there's smog.
Harry: (to audience) Smog contains a lot of ozone.
Connie: That's right, Harry. And smog can really make city life miserable. It can make your eyes burn, make your head ache, and damage your lungs.
Harry: But what I want to know is if ozone is so bad, why are people worried about holes in the ozone layer? (Good Ozone walks in from offstage.)
Good Ozone: That low-level ozone is my rotten twin sister—she's just a good gas turned bad! I'm the good ozone that forms a layer high above the Earth. I help absorb the harmful rays of the sun.
Bad Ozone: (nastily to Good Ozone) So what are you doing here, sis?
Good Ozone: I'm here to support the clean air laws. If certain chemicals keep getting pumped into the atmosphere, I'll disappear. And without me, the harmful rays of the sun will kill some kinds of plants and give many more people skin cancer and eye disease!
Harry: But what kinds of chemicals are making you disappear?
Good Ozone: It's those terrible CFCs! (CFCs walk over from picket line.)
CFC 1: Hey, we're not so bad! People have used us CFCs in coolants for refrigerators and air conditioners for your home and car.
CFC 2: So what if we destroy a little bit of ozone? There's enough to last for years!
CFC 3: Yeah, who needs ozone anyway?
Good Ozone: People do! Tell them what else you CFCs are doing!
CFC 4: What's Ozone complaining about now—global warming? (EPA scientists walk in from offstage. Good and Bad Ozone walk offstage.)
Scientist 1: Excuse me, but did I just hear someone mention global warming?
CFC 2: Yeah. What do you want?
Scientist 2: We just happen to be experts on global climate change.

Connie: Are CFCs really changing the world's climate?
Scientist 1: Well, we're not positive. But over the past 100 years or so, people have been pouring gases, such as CFCs and carbon dioxide, into the air.
Scientist 2: And as they build up in the atmosphere, these gases may be acting like the glass in a greenhouse.
Scientist 1: That's right. They let the radiation from the sun in—but they keep the heat from getting out. And this may be causing the Earth's climate to become warmer.
Harry: I've read that if the temperature goes up, sea levels may rise. Wow, some cities on the coast might be flooded some day!
Scientist 1: Well, nice talking with you all, but we've got to do some more research so that we can really nail these pollutants. (Points to CFCs. CFCs give scientists a dirty look, stick out tongues. Scientists walk offstage.)
CFC 1: Hey, we're not even the biggest cause of global climate change. You gotta talk to another of the big pollutants about that.
Harry: (checks notes) There's only one other pollutant on the list: Carbon Dioxide. (CFCs return to picket line. Carbon Dioxide 1 and 2 walk over.)
Dioxide 1: Did we hear you mention our name? We aren't really a bad gas, in the right amount. About a hundred years ago, there was just the right amount of us in the air.
Dioxide 2: But then people started burning more and more things—they built power plants that burn coal, and cars and trucks that burn gasoline. And they started cutting down and burning forests! Every bit of that burning releases extra amounts of us into the air.
Dioxide 1: As more and more of us got into the air, people started saying that the Earth was warming up—because of us!
Dioxide 2: Yeah—like it's our fault! (to audience) The reason you're in such a mess is because you use so much fuel and cut down so many trees!
Connie: You're right, Carbon Dioxide. Maybe we should be doing a special report on people—we're the ones who are really causing most air pollution.
Harry: But people can change! (turns to audience) How about you? Can you think of some ways that people can help fight air pollution? (Audience responds with ideas, such as driving cars less, using less electricity, conserving forests, planting trees, and so on.)
Connie: And that's the end of our special report. The bottom line? These air pollutants are a pretty tough bunch—but people help create much of them, and people can reduce the amounts that are in our atmosphere. Thank you and good night.
Pollutant curtain call.
The End.

Appendix W

Name ______________________________

Date________________________________

Energy Efficiency Survey

Water/ Hot Water Heater

1. How many of your family members usually take showers instead of baths?
2. When preparing a warm bath, do your family members close the drain before starting the faucet?
3. Are clothes washed and rinsed in cold water?
4. Are there any leaky faucets in your home?
5. How many people in your home turn off the water while brushing their teeth?How many do not?
6. Are there aerators on any of your faucets? If so, How many?

Heating/ Cooling

1. Do you turn off the air conditioner if you're leaving the home for more than one hour?
2. Are any of your registers blocked with furniture? If so how many?
3. At what temperature does your family typically set the air conditioner?
4. At what temperature does your family typically set the furnace during winter months?
5. Does your family readjust the temperature settings on your air conditioner furnace during sleeping hours?

Air Infiltration/ Insulation

1. Are bathroom and kitchen vents frequently left turned on even when moisture and odors are not a problem?

2. Are your storm windows closed when the furnace or air conditioning are in use?

3. Are your storm doors always kept closed when the furnace or air conditioning are in use?

Lighting/ Use of other appliances

1. Are lights always turned off when not in use?

2. Is the television frequently left turned on even when no one is watching?

3. Does your family use small appliances for tasks that could be easily done "by hand" if so , name the appliances.

4. Do" air dry" in the dishwasher?

5. Does your family ever hang clothes on the clothesline rather than using the dryer? If so how often?

Appendix X

Name ____________________

Date______________________

Home Appliance Survey

Answer the following questions by asking your parent/guardian. In cases where your home does not have the appliance in question, simply write N/A (Not applicable). Be sure to record all of your data in a logical fashion.

