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An energy education teaching unit for the fifth grade

Lynn A. Thompson

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AN ENERGY EDUCATION TEACHING UNIT
FOR THE FIFTH GRADE

A PROJECT
PRESENTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE MASTER'S DEGREE IN EDUCATION IN
THE SCHOOL OF EDUCATION OF
CALIFORNIA STATE COLLEGE
SAN BERNARDINO

BY
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California State College
San Bernardino
1981

Approved By
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General Introduction

Since the early 1970's our society has had to face the realization that our energy supplies are not infinite. America contains about six percent of the world's population but consumes thirty three percent of the world's energy. We do not have enough domestic oil to meet our demands and have become increasingly dependent on oil imports from the Middle East. Since 1973, the Middle East has provided us with a sporadic supply of oil as witnessed by the accelerating costs of gasoline, utilities, and other oil based products.

Our youth are going to face perplexing economic and technological problems because of dwindling fossil fuels in their lifetimes. Obviously our patterns of energy usage and our energy sources must change. We are going to have to look toward alternative-energy technology to help solve this problem. The educational system is the logical vehicle to bring about this needed awareness of our youth regarding energy conservation and alternative-energy technology.
Review of the Literature

The importance and interest that alternative forms of energy have been receiving in the last few years is reflected by the demands placed on the school curriculum to teach this subject.

This interest in alternative energy has been a fairly recent phenomenon. Prior to the 1973 oil embargo, educators spent little time on energy. Since this time there has been an increasing demand to include energy education within the curriculum. In a 1977 survey completed by the Educational Testing Service for the Federal Energy Administration concerning the current needs for energy education, it was found that there is a need to develop energy awareness through an energy education curriculum.\(^1\) A more recent survey shows that this need still exists. Its findings reveal that very few comprehensive energy curriculum programs exist, that there will be no national curriculum in energy education, and that effective energy curriculum materials are relatively scarce.\(^2\)

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One would think that science textbooks at the fifth grade level would have begun to address themselves to supplying information and activities pertaining to energy awareness. My review of several fifth grade science texts proved to be the opposite. These textbooks, all published between 1977 and 1980, give very little attention to alternative energy sources. For example, when solar energy is mentioned, the information given is very brief and no projects or activities are mentioned that would enhance one's understanding of the sun's potential for reducing our dependence on fossil fuels to provide energy. Apparently the energy problem has been with us too short a time for textbooks to provide adequate materials.

Although educators are faced with teaching a subject area that has many ramifications for our future life style, most have neglected to do so because of this lack in energy curriculum and materials. Frank Owens has stated that an energy education curriculum should consist of the following four components:

1. The need to develop an understanding of energy technology and the various aspects of the energy crisis including the relationship between the energy, the economy, and the environment.

2. The need to conserve energy resources by using
energy resources more efficiently and by using less energy to accomplish the same amount of work.

3. The need to create a diversified energy economy through the development of alternative energy sources and energy systems.

4. The need to assess the environmental effects and develop environmental safety and controls as an integral part of energy systems design.3

Although Owens was writing these components for an industrial arts class at the high school level, the first three points have a definite value for an energy unit at the fifth or sixth grade level. Since children who are currently in elementary school will probably witness the depletion of fossil fuels in their lifetimes, it should be a goal of education to face problems of energy shortages. In Edward Pattison's article on "Energy Awareness in the Curriculum," it is stated that survey polls have indicated that almost fifty percent of the people in the United States do not feel there is any energy problem.4 We cannot face the energy deficiencies


of the future with a populace as unaware as this and realistically expect to confront these problems successfully. Through our educational system, we must then implement programs that will enhance our youth's awareness of conservation and alternative energy sources. George Hunter tends to agree with Owens by stating that "much can be done in a positive way to influence the community through its student population, toward an understanding of energy conservation and alternative-energy research."  

Ernest L. Boyer, United States Commissioner of Education, contends that energy, environment, and education are tied together in three fundamental ways:

1. The nation's schools are major consumers of energy and must cutback on consumption.
2. Education must train individuals with the technical know-how to lead us toward a conserving society. New careers require new educational preparation.
3. Schools must confront today the realities of the 21st century and begin to focus on the perspectives and attitudes that will be critical in ensuring our global survival in that era.

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A science unit on alternative energy sources can begin to meet the needs of points two and three. The teaching of science can help teach youngsters how to address certain physical problems in their environment. Katherine E. Hill states that the purpose of teaching science in the elementary school "is to assist boys and girls to build skills and concepts which will enable them to cope more effectively this year, this month, this day of their lives with the objects, forces, and events which comprise their environment." There is a need then for science programs to meet future needs. Jerrold Maben comments that science has a social responsibility in the 1980's. Teaching strategies for elementary school science should take into account the growing concern for energy and should be integrated throughout the curriculum. Through a unit on energy, subjects such as math, social studies and economics can be integrated.

However, because of a "back to the basics" trend that is taking place within our school systems today, there has been a general decline in the teaching of science in the classroom.

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The stress is being put on reading, math, and language due to the importance given to standardized test scores. The need for science and its role in the curriculum is supported by the National Science Foundation. It has financed programs and courses to retrain teachers in the teaching of science related subjects. Richard Bamberger contends that the federal government must finance programs in energy education to retrain teachers so that energy awareness will be taught in their classrooms. Federally backed programs such as this will probably not be taking place under the administration of President Reagan. He has called for cutbacks in federal spending and two of the departments that are faced with potentially drastic cuts are the Department of Energy and the National Science Foundation. Thus, for energy education to take place, it's going have to come from the state, district or school site levels.

Barry Jamason blames the government for not developing a comprehensive energy plan that adequately meets our energy demands. He looks upon energy education as a way of preparing students to be responsible citizens when they grow up. "...we must think of energy education for our nation's youth

as an endowment policy. Taking the time now to present all sides of the issue; to explore all energy alternatives; to weigh the consequences of individual activity and personal conservation will, at the very least, predispose most of these children to a sane, sensible energy outlook as adults. It might be then that this environmentally attuned, energy-educated populace will insist upon a workable, liveable energy policy."¹⁰ Schools then have quite a dilemma before them. They have the "inevitable task of attempting to change the energy use ethic of an entire generation"¹¹ without adequate subject material in student texts and without federally financed programs that would retrain teachers in teaching energy education.

