THE DEVELOPMENT OF AN ENERGY EDUCATION CURRICULUM GUIDE AND THE EVALUATION OF TEACHERS' PERCEPTIONS OF THE EFFECTIVENESS OF THIS GUIDE

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PREFACE

A preliminary needs assessment was conducted in the Fall of 1991, regarding the general public's knowledge of the basic concepts involved in the production and use of energy. The results of this needs assessment, along with the results of an extensive review of the literature, gave impetus to the development of an Energy Education Curriculum Guide for use with upper-elementary classrooms, entitled Energy: A Cross-Curricular Approach. Training sessions, three hours in length, were presented to the teachers who were targeted, by grant specifications, to use this curriculum. Survey instruments designed to obtain descriptive data on teacher's perceptions of the effectiveness of both the curriculum guide, and the teacher trainings, were developed, distributed, and analyzed.

The development, printing, and distribution of this curriculum guide would not have been possible without the financial assistance of the Environmental Protection Agency, Region II, New York City, New York, and the Camping Services Branch of the YMCA of Greater New York.

Sincere and heart-felt thanks are given to my advisor, Dr. Ted Mills, for his persistence and temperance. I am also grateful to the other members of my committee, Dr. David Yellin and Dr. Sue Williams, for their efforts and contributions. Dr. Dan Badger, as a friend first and foremost, and as a professor second, has earned my life-long respect and love for his help in guiding me through the maze, in search of what matters most. Dr. Larry Perkins has also helped me see "that which is invisible to the eye."

The teachers, mostly those of the New York City Public School System, who contributed their time, classroom efforts, and feedback also deserve my thanks and gratitude.

Lastly, and warmly, special thanks are extended to my colleagues, Dallas Tomlinson, Mark McBurnett, and Chris Moseley. Dallas, for his efforts, on my behalf, in searching the world over for my very own bottle of demon-be-gone; Mark, for his encouragement, warm support, and great pointers of the fine art of drankin' and dancin'; and Chris, for showing me that it can, indeed, be done. Their friendship over the years has been a tremendous inspiration, both academically, and otherwise.

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CHAPTER I

INTRODUCTION AND STATEMENT OF THE PROBLEM

What would you do? Seventh grade...approximately thirteen years of age...that cursed time in life. Not yet adults--no longer children. That time when adolescents think that they know everything there is to know, and try to prove it. No longer elementary students--not yet high schoolers. That time when students are trying to make sense of all that makes up the world around them...testing and questioning...pushing all limits in search of their own sense of belonging, their own system of values and beliefs, and their own opinions (Thornburg, 1984).

Seventh graders as students can be a challenging lot. On any given day they will question the behavior of adults around them, while at the same time trying to emulate those very behaviors which they question. They will challenge existing beliefs as well as just about any and all information presented to them.

We, at Greenkill Outdoor Environmental Education Center, a service unit of the Young Mens' Christian

Association (YMCA) of Greater New York, recognize the unique traits belonging to seventh graders, and plan our days accordingly. Seventh and eighth grade students comprise approximately 25 percent of our 9000 visiting students each year. Of the remaining 75 percent, approximately 65 percent are fifth and sixth graders, with the last ten percent a mix of fourth graders, high school students and special education groups. Most of our work is done in small groups of ten to twelve students, allowing us to spend time focused on the questions that inevitably arise, giving each student the time and attention needed to formulate his or her own ideas.

One part of our program, out of necessity for logistics sake, however, is large group assemblies. Meals, guest speakers, environmental programs and other similar gatherings allow students the opportunity to develop acceptable group behaviors, as well as to experience things just not practical in smaller settings. From a logistics standpoint, however, two hundred screaming thirteen year olds scrambling for one set of double doors at dismissal time is a scene right out of a late-night horror movie. A controlled system of dismissal needed to be developed. To this end, we started asking trivia questions. A correct answer will earn dismissal for your table or row. An incorrect answer will leave you waiting until a well-meaning passerby whispers a few helpful hints.

The questions are typically such that common knowledge prevails. Watch the news once a week, read a newspaper here and there, pay attention in the classroom and to the world around you, and the answer will be somewhere within the reaches of your memory. For more challenging groups we tend to present more challenging questions. At one particular dismissal during the early fall of 1991, for which we were hoping to present a challenge, I had the responsibility of posing this traditional trivia question, and dismissing the group. My question: "Name the nuclear reactor, and the town, in the former Soviet Union, that has gained world-wide attention since 1986." Keep in mind that these students would have been only seven years old at the time of the Chernobyl reactor disaster, but would have lived through the aftermath that faced Europe. We expected a slight delay as the students reached far back into their memories, and we were ready for more than a few far-fetched answers.