1. Refrigerator- Ask
   When was the last time the coils on your refrigerator were cleaned to remove dust from the coils and vents?

Are the foods in the refrigerator capped or covered?

At what temperature is your refrigerator set?

At what temperature is your freezer set?

If you do not have a frost free refrigerator, what is the approximate thickness of frost built up in your freezer?

Close the refrigerator door on a crisp dollar bill. Is it held tightly in place or does it slip out easily?

Is your freezer full, less than half full, or more than half full?

Is the refrigerator placed away from heat sources such as range, oven, heat registers, and direct sunlight?

Washing Machine/ Dryer

What percentage of your washing is done using cold water? Is hot water ever used?

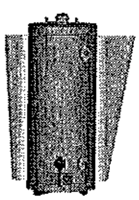
How often are your clothes dried outdoors?

When was the last time the lint was cleaned from the motor, drum and pipes of the dryer?

Look:

Check the drier for lint. Is the lint filter clean?

On what water temperature setting is your washer currently set?



Water Heater

When was the last time a bucket of water was drained out of your water heater to flush out accumulated sediment?

Look:

Is there any insulation on the hot and cold water pipes going in and out of the water heater?

Is there any insulation blanket on your water heater?

At what temperature is your water heater set?

 Dishwasher

Ask:

Do you use the drying cycle on your dishwasher?

Do you wash only full loads in the dishwasher?

Do you wash dishes by hand? If so, how often?

Is there a certain time of day at which you typically use the dishwasher? If so, what time

Look

How many different settings does your dishwasher have? On which setting is your dishwasher currently

Furnace/ Air Conditioner

Ask: How often is the furnace/Air conditioner filter cleaned or replaced?

At what temperature is your air conditioner typically set during summer months?

At what temperature is your furnace/Air Conditioner typically set during winter months?

Do you adjust the thermostat at different settings for daytime than for nights?

Is your furnace/ Air Conditioner checked annually by a professional?

Locate the air conditioner compressor unit or window air conditioner outside your home. Is the unit located in a shady area?

Are any structures or bushes touching the sides of the Unit?

Do you have a programmable thermostat?

Appendix Y

Date____________________

Name___________________

Proposal for Energy Efficiency Program for Your Home

1) Introduction-This is where you will write FCAT style. This will be your introduction as to how your energy efficiency program will work for the good of your home.

2) Literature Review- This section will be expository written where you have seen, reported, and obtained valuable information concerning your newly added energy efficient appliances and supplies.

3) Action Plan- How will you realistically obtain involvement of your parents in order for this to be a do-able plan. Please keep in mind that your parents are not going to immediately buy a new refrigerator. Especially if they do not need one. However you can propose energy efficient light bulbs.

4) Conclusion- This section will be for you to tie in all that you learned all that you done in your home so that you may have an idea of what saving you have suggested to your family. Conclude with what you would like to see the saving of the money go toward.

THIS IS YOUR FORMAT. THE FINAL FORMAT WILL BE WRITTEN IN CURSIVE OR TYPED. THIS WILL BE DUE ____________
Parent signature____________________ Date__________________

Appendix Z

Name____________________

Date____________________

Air Pollution- Should you be Worried?

Air pollution is a problem for everyone. The average adult breathes over 3,000 gallons of air every day. Children breathe even more air per pound of body weight and they are more vulnerable to air pollution than older people. According to the World Health Organization, over one billion people (one out of five) live in areas where pollution causes health problems such as burning eyes, an irritated throat or difficulty breathing. Long-term exposure can cause cancer, damage to the immune, nervous, reproductive or respiratory systems; maybe even death..

An air pollutant is a chemical in the wrong place and of the wrong concentration; there is too much of it and it stays in an area long enough to harm humans and other living things (animals, plants) or materials (buildings, tombstones, etc). Air pollutants such as urban smog and toxic compounds tend to stick around for a long time and may be carried on the wind for hundreds of miles before they return to earth's surface as solid particles or dissolve in precipitation like rain, fog, sleet or snow.

Many areas in the U. S. are being contaminated by the burning of fossil fuels(coal, oil, natural gas) in homes, power plants and factories (stationary sources) and in motor vehicles (Mobile sources). Industries often release toxic gases referred to as hazardous air pollutants. Even individual s add gases and particulate matter to the air through daily acitivites such as dry cleaning, gassing up cars and painting houses. When these materials become concentrated enough, they become air pollution, harmful to us and our environment. As our population increases and more countries become industrialized, pollution increases also.