We must now turn and look at what individual educators have done in terms of energy education. In Lakewood, Colorado, William White and B. Meadows developed an Earth and Energy Unit which is applicable to the eighth and ninth grades. "It integrates content from environmental education with the physical, earth, and social sciences."¹² Activities include


"...interviewing community members, conducting lab experiments... clarifying personal goals, designing a conservation plan for personal energy consumption, and visiting solar heated buildings."\textsuperscript{13} At Central Senior High School in Prince George's County Maryland, teachers Jerry Silver and Kurt Johnson, along with students, built a solar heating system for one of the classrooms.\textsuperscript{14} At West Seneca High School, Seneca, New York, there is an energy program entitled Power Technology. Topics covered within this course are "sources of energy, energy production and consumption, the exponential century and scenarios, the energy laws, fossil fuel energy systems and conservation, alternative energy systems...wind and solar power...and energy and the environment."\textsuperscript{15}

Although there has been a surge of essays in the last several years discussing the need for increased energy awareness, few have given specifics on how to make students more aware of the energy problem and of the alternatives to fossil fuels that are available.

\textsuperscript{13} Ibid., p. 35.


Statement of Objectives

This project consists of a series of lessons at the fifth grade level exploring the usage and conservation of energy sources. The objectives of this project are to develop an awareness of the following:

1. The advantages and limitations of finite energy sources.
2. The advantages and limitations of intermittent energy sources.
3. The utilization of energy in daily living.
4. The practicality of energy conservation and the effects on personal life styles.
Unit Design

Energy consumption in the United States is on the increase. In 1970, we consumed 67 quads of energy (one quad equals a quadrillion British thermal units, the equivalent energy contained in eight billion gallons of gasoline). In 1980 our consumption was 78 quads and it is projected that in the year 2000, it will rise to 108 quads. Oil production will not be sufficient to meet this demand here or abroad. It is essential then to develop an awareness of conservation and alternative energy sources.

This unit will help to develop an awareness of the advantages and disadvantages of our various energy sources. The feasibility of alternative energy sources such as solar and wind energy will be examined. Modes of conservation will also be explored in order to see the effects on our life styles as well as our efficient use of energy.

Through readings, activities, investigations and discussions, students will expand their abilities to observe carefully and accurately, to draw conclusions, and to apply these conclusions to their daily lives.

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Unit Sample

Seven sources of energy will be investigated in this unit: oil, coal, natural gas, nuclear, geothermal, solar, and wind. We will also explore conservation techniques so that students may discover efficient and economical ways to use energy. One of the best ways for students to learn is through investigation. Investigations will be used whenever possible to enhance the understanding of the subject matter. Below is a sample of the introduction of solar energy:

Initiating Activity: Place two empty plastic containers on a table. Ask: What would happen if we paint these containers, one white, one black, fill them with water and place them in the sun? Which container of water is going to get hotter? How hot will it get?

Basic Science Information:

A. Light from the sun can be used to heat water.
B. The color of the container has an effect on the heating process.
   1. Black absorbs heat, therefore it heats the container the faster.
   2. White reflects heat, therefore it heats the container the faster.

Learning Activity:

1. Group the class into pairs.
2. Give each pair two plastic containers. Students will paint one container white, the other black.

3. Fill the containers with the same amount of water. Seal the top and place outside in the sunlight.

4. Return in two hours and measure the water temperature in each container.

5. Compare results with original hypotheses.

**Supplies and Equipment:** Plastic containers—one per student. Spray paint, one black one white. Water. Thermometers.

**Extended Activities:** Allow students to repeat the same experiment with other paint colors. Paint a container half black and half white. Use a clear container. Try clear containers filled with different colored water.
ENERGY EDUCATION UNIT
FOR THE FIFTH GRADE
Whenever possible, investigations that allow students to actively participate have been included. However, there are some energy sources, such as nuclear, that do not lend themselves to hands-on classroom investigations. In these instances, student worksheets and teacher directed presentations have been utilized.
COAL
Coal

Coal is a black, solid fossil fuel that is burned for heating homes and as a fuel for electric power plants. While coal can be found around the world, two-thirds of all known coal reserves are owned by the United States, the Soviet Union, and China. It is the most plentiful fossil fuel in the world and can be expected to meet some of the future demands for energy.

In the United States, coal mining began in the mid 1700's and became the major source of fuel in the 1880's. By the 1920's, our country relied on coal for 70 percent of its energy. In the years that followed, the use of coal was surpassed by oil and natural gas since they were less expensive, cleaner, and easier to transport.

It is very expensive and dangerous to mine coal. Many miners are killed and injured each year. Because of the costs of labor and transportation, capital shortages and high interest rates, coal is not produced and used as much as it could be. In addition to this, some environmental groups do not look favorably upon coal usage due to the detrimental effects its mining has upon the land, and the pollution of the air when it is burned.
Currently, coal provides only one fifth of the energy we use each year. Since coal is so plentiful, it is being looked at to help offset our future energy needs. Scientists are looking for practical ways to convert coal into a liquid fuel and a gas. If this conversion can be made, the liquid fuel could be used in place of heating oil, as a gasoline for automobiles and a kerosene fuel for jet planes. The gas produced could be mixed with natural gas for the heating of homes and industrial use.
COAL WORKSHEET 1

How Coal is Mined:

Strip or Surface Mining - Uses huge bulldozers and power shovels to remove coal from a shallow seam near the earth's surface.

Deep or Underground Mining - Tunnel or shaft is built into the earth to the seam of coal sometimes many hundreds of feet below the surface. Workers and equipment remove the coal through the tunnel or shaft.

***

Read each set of statements below. If there were nothing else to consider, would you think that surface or deep mining (or both) is the best way to obtain coal? Write your choices on the blanks at the left, using S (for surface) or D (for deep).