One girl in the front row surprised us, though. Her hand shot up before I could finish asking the question. "WOW!", we thought, "This girl is on the ball." Her response? With a tone that made it clear she was testing the words, as if they belonged to a foreign language, "What's a nuclear reactor?"

One of an environmental educator's worst nightmares. What a shock! We had expected a delay...we had expected the question to be a challenge...but in a country where a full ten percent of our electricity is produced by means of nuclear power (US Department of Energy, 1991), and in a region where that percentage jumps to 45 (Consolidated Edison, ConED, Department of Education, 1991), we had not expected this response.

In the days and weeks that followed, while the staff continued their daily teachings of ecological concepts, outdoor skills, and team building and development, side conversations began taking on an introspective tone. Each question that we asked ourselves lead to the formulation of even more. "When should students be exposed to the issues concerning energy production?" "How can we better relate energy issues to the ecological concepts that we teach?" "Just how much exposure to these issues are students currently getting, anyway?" "Why don't thirteen year olds know what a nuclear reactor is?" In effect, the question we kept coming back to was "Where have we, as environmental educators, failed and what can be done about it?"

We all like to think of ourselves as rational adults. One off-key comment should not be allowed to dictate our actions. So before making any rash decisions, we informally decided to test our belief that knowledge of energy concepts and energy-related issues needed our attention. We took a random approach, asking questions of those with who we had daily contact. The students (ages 10-15) who visited our center, the teachers who accompanied these students, the kitchen, maintenance, and clerical staffs from our center, the counter workers at the local post office, convenient marts, and our own families--parents, spouses, children, brothers, sisters, and assorted others--were all targets for our questions.

Representatives from a mix of ages, and socio-economic and education backgrounds were included. Our premise? That we are all consumers of energy, and, therefore, should posses, at least, a certain base of information. Our question? "How does coal get turned into electricity at a power plant?" "When you flip a switch, why does the light come on or go off?" "What uses more electricity per hour of use, your color T.V., or your refrigerator? Why?" "Per year, what is the largest energy-consuming item in your house?" "What is strip-mining?" We were looking for simple, not detailed, explanations and answers.

The results were not encouraging, and, to say the least, disturbing. We had to confess that even adults (our environmental education teaching staff included), at times, were "energy ignorant". We were finding that the lack of knowledge in the area of energy production and use was not limited to thirteen-year old girls. Preliminary research into the area of energy education helped us to understand why.

According to the National Energy Education Development (NEED) Project, most teachers in the United States will spend an average of 0-1 hour per year teaching about energy-related concepts and issues. K-6 teachers average 0-2 hours per year; math teachers, 0 hours; social studies teachers will average 0-2 hours; while science teachers on the secondary level will devote 0-10 hours per year (NEED, 1990).

This information gave us, the staff at Greenkill Outdoor Environmental Education Center, grounds for increasing our efforts in teaching the connections between energy use in natural communities and energy use in the human world. We also had cause, and motivation, to reach even further than our center with our teaching efforts. When, in the January of 1992, the United States Environmental Protection Agency (USEPA), federal level, put forth a call for grant proposals for the development of projects, programs, or curriculum dealing with environmental issues, we were quick to respond. Unfortunately for us, so were hundreds of other schools and educational institutions. For an available one-hundred-thousand dollars in grant money, the EPA reported submitted proposals totalling over $57 million. Our proposal was rejected.

The staff who had joined to write the original proposal took the rejection in stride, and kept about our daily work, trying to learn from the whole grant experience. We dissected our proposal, looking at each individual part, putting it back together bit by bit. So, when, a representative of the Environmental Protection Agency, Region II, New York City, contacted us in the March of 1992, having had received a copy of our proposal from Washington, we were prepared to rewrite our proposal to fit within the guidelines of the Region II call.

Our request, dated March 5, 1992, with a proposed budget of $21,056 was accepted by EPA Region II, Grants Management Section, Federal Plaza, New York, New York, on October 6, 1992, for the amount of $20,358. Objectives of the proposal were as follows: 1) To develop an interdisciplinary environmental education teachers' guide on energy, to be used with urban students in the upper-elementary grades; 2) To provide training sessions, three hours in length, using this guide, to New York City teachers attending our resident program in the 1992-93 school year; 3) To distribute the guide free to all teachers who participate in the training; 4) To outreach to additional New York City teachers not currently involved in our program by offering the same training, and 5) To distribute the guide and conduct training for those in attendance at the next YMCA National Consultation on Outdoor Environmental Education in the November of 1993.