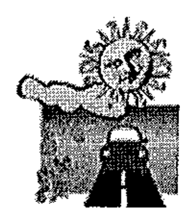
Air pollution is not a new phenomenon, but it has increased greatly since the industrial revolution. As clean air moves across earth's surface it picks up products from natural events such as dust storms and volcanoes, as well as those of human activities such as car and smokestack emissions. As these potential or primary pollutants are mixed and dispersed by moving air in the atmosphere, they can combine with each other or with other of air's components to produce new secondary pollutants. Once pollution sources are identified, ways to prevent or reduce their release should be explored.

How Pollution Disrupts Our Natural Environment

Sheila Mckinnon
11556 South Hale St.
Chicago IL 60643

Sherman Elementary School
1000 W. 52nd Street
Chicago IL 60609

ALTERNATIVE FUEL MATTERS



Air Pollution - Activity 4

Time: 1- 2 hours

Student Objective
The student will:

- Design and create an editorial cartoon that illustrates the effects of air pollution on select body systems.
- Share cartoon with classmates.

Key Words:

- Allergen
- Allergy
- Alveoli
- Asthma
- Chronic

- Sinusitis

Materials:

- Posterboard
- Markers, crayons and/or paints
- Resource materials, such as books, magazines, and the internet
- Researcher's Portfolio, Air Pollution

Internet sites:

Clean Air Act Advisory Committee

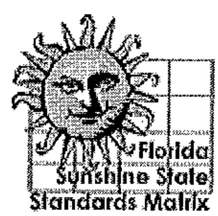
National Association of Physicians for the Environment

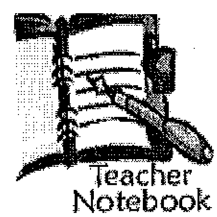
Unified Air Toxics Website

Procedure:

Air pollution affects many systems in the human body. Editorial cartoons are drawings that express opinion.

1. Assign the students to small groups.
2. Give each group one of the following topics to research: the nose, the heart and blood vessels, the skeleton, blood, lungs or asthma sufferer.
3. Team members should work cooperatively on their assigned topic as they search the internet, books, magazines and other resource materials to find information about the effects of air pollution on the human system.
4. Teams will create editorial cartoons to share with the class.





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www.fsec.ucf.edu

Please address questions and comments regarding this web page to AFMMaster

Appendix 2-A

Name________________________

Date________________________

Things you Want and Things You don't Want

Item	Location
Lichen	
Ash/soot	
Spiderwort	
Clouds	
Lightning	
Aerosol sprays	
Farm	
Carbon Monoxide	
Catalytic Converter	
Combustion	
Tombstone	
Green Plant	
Limestone/Marble Statue	
Vehicles	
Milkweed	
Carbon Dioxide	
Factory	
Battery	
Landfill	
Greenhouse	
Hydrocarbon	
Dust	
Airborne Organisms	
Amphibian	
Fossil Fuel	
Methane	
Power plant	

Resource List

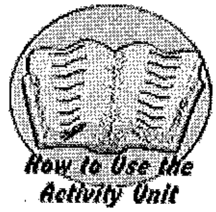
Energy

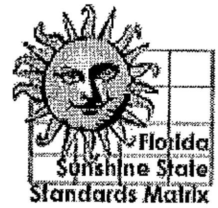
Publications

- *A Golden Thread: 2500 Years of Solar Architecture and Technology* by Ken Butti & John Perlin, Cheshire Books, 1980
- *Annual Energy Outlook 2000 with Projections to 2020*
    - Energy Information Administration, Office of Integrated Analysis and Forecasting, United States Department of Energy, Washington, DC 20585
- *Energy Education Resources K - 12th Grade*
    - National Energy Information Center, EI-30, Energy Information Administration, Forrestal Building, Room 1F-048, Washington, DC 20585; phone (202) 586-8800
- *Energy Exchange* Educational Periodical
    - National Energy Education Development, 102 Eldon St, Suite 15, Herndon, VA 20170; phone (703) 471-6263
- *From Space to Earth: The Story of Solar Electricity* by John Perlin, Aatec Publications, 1999
    - National Technical Information Service, US Department of Commerce, 5285 Port Royal Rd, Springfield, VA 22161
- *Intermediate Energy Infobook*
    - National Energy Education Development, 102 Eldon St, Suite 15, Herndon, VA 20170; phone (703) 471-6263
- *Photovoltaics Now* - SAND88-3149
    - National Technical Information Service, US Department of Commerce, 5285 Port Royal Rd, Springfield, VA 22161
- *Renewable Energy: Experts and Advocates, A Debater's Resouce Book*
    - American Association of Fuel Cells, 50 San Miguel Ave, Daley City, CA 94015; phone (650) 992-3963; contact Tom Dickerman
- *State Energy Data Report 1997: Consmption Estimates*
    - Energy Information Administration, Office of Energy Markets and End Use, United States Department of Energy, Washington, DC 20585

Websites

- Energy Information Administration: Office of Energy Markets and End Use
- Energy Information Administration: Office of Integrated Analysis and Forecasting
- National Energy Education Development
- National Energy Foundation
- National Energy Information Center





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http://www.earth.uni.edu/EECP/mid/mod1_sc.html

http://www.earth.uni.edu/EECP/mid/mod1.html

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