SURFACE MINING

1. Each miner can produce 26 tons of coal a day.
2. 90 percent of the coal in a surface mine can be removed (80% west of the Mississippi).
3. In 1976, surface-mined coal cost $14.00 a ton, at the mine site.
4. Forest and fields, along with their topsoil, are turned over before the coal is removed - at a rate of 1000 acres a week. New Federal laws require land reclamation, but the cost is added to the price of coal.

DEEP MINING

Each miner can produce nine tons of coal a day.
50-80 percent of the coal in a deep mine can be recovered.
In 1976, deep-mined coal cost $27.00 a ton, at the mine site.

Much less damage to land and environment.

(Condensed from The Energy Challenge)
It would be easy to decide how to mine coal if there was only one set of facts to consider. As you have seen, however, there are many. What would you say is the main advantage of surface mining?

What would you say is the main advantage of deep mining?

Can you think of a compromise?
COAL WORKSHEET 2

How Coal is Used
1. Coal is mined either by surface or underground mining.
2. About 2/3 of the coal is transported by train.
3. 46 percent of U.S. electrical generators are powered by coal.
4. The electricity produced by these power plants is transported on wires. The electricity is usually not shipped more than 600 miles by wire because of expense and loss of energy. Only 26 percent of the original energy remains when the electricity is used.

* * *

Some Facts About Coal

Decide whether each of the following facts is a problem (P) or an opportunity (O). Put a P or an O - or both - in each blank.

_1. 90% of U.S. fossil fuel reserves (coal, oil and natural gas) are coal.
_2. Some deep mines are dangerous.
_3. 50% of our mineable coal is in the western United States.
_4. We have enough coal to last for 350 years, at current levels of use.
_5. Mining coal can cause damage to the environment.
_6. In the future, we will rely more on coal as a source for synthetic oil and gas.

Write down some of the ways these problems could be overcome. Compare ideas with your classmates.

(condensed from The Energy Challenge)
CONSERVATION
Conservation

Conservation is probably the fastest road to take to meet our current and future energy needs. By using the resources we have more efficiently, the resources will last for a longer time. Through conservation, energy consumption is reduced. Conservation can be thought of as an energy resource since it is more cost effective to save a barrel of oil than it is to produce an additional barrel.

The United States has six percent of the world's population but consumes about one third of the world's energy. Our oil consumption alone has tripled in the last 30 years. Industry consumes around 36 percent of the fuel used in the United States, with one fifth of this consumed by the metal industries. By implementing improved technologies, the steel industry could reduce its energy consumption by 50 percent by 1995. Another example of conservation technology is the recycling of scrap metal. Recycling aluminum requires only 5 percent of the energy required to refine aluminum from ore. Industries can reduce energy usage by having steam generate electricity as well as in the manufacturing process itself (currently 45 percent of industrial fuel is used to generate steam).
Personal use of energy accounts for about 37 percent of our country’s energy consumption. Personal use includes things such as home heating, lighting, air-conditioning, cooking, refrigeration, and transportation. Reduction of personal energy usage can occur through some of the following ways:

1. Heating

   A. Install insulation in the attic, walls, and under wood floors.
   B. Install weatherstripping around doors and windows.
   C. Passive solar techniques such as orienting the house to the south so that windows admit heat from the sun in winter, while roof overhangs and awnings exclude the summer sun.
   D. Turning thermostats down two degrees in winter and raising them two degrees in summer (which could save more than half a million barrels of oil a day).

2. Lighting

   A. Use fluorescent lighting wherever possible since it uses less watts to produce the same amount of light as incandescent lighting.
   B. Turning lights, TV, etc. off in rooms when the
rooms are not occupied.

3. Cooking
   A. Boil water with the pan covered.
   B. Match the size of the pan to the burner.
   C. Keep the heat reflectors below the heating elements clean so that they will reflect heat better.
   D. Do not preheat the burners or oven unless absolutely necessary (most foods can be started in a cool pan or oven).
   E. Use the smallest appliance that will do the job (for instance, heating rolls in a toaster oven uses less energy than in a conventional large oven).

4. Transportation
   A. The use of car pools or public transportation.
   B. The use of a bicycle instead of a car to do small shopping errands or to commute to work.
   C. Automobile gas consumption can be reduced by using a car that is light weight, has a small engine, a manual transmission, and a low axle ratio.
CONSERVATION INVESTIGATION 1

Concept: Leaks around doors and windows can waste energy, and detection can be made easily.

Materials: 1 pencil, tape, plastic food wrap

Activities and Learning: "How drafty is our school room?"

Cut a 4" by 8" strip of plastic food wrap and tape it to the pencil. Test the room for air leaks by holding the "draftometer" near the edges of windows and doors. If the plastic moves freely, then the room is drafty. Fuel is being wasted because of inefficient use of the heating or cooling system by allowing air to move out of the room. Various samples of caulking and weather stripping materials should be available to show students what measures can be taken to prevent air seepage. Students should take their draftometers home and investigate for drafts there as well.
CONSERVATION INVESTIGATION 2

Concept: A covered pan conserves heat while an uncovered pan wastes heat.

Materials: 2 hot plate burners, 2 pans of the same size (one with a lid), 2 stop watches, 1 measuring cup, water

Activities and Learning: "Which pan will boil water first, an uncovered pan or a covered one?"

Turn on the hot plates and add an equal amount of water to each pan. Place the pans on the burners and place the lid on one pan. Start timing how long it takes for the water to boil in each pan. It will be determined that the covered pan will boil water much faster than the uncovered one. The lid holds in the steam, but the uncovered pan allows the steam to escape, which also removes heat from the water.
CONSERVATION INVESTIGATION 3

Concept: It takes more energy to move a vehicle with underinflated tires.

Materials: 1 bicycle, 1 tire pump, 1 tire pressure gauge

Activities and Learning: "Will a bicycle coast twice as far if the tires have twice the pressure?"

Inflate the tires to normal pressure. Have a student pedal until he reaches a marked line on the black top and then coast. Mark the point where the bike stops. Remove half the air from the tires and repeat. The comparison should indicate that the bike with properly inflated tires coasted much further. Since friction makes machines harder to move, bikes and cars require more energy to move if their tires are underinflated. Therefore, an automobile will not get as good gas mileage if its tires are not properly inflated.
CONSERVATION INVESTIGATION 4

Concept: Efficient use of electrical energy is a conservation measure.