As Project Leader I began the task of researching and writing the energy curriculum guide mentioned above. The fall of 1992 was spent gathering factual information regarding the production, use, and effects of energy usage from as many sources as possible. Sources of accessible energy activities and guides, currently in print, were also contacted. For a complete list of those agencies and sources contacted see the Reference Section of the completed guide, <u>Energy: A Cross-Curricular Approach</u>, (EACCA) in the Appendix of this thesis, page 153.

The State University of New York's Bureau of Curriculum Development provided state-suggested objectives for the areas of language arts, social studies, math, and science for upper-elementary (4-6) grades. These objectives were used as a guideline for organizing the information and activities gathered during the fall of 1992. Each activity developed for <u>Energy: A Cross-Curricular Approach</u> is based, by design, on the above-mentioned New York State learning objectives.

Once activities were in draft form, several formative evaluation sessions with Public School (P.S.) teachers from New York City took place at Greenkill Outdoor Environmental Education Center's site in Huguenot, NY, from January to April 1993. The intent of these sessions was to gain input and insight from those who would most likely use the guide and its activities in their classrooms. All tolled, eighteen public school teachers, from various grades and subject areas, were involved in these preliminary evaluations. Drafts of activities, along with required materials for each activity, were presented, and the teachers were left to experiment and evaluate. Revisions took into account the concerns and comments of the participants, and the process was then repeated. Greenkill's 1992-93 environmental education teaching staff was also involved in one such formative evaluation session.

The curriculum guide was completed and printed in November, 1993. The first Energy Training Session was presented November 17, 1993, at the Blue Ridge Assembly, Blue Ridge, North Carolina. Participants were YMCA Professionals from Environmental Education Centers throughout the United States and Canada.

Since that time, fourteen three-hour training sessions have been conducted. These training sessions, which take participants through an introduction of the EACCA rationale, four or five of the 21 activities described in the curriculum guide, and short tips on modifying the activities for varying age groups, are run by both myself and Steven Hagenbach, a fellow environmental educator employed by the YMCA of Greater New York. Currently, over 250 public and private school teachers and YMCA Professionals have received copies of this curriculum, and have been trained in the use of the energy-related activities within this guide.

This thesis is based on the development and production of the previously-described energy education teachers' guide. It is an evaluation of the guide and the trainings that accompany its distribution. A survey instrument was developed to obtain descriptive feedback of the participating teachers' perceptions of the overall effectiveness of the guide. A more detailed explanation of the survey design appears later in this thesis.

CHAPTER II

LITERATURE REVIEW

Name any problem facing the world today. It can be environmental, political, economic, or social. Go ahead! Brainstorm a whole list. Chances are, the topic(s) that you just thought of is (are) related (either directly or indirectly) to the issue of energy. Energy production... energy consumption... energy distribution... possession of energy-related resources, or lack of possession of the same. And yet, remarkably, as important a topic as energy would appear to be in our lives, and in our world, a recent poll (NEED, 1990) of classroom teachers, K-12, discovered that the average teacher this year will spend between zero and two hours (total for the entire year) teaching about or discussing energy-related topics!

This same poll found that of 25,000 junior and senior high school students, only 30% knew the major use of coal in the United States, and 70% did not know that uranium gives off energy when atoms are split. To compound the situation, although most labeled themselves as "energy savers", most showed from further answers that they lacked the practical knowledge needed to make informed energy-use decisions.

Lawrenz (1983) found similar results. Deficiencies in knowledge were consistent among three student groups (fourth graders, seventh graders, and high school students). Knowledge bases recognized as consistently lacking concerned the following: 1) the nature of energy itself, 2) the availability and use of coal and oil, 3) the viability of alternative power sources, and 4) the practical considerations involved in power generation.

Most startling of all information gathered by Lawrenz was the surprisingly small deviance in percentage of correct answers between fourth graders and high school students. The average fourth grader answered correctly 57 percent of the time. The average high school student answered 63 percent of the questions correctly. Participants were presented with the same question content, with certain questions reworded to accommodate differences in reading level. This information corresponds with NEED's findings on the amount of classroom time between fourth grade and high school during which students are exposed to energy-related information or activities. Krockover, et al, (1989) reported that most energy education occurring in classrooms in the United States was taking place in the elementary grades. It can be presumed that the six percent increase in correct answers that took place from fourth grade to high school was a result, to some extent, of outside exposure, as opposed to classroom exposure, to energy-related issues.