Materials: A demonstrator KWH meter (teacher made), worksheet

Activities and Learning: "How much electricity does your family use at home daily?"

With the following worksheet, show how one reads an electric meter. After the students have mastered how to properly read a meter, have the students read their own meter at home at a given time (e.g. 4:00 p.m.). Record the reading and take another reading at the same time on the following day. Subtract the first reading from the second to determine how many kilowatt hours were used in one day's time. Have the students compare their findings. Have the students turn on different appliances (with parent's permission) and check the meter to see which uses the most electricity.
LEARNING TO READ METERS CAN HELP YOU LEARN TO
SAVE ENERGY

The four dials on your meter record kilowatt hours.
Steps to follow:

1. Write down the number the pointer is pointing
to. When the indicator lies between two numbers,
record the number it just passed (It will always
be the smaller number). Your answer for reading
the meter above is ____________.

2. To find how much electrical energy you have used
at home in a 24-hour period, read the meter at
4:00 p.m. on one day and again the following day
at the same time. Subtract the first day's
reading from the second day's reading.

   Example: 4:00 reading (day 2)...
   4:00 reading (day 1)_________ Subtract
   Wattage used in 24 hours:

3. To find how much electrical energy you've used in
one month you must take two readings one month
apart. Then you subtract.
Example: October 1 reading.... 9318
September 1 reading...-7846
Difference: ______ kilowatts used

4. Find the meter in the school. Compare school
and home meter readings. Subtract. Which uses
more energy?
GEOTHERMAL ENERGY
Geothermal Energy

Geothermal is a form of heat energy found in hot water or steam deep in the earth. The word geothermal comes from geo (earth) and therm (heat). The core of our planet is a large mass of molten material called magma reaching a temperature of 8000 degrees Fahrenheit. At some places on the earth, the magma comes close to the surface creating hot spots. When water comes in contact with these hot spots, the water turns to steam. Well known examples of geothermal energy are the geysers in Yellowstone National Park, Wyoming. The steam from geysers can be used to spin turbines that drive electric generators. An example of this can be found at the Geysers Geothermal Field in Northern California which produces one half of the electricity that San Francisco consumes.

Before geothermal energy can compete economically with conventional sources of energy (oil, coal, and gas), more technology is needed. One of the problems is that minerals from the water can clog and corrode the generating equipment.

Since the United States has about 1.8 million acres of land where geothermal energy is known to exist, it is believed that geothermal energy may become an important source of electricity. Experts contend that early in the 21st century geothermal could be adding up to 17 percent annually to the national energy supply.
GEOTHERMAL INVESTIGATION

Concept: Steam from geothermal energy can be used to drive generators which produce electricity.

Materials: 1 empty soup can, 1 hot plate, aluminum wrapping foil, 1 small pan, 1 pinwheel

Activities and Learning: "How can steam be used to drive a generator?"

Take the soup can and punch two 1/8 inch holes opposite one another in the bottom. The holes should be located 1/4 inch from the rim. Put two cups of water in the pan and cover the top with aluminum foil, pinching the edges all the way around. Make a pencil sized hole in the center of the foil. Put the pan on the hot plate and turn it on. Place the can over the hole in the foil. When the water begins to boil, hold the pinwheel over the can. The steam coming from the two holes in the soup can will start the pinwheel spinning.

In an actual powerplant, high pressure steam blasts against a series of turbine wheels on the same shaft. The shaft, in turn, drives an electric generator, which produces electricity.
NATURAL GAS
Natural Gas

Natural gas supplies about 26 percent of our nation's energy needs. We consume approximately 20 trillion cubic feet of natural gas annually, primarily for heating homes and water. Gas is a gradually declining resource because production has outstripped discoveries of new reserves.

The decontrol of prices in 1978 has led to a surge of exploration for new gas fields. Advanced technology for the recovery of natural gas combined with the potential of new gas fields lead to hopeful signs for the future. However, many experts feel that little change will occur in the United State's gas supplies during the next ten years.
How Long Might Our Oil and Natural Gas Last?

Both oil and natural gas were formed in rock layers of the earth by the chemical changes of ancient plants and animals over millions of years and were trapped in rock layers of the earth. Natural gas is more commonly called oil, whereas gas that runs our cars, trucks, and planes is called gasoline.

Natural Gas

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Natural Gas

How Long Might Our Oil and Natural Gas Last?

Both liquid petroleum, which is more commonly called oil, and natural gas are fossil fuels. Like coal, they were formed by the chemical changes of ancient plants and animals over millions of years and were trapped in rock layers of the earth.

Item #1:
During 1977, the United States produced from oil wells about 3 billion barrels of oil (a barrel holds 42 gallons).

Item #6:
Our proved reserves at the beginning of 1977 were 216 trillion cubic feet.

Item #5:
During 1977, the U.S. produced from oil wells about 20 million additional barrels of oil.

Item #3:
Many geologists figure that it is fairly certain that an additional 28 billion barrels of oil exist.

Item #7:
Estimated additional reserves of natural gas (1977 estimates) are about 12 trillion cubic feet.

Item #8:
The highest estimate of undiscovered recoverable natural gas resources is as much as 73 trillion cubic feet.

Item #2:
The Department of Energy estimates that our proved oil reserve in the U.S. (known to exist and to be recoverable) is 31 billion barrels (1977 figure).

Item #4:
The highest estimate is as much as 89 billion barrels of additional domestic oil still undiscovered.

BUT...the United States is now using each year almost double the amount of domestic oil and natural gas that we had in 1977. As a result, the United States is now producing less oil and natural gas than it used to. Hence, our supplies of oil and natural gas will not last as long as they might have.

Read the following items; then see if you can determine how long our supplies of oil and natural gas will last.

What if oil and natural gas usage increases in other countries?

What could happen if our usage continues to increase each year?

At what time in your life could the U.S. run out of oil and natural gas?
NUCLEAR ENERGY
Currently, nuclear power plants produce about ten percent of the electricity consumed in the United States. Most of the nuclear power plants are located in the Northeast and the Midwest. These power plants produce eighty percent of the electrical power in Vermont, sixty percent of Maine's, and half of that in Connecticut and Nebraska. Outside of the United States, the greatest concentration of nuclear reactors is in Europe.

The energy that nuclear reactors use is found in a radioactive metal called uranium. Uranium contains a vast amount of energy. A pound of enriched uranium holds three million times the energy in a pound of coal. The United States possesses more than a quarter of the world's uranium, primarily in New Mexico and Wyoming. From each ton of raw uranium, mills and enrichment plants extract a few ounces of radioactive uranium 235. This isotope is split by the reactor in order to release the atom's energy.

In the early 1970's, nuclear energy was projected to take care of a great part of our energy needs in the future. Since then, however, the demand for nuclear reactors has dropped. Among the reasons are the rising electrical costs,
the Arab oil embargo, rising inflation, plant costs, and concerns for health, environment and the disposal of waste products. In addition, the nuclear accident at Three Mile Island in Pennsylvania in 1979 brought to a focus the potential dangers these plants possess. Because of these factors, the future of nuclear power plants is uncertain.
One of the energy resources being considered to supplement our limited oil and natural gas supplies is nuclear power. | Generated by splitting apart of atoms of uranium. This power can be captured and used to create steam which produces electricity much as the power of burning coal is used in a fossil fuel electric generating plant.

Nuclear Energy Worksheet 1
The following is a list of benefits and problems associated with nuclear power plants. A key word or phrase in each item is printed in bold type. Read the list and put a (B) in the blank if it is a benefit, a (P), if it is a problem.

- LESS NEED FOR MINING AND TRANSPORT OF FUEL
- NO POLLUTANTS FROM BURNING FUEL
- LESS RELIANCE ON IMPORTED FUEL
- COULD BE TARGETS FOR TERRORISTS
- REACTORS PRODUCE LESS WASTE THAN FOSSIL FUEL PLANTS DO
- OVERALL COST OF ELECTRICITY WILL BE LESS THAN WITH FOSSIL FUELS
- HIGHER COST TO BUILD
- LARGE AMOUNTS OF PLUTONIUM COULD LEAD TO SPREAD OF NUCLEAR WEAPONS
- POSSIBILITY OF RADIATION ESCAPING
- RADIOACTIVE WASTE MUST BE HANDLED AND DISPOSED OF SAFELY FOR THOUSANDS OF YEARS

Now that you have identified the problem areas, look at the arguments below. Each one concerns a problem area and offers arguments for (PRO) and against (CON) expansion of nuclear energy. Complete the arguments by inserting a KEY WORD (above) into the blanks for each problem area.

PRO: The _________________ is made into a type of glass or ceramic, put into special containers, and stored in places like salt beds which have been undisturbed for millions of years.

CON: It takes thousands of years for the _________________ to lose its radioactive properties. We cannot assure safe disposal for thousands of years and future societies may be hurt.

PRO: In more than 20 years of commercial nuclear power plant operation, no one has suffered any ill effects brought on by _________________.

CON: There's always a chance that an accident or mechanical malfunction could present the danger of _________________

PRO: Regulations and safeguards can be strictly enforced to keep the _________________ out of the hands of terrorists. This radioactive waste is usually sealed in an unbreakable capsule right after the fuel processing.

CON: Just 10 pounds of radioactive _________________ is enough to make an atom bomb.

(from The Energy Challenge)
OIL
Oil

The first deposit of oil discovered in the United States was in Pennsylvania in the late 1850's. Since then, many more deposits have been discovered, the majority of which are in the state of Texas. Once oil was discovered, it fast became the most popular fuel for lighting and lubrication. Within a century of that first oil strike, petroleum not only surpassed coal as the leading energy source, but the United States found it could not produce enough oil to meet the demand and therefore became a net importer of petroleum.

The worldwide production of oil is sixty million barrels per day. In 1980 America consumed more than a fourth of that daily in automobiles, trucks, boats, to heat homes, industrial uses, and providing raw materials for petrochemicals. The leading countries in the production of oil are the Soviet Union, Saudi Arabia, and the United States. The United States produces almost nine million barrels a day. The remainder of what we need must be imported. Much of our imported oil is controlled by the 13 countries comprising OPEC, the Organization of Petroleum Exporting Countries. These countries produce half of the world's oil. In addition to the United States, Europe and Japan rely heavily upon OPEC. Japan
essentially has no oil fields of their own and therefore has to rely solely upon imports to feed their industrial economy.

Because oil is a finite energy resource, we cannot depend on it to meet our future needs. At the current production rate, the United States has about nine years of oil reserves left. Many new wells are being drilled yearly but the new finds are still falling short of the depletion rate. The new surge of domestic drilling activities was in response to the escalating OPEC prices and the Arab oil embargo of 1973.

New discoveries of oil fields and improvements in the technology of recovering oil are needed to ensure its role in the future of our energy needs.
Petroleum and the Way You Live

Fill in the blanks in the following story from the list of words at the bottom of the page (all products made from petroleum). Each word will be used at least once. How many petroleum or petrochemical products can you think of that you used before school this morning?

Sam Super, a seventh grader at O.K. Junior High, hated to get up one dreary, rainy day. Sam flicked on the _______________ lights and washed his hair with _______________ shampoo. To cheer himself up, he put on his brightest plaid _______________ sweater. On the way downstairs, Sam passed his sister’s room as she was fixing her new hairdo with her can of _______________ hairspray. Down in the kitchen, Sam’s mother had fixed him some eggs in a _______________ -coated pan, using her _______________ range. Sam’s mother complained that he ate too quickly from the colorful _______________ plate and insisted that, because it was raining, Sam wear his _______________ boots. All that hassle had given him a headache, so he gulped down an _______________, grabbed his peanut butter sandwich wrapped in _______________ and banged the _______________ storm door on the way out. On the way to the corner, Sam slipped in a puddle on the _______________ roadway. Finally, he climbed on the bus, powered by high octane _______________. He sank back onto the _______________-covered seat and unrolled a butterscotch drop from a _______________ wrapper, opened his _______________ notebook, and started his homework from the night before.

plexiglass  plastic wrap  aspirin
teflon  gasoline  electric
detergent  vinyl  natural gas
aerosol-propelled  acrylic knit  synthetic leather
asphalt  melamine plasticware  cellophane

(from The Energy Challenge)
SOLAR ENERGY
Solar Energy

Solar energy is produced from the sun's light or heat. The earth receives a tremendous amount of heat from the sun. Without heat, our planet's temperature would not rise much above -450 degrees Fahrenheit. In fact, it has been estimated that the sunlight falling on the United States during a single summer day contains twice as much energy as our country uses in an entire year. Solar energy is a clean and inexhaustible source of energy. The problem with solar energy is how to harness or collect its energy in an efficient, economic way.