A brief look at the energy history of the United States might allow a better understanding of these findings. When immigrants from Europe first called themselves "colonists" on American soil, wood, as a primary energy source, was extremely abundant. Whole old-growth forests on the Eastern seaboard were sacrificed to make way for homes, farms, towns, cities, and commercial areas as the population of white settlers grew. By the time the immigrant population of the United States had risen to approximately two and one-half million (1994 Information Please Almanac), and America declared itself a free and independent nation, large tracts of this precious resource had already been depleted. More, however, still stood as a renewable source of energy. Wilderness (and its as of yet untapped resources) became associated with the independent spirit of the growing American colonies. Water and wind power were utilized to varying degrees as rural and urban areas, alike, began enlarging grist and lumber mills. Both energy sources have colored histories in Europe and other parts of the world. Horizontal water wheels can be dated back to the time of Christ, the vertical water wheel, with a power capacity approximately seven times that of the horizontal wheel, from approximately 400 A.D. Wind mills, as established energy sources in the Western world, date from around the twelfth century (Kranzberg, 1972). Wood, however, continued as the nation's primary energy source, with the majority of citizens farming for a living. Most of these farms were sustenant in nature: available energy was used for the production of food and other basic needs of families and farm animals.

England's Industrial Revolution, and its newly developed or adapted technologies changed all of that. The steam engine brought people from rural farmlands into city production areas. The factory became the center of production; the city, the center of human life. America's similar social shift was not far behind. But as Melvin Kranzberg (1972) explains, demographics were not the only area of drastic accompanying change. Hugh political shifts accompanied the technological and social changes of the time. "The steam engine gave the industrial advantage to countries with abundant supplies of coal." (Kranzberg, p. 28). The politics of energy production and supply had begun.

When steel became the basic industrial material (in the 1800s) this energy advantage or disadvantage was reinforced. Coal deposits, of course, being imperative in the transformation of raw iron into steel, become a symbol of power. The haves vs. the have-nots had entered into a new chapter in the history of man. Not surprisingly, Britain became the world's industrial leader and a dominant political power during the nineteenth century.

America's transformation, again, took on a similar pattern. Discovery and extraction of coal deposits (as well as the burning of vast forest tracts in the production of char) allowed for the rise of steel mills, steam locomotives and expanding railways, and ultimately, the production of electricity. Coupled with the development of the internal-combustion engine, and the rising tide of the automobile, America's economy, at the turn of the nineteenth century, became one based on industrial production and mobility. The American farm, at the same time, became more energy efficient, causing less of a demand for human labor. Displaced rural workers flooded the cities, bringing with them the start of a social crisis.

Somewhere along the way, from the independent nation of 1776, to the industrialized nation of today, America crossed the boundary. We now consume more energy than we can produce with our own developed technology and resources. We currently import over fifty percent of the crude petroleum used daily in this country (US Department of Energy, 1991). As recently as the Arab Oil Embargo of the 1970s America was shocked into the realization of its energy dependency on foreign nations. As mentioned earlier, the possession and control of energy resources can be used as a source of great political and economic power.

President Jimmy Carter, in a televised speech to the

American people, delivered April 18, 1977, outlined a proposed energy policy for the country (Vital Speeches of the Day). Among the ten fundamental principles outlined that evening were the development of alternative energy sources, the conservation of existing sources, the setting of energy prices to truly reflect the replacement costs (to the environment and to the nation), and the equal sacrifice needed throughout the American population. His timeline? To have these changes implemented by the year 1985. President Carter took this very same message to a Joint Session of the United Stated Congress on April 20, 1977. Again, on July 15, 1979, a full two years after his first address, President Carter came in front of the American people to discuss the dire energy problems being faced by the nation (Vital Speeches of the Day).

During this same time period, a drastic increase in the production of energy-education and energy-conservation curriculum can be noted. Government agencies, school districts, and local civic and private organizations all contributed, to varying degrees, to the pool of available materials. Pessimists attributed this fact to the ever-present gas lines and quadrupling of petroleum costs. Meanwhile, optimists perceived this influx as an indication that the idea of energy-education had permeated the educational system as a rational alternative to the options facing the nation. In Morrisey and Barrow's review of

Energy Education (1984), a full twenty studies relating to energy education were described for the time period from 1976 to 1980. But then a funny thing happened on the way to established energy-education programs. The political leadership of the United States changed from Democratic (with Jimmy Carter as President) to Republican (beginning the eight-year Presidency of Ronald Reagan). President Carter's call for a National Energy Plan became equated with Chicken Little's prophesy of a falling sky. Gas lines abated and the nation forgot thoughts of common sacrifice for an energy-sound future, as we moved into the start of what has become known as the "Me Decade".

Most of the printed materials and curriculum programs examined by Morrisey and Barrow are currently out-of-print. And finding useful energy-education materials or information that can be easily incorporated into existing curricula is a hit-or-miss experience. This exact dilemma was predicted by Morrisey and Barrow.

The four major problems in the field of energy education, identified in 1984, still hold true today. To begin, there has not been a systematic approach to determining what should be included in energy education. The National Science Teachers Association (NSTA) argued that energy should be studied and presented as an interdisciplinary program (Fowler, 1977). Agreeing in concept to this proposal are Kuhn (1978), Agne, Conrad, and

Nash (1974), Sartwell and Abell (1975), Duggan (1978) and Fowler (1976).

Allen (1980), however, is not alone when he makes a case for energy to be included in the realm of the biological and physical sciences. Still further, Allen and LaHart (1979) suggest a values-based approach, while Gierke (1978) advocates the use of industrial arts to introduce energy-related concepts. Not being able to determine what should be included in energy education leads the way for not being able to determine where energy education should fit in the school system, this being the second major problem outlined by Morrisey and Barrow.

Shrigley and Koballa (1983) reported that approximately 90% of pre-service teachers polled considered themselves to be energy conservers. (Remember the high school students from the NEED Poll?) A corresponding 89% felt that conserving energy should be important to everyone. How many felt it should be their responsibility, in their classroom, to persuade or teach others to conserve? Less than 30 percent. This poll brings us back to important issues presented in Morrisey and Barrow's (1984) first premise. Should energy education be just, or more than, or something totally separate from, energy-conservation education? This debate still has no definitive answer.

Next, comes the problem of disjointed efforts, ultimately leading to the lack of a functional energy education network. The further development of the ERIC data base, and others like it, since the early 1980s has gone a long way in addressing this concern. However, finding current materials is still an area of frustration. Private utility companies almost all offer some form of printed materials for use in energy conservation education, mainly in the form of coloring books with kilowatt characters for lower-elementary aged children. Various state agencies offer similar programs, but the agency responsible for such materials varies from state to state, adding to the confusion. The only state materials found that contain true energy education activities in an easily usable form came from the California Energy Extension Service, a division of The California Governor's Office of Planning and Research. If research authors of the 1970s and 1980s thought the direction of energy education in the 1980s remained unclear, what would they say about energy education in the 1990s and beyond?

According to the Education Commission of the States (1979), major contributing factors to the dirth of energy education programs are a lack of communication between state education and state energy agencies, and a lack of quality materials (those that contain student activities, visual aids, appropriate reading levels, enrichment activities, or measures to evaluate student progress) available to teachers. No such recent report can be found but it can be assumed that similar reasons exist today. Also noted (Krockover, et al, 1989) were the exclusion of energy-education components in favor of energy-conservation teachings, and the lack of quality inservice programs (Duggan, 1980).

A successful energy-education program, it would then appear, needs to incorporate all of the concerns addressed above. It needs to produce informed citizens; it needs to address current values and environmental ethics, political policies, and social and economic systems; it needs to meet the needs of teachers who are asked to make use of it; it needs to teach concepts, not just conservation.

We have already examined America's history and found it to be a history of energy and energy development. Our current value, political policy, social, and economic systems have root in our system of energy usage. The elements cannot be simply separated, for reasons of study, or any other. Energy, as a concept and as a reality, permeates all aspects of our daily lives. In theory, then, it should permeate all aspects of our education system as well.

Hoping to meet these challenges, my partnership with the Environmental Protection Agency began.