Currently, solar energy supplies six percent of our country's power, primarily in the forms of hydroelectric power and wood. To further tap the sun's energy, we need systems that will store solar energy, use it directly, or convert it into electricity. Some of the major disadvantages of solar energy are that it is an intermittent source of energy (it "turns off" at night and during cloudy weather), it is at its weakest during the winter months (when homes and industries need energy the most), and with today's technology, it is quite expensive.

Some of the ways used to harness the sun's energy are through flat-plate collectors, concentrators, forms of passive...
solar architecture, and photovoltaic cells.

Flat-plate collectors convert the sunlight into heat energy. These collectors are installed on rooftops facing south and the energy collected heats either air or water. In active solar systems, the warmed air or water can heat buildings with the assistance of pumps and fans. And the hot water can of course be used for household needs.

Some solar devices use concentrators. These concentrators reflect sunlight striking a large area onto a smaller surface, which gets hot enough to boil water and create steam to generate electricity. An example of this can be found locally in Daggett, approximately twelve miles southeast of Barstow, California. Currently under construction, this electrical generating plant will have 2000 mirror modules called heliostats. These heliostats will adjust continuously to the sun's movement and reflect the sunlight to a central receiving tower/boiler that absorbs the heat and turns water to steam, which in turn drives a turbine generator that produces electrical power.

Forms of passive solar architecture can also be used for heating a building. By having south facing windows or glass walls, shortwave solar radiation is absorbed to heat the inside. During the summer, heat would be kept out by having roof overhangs that shade the windows.
Photovoltaic, or solar electric, cells have considerable potential. These are a spinoff from space technology. The Sky Lab space vehicle had photovoltaic cells that produce the electricity for the craft. Currently, the cost of photovoltaics is economically unfeasible, but in a few years, through advanced technology, it will probably be used in residential and industrial properties.
SOLAR INVESTIGATION 1

Concept: The sun can be used to preserve foods.

Materials: Sliced fruit (apricots, grapes, peaches, or bananas), cardboard (10" by 12"), two plastic window screens (10" by 12"), tape

Activities and Learning: "How long does it take to dry various types of fruit?"

Have students cut a large rectangular hole (9" by 12") in the cardboard and tape plastic screen over the hole. Place the fruit on the screen. A second sheet of screen should be taped over the fruit in order to keep the fruit in place and to keep insects off. Put the fruit outside in a sunny location, or inside if you have a sunny window. The fruit should dry within one to two weeks (depending on the weather).
SOLAR INVESTIGATION 2

Concept: Direct rays of sunlight heat a collector more than slanting rays of sunlight.

Materials: 2 shoe boxes, 2 thermometers, soil

Activities and Learning: "How does the slant of the sun's rays affect a collector's temperature?"

Put equal amounts of soil in the two shoe boxes. Place the thermometers into the soil to the same depth. Place both boxes in direct sunlight in the morning. Prop one box up so that the sun's rays strike the soil directly. The other box should lie flat so that the sun's rays strike the soil at a slant. Record the temperature readings every ten minutes. The comparison should indicate that the soil in the box that was propped up is hotter than the other. This has implications for the solar collectors that are installed on the rooftops of buildings. They should be slanted facing south in order to receive the greatest amount of direct sunlight.
SOLAR INVESTIGATION 3

Concept: It takes more energy to heat water than many other substances.

Materials: 2 small tin cans, 2 thermometers, 1 hot plate, sand, water

Activities and Learning: "Which will get warm faster, a can of water or a can of sand?"

Fill one can half full of water and the other can half full of sand. Measure and record the temperatures of each. Place the cans on a hot plate and heat for two minutes. Remove the cans, stir the contents with a spoon, and measure the temperature. The results will show that the sand gets hotter. The implication is that it takes a lot of energy to heat water (5 times more energy to heat a given amount of water than sand). Thus, the water heater is one of the largest energy consumers in the home. Ways of conserving energy needed to heat water are:

1) Repair leaky faucets.
2) Use cold water whenever possible.
3) Insulate the water heater and hot water pipes.
4) Install a solar heating system (this is being done on many new homes).
SOLAR INVESTIGATION 4

Concept: The size of the collector determines how much solar energy can be collected.

Materials: 2 metal pie plates (one large and one small, painted black), 1 measuring cup, 1 thermometer, clear plastic wrap, water

Activities and Learning: "Which pan of water will provide more solar energy?"

Begin the investigation by pouring the same amount of water (approximately ½ cup) into each pan. Record the temperature of the water in each pan. Cover the pans tightly with the plastic wrap. Place the pans in the sun for 15 minutes and then recheck the temperature. The larger pan will record the higher temperature because a larger area was exposed to the sun (the implication for residential solar collectors is that the larger the collector, the more solar energy can be collected).
SOLAR INVESTIGATION 5

Concept: Light can be used to generate electricity.

Materials: 1 light meter from a camera

Activities and Learning: "How can light generate electricity?"

   The light meter is actually a galvanometer (an instrument which detects weak electric currents). A special material in the light meter releases electrons when it is struck by light. The stronger the light, the farther the needle swings along the scale. The electricity in solar or photovoltaic cells is generated in the same way as it is in a light meter.
SOLAR INVESTIGATION 6

Concept: The rays from the sun can be concentrated. The larger the magnifier, the more the light can be concentrated.

Materials: 1 one inch diameter magnifying glass, 1 two inch diameter magnifying glass, 1 sheet of dark paper

Activities and Learning: "How much faster can you burn paper with a two inch magnifying glass than a one inch magnifying glass?"