CHAPTER III

CURRICULUM GUIDE DEVELOPMENT AND STUDY DESIGN

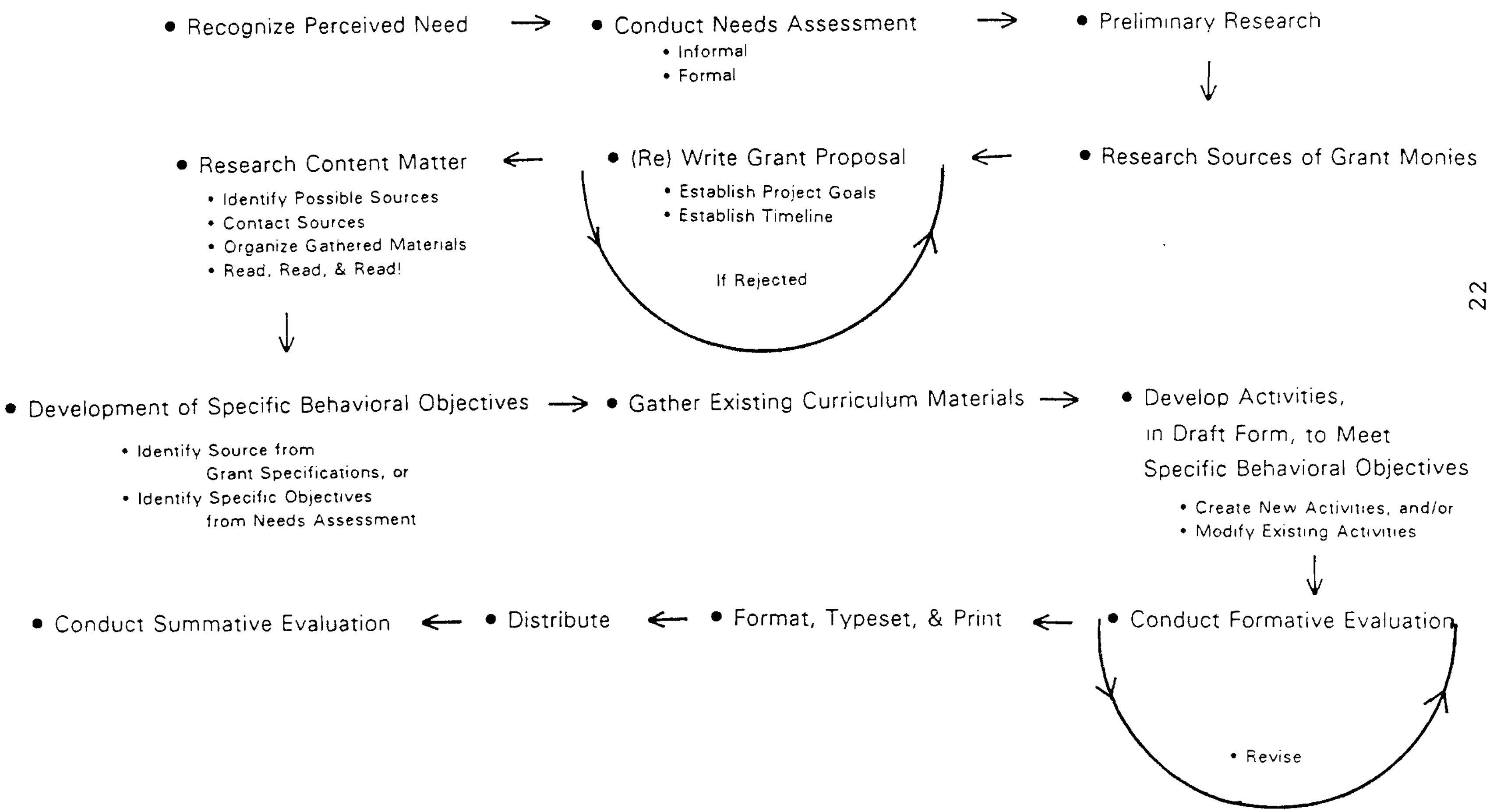
Objectives

This thesis is based on the development, distribution, and summative evaluation of my text, Energy: A Cross-Curricular Approach. As already detailed, the grant proposal submitted to the Environmental Protection Agency, Region II, Federal Plaza, New York City, included the development of an interdisciplinary environmental education curriculum guide on energy, and the training of New York City teachers and YMCA Professionals in the use of this curriculum guide. Figure 1 (see page 22) presents the development of this project from idea conception through completion and evaluation of the resulting curriculum guide. Each step along the way is an independent, yet essential, part of the whole development process.

Figure 1.

DEVELOPMENT OF A GRANT-FUNDED

CURRICULUM GUIDE



The Curriculum Development Process

Essential components of the curriculum design and development process are a preliminary needs assessment, the development of general goals and specific objectives, research of content matter, development of drafts, some form of formative evaluation, and, finally, a summative evaluation (Dick & Carey, 1985).