Proceed then to investigate with the magnifiers to see which one burns the paper the fastest (the larger one will). Be sure that the magnifying glasses are positioned so that the sun's rays focus the smallest amount of light on the paper (This has applications to solar collectors—the effectiveness can be increased by focusing the sun's rays with a magnifier).
SOLAR INVESTIGATION 7

Concept: The sun can be used to cook food.

Materials: 1 cube shaped cardboard box (70 to 100 cm each side), aluminum foil, clear plastic wrap, tape, 1 coat-hanger, hot dogs

Activities and Learning: "How long would it take to cook a hot dog with the sun?"

Have students make their solar cookers. Cut away one side of the box at an angle. Cover the inside of the box with aluminum foil, shiny side out. Make a hole in each side of the box for a straightened coat hanger to fit through. Put the coat hanger through the hole in one side of the box, push the hanger through the hot dog until the hot dog is centered and on through the hole on the other side of the box. Cover the angled front with the plastic wrap and seal with tape. While cooking the hot dog, be sure to turn it so that it cooks evenly. The cooking time will be around 15 minutes on a sunny day.

Additional Suggestions:

1. Use a curved surface cooker instead of the flat surfaced one.

2. By adding an insulating material (i.e. plastic foam or cardboard several centimeters thick) around the bottom and sides, the cookers will be able to hold heat much better.
3. By painting aluminum foil (one side only) with a flat black paint and then wrapping the hot dog with the foil (black side out), the cooking time will be shortened.

4. Try other foods to see what else could be cooked and how the cooking time varies.
WIND ENERGY
Wind Energy

Wind energy is a form of solar energy caused by variations in the temperature of the air heated by the sun which forces air to move.

Wind power has been used by mankind for centuries. One of the first uses was to propel sailing ships. Windmills were used to grind grain and pump water for many years in Europe. In the United States, windmills played an important part in our industrial development. By 1920, there were about one million windmills being used in the United States, primarily on farms. The use of windmills declined, however, as the use of fossil fuels increased. Today, the use of wind power is again receiving notice as a means of coping with our dwindling oil reserves. The Wind Energy Systems Act of 1980 initiated an eight year, 900 million dollar program in order to develop cost-effective wind power systems in the United States. Locally, we can witness some of these experimental wind turbines eight miles northwest of Palm Springs. They are being tested by the Southern California Edison Company to see what role they may have in meeting our electrical needs in the future. It should be noted that it would take 30,000 large wind turbines and thousands of smaller ones in order to supply ten percent of our country's electrical power needs by the year 2000.
WIND INVESTIGATION 1

Concept: Wind is the result of unequally heated air (made warmer at one place than another).

Materials: 1 beam balance, string, 1 candle, matches, 2 pyrex flasks

Activities and Learning: "Which weighs less, warm air or cold air?"

Attach the pyrex flasks with string to the ends of the balance, moving them along the beam until they balance. Place a lit candle under one flask and observe what happens. The flask over the candle raises because the air became warmer and expanded, showing that warm air weighs less than cold air. Winds are produced when cooler, heavier air moves in to take the place of warm air that has risen.
WIND INVESTIGATION 2

Concept: Wind speed varies and can be measured by means of calibrated instruments called anemometers.

Materials: 1 ping pong ball, 1 piece of fishline 8" long, 1 protractor, glue, 1 needle

Activities and Learning: "Is the wind blowing fast enough to generate electricity?"

Take one end of the fishing line and attach it to the center of the protractor with glue. Thread the line through a needle and push the needle through the ping pong ball. Remove the needle and glue the end of the line to the ball. Holding the protractor level (a bubble level can be attached to the protractor for more accurate readings). The wind speed can be determined by recording the angle at which the line is closest to and comparing it to the wind speed chart. When determining if the wind speed is high enough to generate electricity, keep in mind that the minimum wind speed needed is 8-10 miles per hour. Wind speeds can be measured hourly and recorded on a chart.
Beaufort Wind Scale

Here's a way to estimate wind speed that doesn't require any equipment. A Beaufort number of three or more is needed to generate electricity.

<table>
<thead>
<tr>
<th>Beaufort number</th>
<th>Description</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>calm (0-1 mph)</td>
<td>smoke rises vertically</td>
</tr>
<tr>
<td>1</td>
<td>light air (2-3 mph)</td>
<td>smoke drifts slowly</td>
</tr>
<tr>
<td>2</td>
<td>slight breeze (4-7 mph)</td>
<td>leaves rustle; wind moves</td>
</tr>
<tr>
<td>3</td>
<td>gentle breeze (8-12 mph)</td>
<td>twigs move; flags extended</td>
</tr>
<tr>
<td>4</td>
<td>moderate breeze (13-18 mph)</td>
<td>branches move; dust and paper rise</td>
</tr>
<tr>
<td>5</td>
<td>fresh breeze (19-24 mph)</td>
<td>small trees sway</td>
</tr>
<tr>
<td>6</td>
<td>strong breeze (25-31 mph)</td>
<td>large branches sway; wires whistle</td>
</tr>
<tr>
<td>7</td>
<td>moderate gale (32-38 mph)</td>
<td>trees in motion; walking difficult</td>
</tr>
<tr>
<td>8</td>
<td>fresh gale (39-46 mph)</td>
<td>twigs break off trees</td>
</tr>
<tr>
<td>9</td>
<td>strong gale (47-54 mph)</td>
<td>branches break; roofs damaged</td>
</tr>
<tr>
<td>10</td>
<td>whole gale (55-63 mph)</td>
<td>trees snap; damage evident</td>
</tr>
<tr>
<td>11</td>
<td>storm (64-72 mph)</td>
<td>widespread damage</td>
</tr>
<tr>
<td>12</td>
<td>hurricane (73-82 mph)</td>
<td>extreme damage</td>
</tr>
</tbody>
</table>
WIND INVESTIGATION 3

Concept: Wind energy can be converted into electricity.

Materials: Model airplane propeller (6" long), wood block (3½" by 5"), 2 nails (1" long), 2 nails (3" long), bar magnet (1" long), 2 metal strips (1½" by 4") cut from a tin can, magnet wire, germanium diody type 1N34A, tape, glue, soldering iron and solder, galvanometer (directions for making galvanometer follow this investigation)

Activities and Learning: "How can wind energy be converted into electricity?"