Greenkill Outdoor Environmental Education Center's efforts in conducting a needs assessment of our students is detailed in Chapter I of this thesis. A real need for exposure to activities and concepts dealing with energy production and use was found. The results of my literature and curriculum reviews in the field of energy education are detailed in Chapter II of this thesis. To summarize the findings, very little usable and accessible energy education curriculum guides are currently in print. The coupling of these findings gave merit to the development of our own energy education curriculum guide.

EPA Grant Specifications gave us specific goals for developing activities and presenting concepts in the areas of energy production and use, and their effects, while New York State learning objectives for the upper-elementary grades provided specific behavioral learning objectives in the areas of Social Studies, Science, Mathematics, and

Language Arts.

Researching content matter to assure accuracy of information presented was, perhaps, the most time-consuming step in the curriculum design process. Gathering and comparing information obtained from various sources, while accounting for inconsistencies in statistics and reports took the better part of the fall of 1992.

The next step is pairing learning objectives with existing activities, or modifying or creating activities to help the student reach stated objectives. The curriculum designer is allowed as much creativity (or as much conservatism) as can be mustered during this stage of the design process. Once draft activities are created, these activities then need to be evaluated (called formative evaluation) for flow, content, and their ability to meet stated objectives.

The formative evaluation sessions, as part of the design process, are meant to act as "litmus" tests of printed materials, activity designs, and various other components of the curriculum. These formative evaluations take place as the curriculum is being developed, with possible revisions as the ultimate goal. The formative evaluation sessions conducted for the development of the energy curriculum are detailed in Chapter I of this thesis.

Survey Design

Just as integral, however, is a summative evaluation of curriculum material. Summative evaluations act as follow-ups to obtain information on usage, and overall effectiveness of materials. Since the final printing of Energy: A Cross-Curricular Approach, in November of 1993, careful accounting of individuals trained in its use has been made. Of the over 250 individuals currently in possession of this curriculum guide, and trained in its use, 100 were selected to participate in this study. These 100 were selected based on the length of time they have been in possession of this guide. Each of the 100 participants have had, and presumably have been using, Energy: A Cross-Curricular Approach in their classrooms for at least one full school year (defined as a nine-month period, from September to June). This full school-year time frame was chosen to allow for one full cycle of state-required learning objectives and corresponding activities.

A survey instrument was developed to evaluate the curriculum guide on the following components: 1) the activities themselves (Questions 1-17), 2) suggested materials to be used in the activities (Questions 18-23), 3) content other than activities, for example, the glossary and cross-reference of related activities (Questions 24-35), 4) the layout and format of the curriculum guide (Questions

36-40), and 5) general information about each teacher's classroom and classroom habits (Questions 41-45). The survey was designed to contain both closed- and open-ended questions. The instrument was then examined by a panel of educators familiar with both the content and purpose of the curriculum guide and the target population whom we were trying to reach. Education staff responded with opinions regarding the clarity and readability of the survey, its breadth, and its depth. Revisions were made, and the survey instrument then sent on for further evaluation.

University committee members familiar with the purpose of this study were the next group to evaluate the content of the survey. This panel consisted of three Ph.D professors, Dr. Ted Mills, an Environmental Science professor, and Director of the Oklahoma State University Center for Environmental Education, Dr. Sue Williams, a professor of Human Environmental Science, with a background in energy research, and Dr. David Yellin, a language professor in the Department of Curriculum and Instruction. This panel reviewed the survey instrument to establish content validity. Revisions were made, creating the final survey instrument.

Surveys, along with cover sheets requesting the recipient's input, were mailed, with self-addressed, stamped envelopes, in January and early February, 1995. Although respondents had the option to remain anonymous, requests were coded so that a second round of requests could be sent to non-respondents. Once received, surveys were pooled with other responses before being read, the codes being used only to remove their names and addresses from the second mailing list. This second-round request was sent the first week of March, 1995.

CHAPTER IV

REPORT OF DATA

This chapter will deal with the data obtained from the survey instruments distributed to the 100 participants described in the Survey Design section of Chapter III. These participants were selected based on the length of time they have been in possession of Energy: A Cross-Curricular Approach. Each of the 100 participants chosen to receive survey instruments had received training in use of the curriculum over one full year prior to the start of this study. This time allows for one full school year of state-suggested learning objectives and corresponding activities. Of the 100 survey instruments mailed, 65 surveys were returned. This figure is a total of respondents from both the first- and second-round mailings. One survey was sent back incomplete, reducing the number of usable returned surveys to 64. Table I shows the breakdown in demographics of the 64 respondents.