Begin making the model wind generator by wrapping 1000 turns of magnet wire around one of the large nails. The coil should be 2" long, measured from the head end. A few inches of wire (on both ends) should be left for connections. Scrape the enamel insulation off the ends and twist them so they won't unravel. Drive this nail into the center of the wood block. Drive the 2 small nails into the block. Wrap the ends of the wire around the nail heads. Hook the diode across the nails and secure all connections by soldering. Glue the bar magnet to the head of the other large nail to make a propeller shaft (make
sure the magnet is centered on the nail head). This propeller shaft will be supported by the two tin can strips. Fold these strips in half lengthwise. Make a bend at one end of each strip (3/4") for the base. Nail them to the wood block, in line with the upright nail. the shaft holes (drilled with a drill) should be located so that the magnet end is close to the upright nail head and still be able to spin freely.

Insert the shaft in the supports and position it so that the magnet is directly over the nail head. Make a collar with electrical tape between the magnet and the two supports to keep the shaft in place. Put the propeller on the pointed end of the nail. Connect the galvanometer to the two nail terminals. Set the generator in the wind or in front of a fan. When the shaft turns, the compass needle will move. This demonstrates that electricity is being produced from the wind. When the propeller spins, the magnet moving past the nail head generates a tiny alternating current (AC) in the coil wound around the nail. The small germanium diode then converts the AC into DC (direct current).
Galvanometer Directions:

Take a length of bell wire and wrap it around a compass six times leaving two inches exposed at each end. Scrape the enamel insulation off the ends.
GLOSSARY
Glossary

British Thermal Unit (BTU)—the amount of heat necessary to raise the temperature of one pound of water one degree Fahrenheit. About a quarter of a calorie.

Coal—a black, solid fossil fuel that is burned to make heat. Although the United States has the largest supply of coal in the world, only a fifth of the energy we use each year comes from coal.

Conservation—Using a resource efficiently instead of wasting it.

Consume—to use up, as with a fuel or water.

Crude Oil—a black liquid fossil fuel that is found deep in the ground. Crude oil is used to make gasoline, kerosene, diesel fuel, etc.

Efficiency—the ratio of useful work or energy output to total work or energy input.

Electricity—a fundamental entity of nature consisting of negative and positive particles composed respectively of electrons and protons.

Energy—the capacity for doing work. Some forms of energy are electrical, mechanical, chemical, heat and light.

Finite Natural Resources—these are natural resources that are limited in supply and are nonrenewable. Resources such as oil, natural gas, coal and uranium are finite.
Fossil Fuels—fuels such as coal, crude oil, or natural gas, formed from the remains of plants and animals over millions of years.

Fuel—anything that is burned or consumed to produce energy such as wood, oil, natural gas, food, and uranium.

Gasoline—a liquid fuel made from crude oil. It is used to power engines in cars, trucks, etc.

Geothermal—a form of heat energy found in hot water or steam deep in the earth. This energy can be used to produce electricity.

Hydroelectric Power—electricity made by using falling water to power a generator.

Insulation—any material that provides a high resistance to heat flow. Insulation can be used in ceilings of houses and buildings to keep heat in and cold out, and vice versa.

Kilowatt—one thousand watts.

Kilowatt Hour—a measure of work performed. The equivalent of using 1000 watts of electrical power over a one hour period.

Meter—an instrument used to measure the amount of something. The amount of electricity, natural gas, and water consumed in a house or building for a given period is measured by a meter.
Natural Gas—a fuel that comes from the ground that can be burned to produce heat or light.

Nuclear Energy—the heat produced by the splitting of atoms in a nuclear reactor.

Nuclear Reactor—the part of a nuclear power plant where uranium is used to make heat in order to produce electricity.

Nuclear Waste—the radioactive substance remaining after uranium has been used.

OPEC (the Organization of Petroleum Exporting Countries)—made up of 13 countries that aim at developing common oil-marketing policies.

Photovoltaics—the process by which solar energy is converted directly into electrical energy through the use of a solar cell.

Quad—a quadrillion Btu's. The energy contained in eight billion gallons of gasoline.

Renewable Energy Sources—sources of energy that can be replenished. These sources include trees, water, sun, and wind.

Reserve—that portion of a resource that has been discovered but not yet exploited.
Solar Energy--energy that is produced from the sun's light or heat. Solar energy can be used to make electricity, heat buildings, and heat water for water heaters and swimming pools.

Steam--water which has been heated to form a gas. Steam can be used to turn generators that make electricity.

Therm--a measure of how much natural gas has been burned.

Tidal Energy--energy produced by the motion of ocean waves.

Uranium--a metal used as a fuel in nuclear reactors for the making of electricity.

Watt--a measure of electrical power which gives the rate at which energy is used.

Weatherstripping--an insulating material that is used around doors and windows in order to keep heat in or out of a building.

Wind Energy--a form of solar energy that is caused by variations in the temperature of the air heated by the sun, forcing air to move. Winds over 8-10 miles per hour can be used to generate electricity.
STUDENT BIBLIOGRAPHY
Student Bibliography

There are a number of books pertaining to energy related topics available to children. The following bibliography contains books that are appropriate for students at the intermediate grade level.


FILMSTRIPS
Filmstrips

There are a number of energy related filmstrips available. The following list contains filmstrips that are applicable to the intermediate grades.

Energy Applied
Energy: Catching the Sun
Energy from Fire
Energy from the Atom
Energy from the Earth
Everything You Use Uses Energy
From Problem to Problem
Harnessing the Sun
How Heat Travels
Putting the Sun to Work
Power and Energy
Saving Energy
Solar Energy
Some Real Solutions
Story of the Atom
Sun, Wind, and Water
The Sun: An Old Solution to a New Problem
Understanding Nuclear Energy
What is Energy?
What is Heat?
You Live in a Spaceship
UNIT BIBLIOGRAPHY
Bibliography


Energy Challenge, The, Department of Energy, Education Programs Division, Washington D.C.