Note that of the 64 participants, 17 of those were YMCA Professionals. These 17, for various reasons, are not included in the tabulations of survey results, found in Table II. YMCA educational programs are not required to

TABLE I

DEMOGRAPHICS OF PARTICIPANTS

Number	Description of Respondent
8	Special Education Teachers
3	4th Grade Teachers, Contained Classrooms
18	5th Grade Teachers
(10)	Science
(6)	Social Studies
(2)	Mathematics
14	6th Grade Teachers
(4)	Science
(5)	Social Studies
(4)	Mathematics
(1)	Physical Education
1	7th Grade Teacher
(1)	Math
3	High School Teachers
(1)	Science
(1)	Language
(1)	History
17	YMCA Educational Professionals
(10)	Outdoor Environmental Educators
(7)	Day Care or After School Program Workers
(47)	Classroom Teachers
(17)	YMCA Professionals

TABLE II

RESULTS OF EACCA SURVEY

Question	Responses				
	Yes	No	Don't Know	No Response	Does Not Apply
Activities:					
1. Do the EACCA activities meet NYS Syllabi's stated objectives for grades 4-6?	35	3	0	9	0
2. Do the stated objectives of EACCA activities adhere to NYS Guidelines for the same grades?	34	4	0	9	0
3. What portion of the EACCA Manual presented you with new ideas?					
4. Do the activities keep the interest of your students?	35	4	0	8	0
5. Are the activities age-appropriate?	35	12	0	0	0
6. On a scale of one to ten, one being the simplest, ten being the most difficult, what overall rating would you give the activities in this guide?					
7. Is there enough background information presented with each activity?	32	5	0	10	0
8. Is the background information relevant?	47	0	0	0	0
9. Is the background information accurate?	30	0	7	10	0
10. Are the skill objectives achieved?	35	0	12	0	0
11. Are the suggested times listed for each activity accurate?	30	12	0	5	0
12. Are the suggested times for preparation and follow-up adequate?	40	2	0	7	0
13. Is the procedure section of each activity easy to follow?	40	2	0	5	0
14. Can each activity stand alone?	44	0	0	3	0

TABLE II (CONTINUED)

Question	Responses				
	Yes	No	Don't Know	No Response	Does Not Apply
15. Is there coherent flow from activity to activity?	42	2	0	3	0
16. Is the information presented in EACCA activities relevant to the lives of your students?	47	0	0	0	0
17. Are the skills which the activities profess to develop relevant to the lives of your students?	38	9	0	0	0
18. Are the required materials or equipment easily obtainable?	44	3	0	0	0
19. Are the required materials or equipment easily replaced?	44	1	0	2	0
20. Are the required materiasl or equipment easily maintained?	44	0	0	3	0
21. Are the required materials or equipment within your budget?	44	1	0	2	0
22. Are the required materials or equipment safe for classroom use?	46	0	0	1	0
23. Is there any question or controversy of use of the required materials or equipment within your school or district?	0	47	0	0	0
Content:					
24. Are concepts or activities missing that you feel are important for a general energy guide?	4	36	0	7	0
25. Are there concepts or activities included that you feel should not be?	0	46	0	0	0
26. Are the general directions for using the curriculum guide easy to follow?	45	0	0	2	0
27. Are the follow-up questions valuable to you?	29	8	0	10	0
28. Are the follow-up questions self explanatory?	37	1	0	9	0

TABLE II (CONTINUED)

Question	Responses				
	Yes	No	Don't Know	No Response	Does Not Apply
29. Do the follow-up questions allow students to explore ideas on their own?	27	5	0	5	10
30. Have any of your students used the "Extensions for Further Research" included with most activities?	6	40	0	1	0
31. Is the Index usable?	5	0	0	40	0
32. Is the Glossary usable?	32	0	0	15	0
33. Is the Glossary accurate?	30	0	0	17	0
34. Is the cross-reference of related activities helpful?	37	0	0	10	0
35. Is the cross-reference of related activities accurate?	5	0	0	42	0
Layout:					
36. Is the layout visually appealing?	40	3	0	4	0
37. Does the layout add to or detract from your use of this guide?					
38. Is the layout helpful in the use of this guide?	22	3	0	22	0
39. Are the illustrations relevant?	40	0	0	7	0
40. Do the illustrations clarify or confuse activity directions?					

follow state-suggested learning objectives, making the activities in Energy: A Cross-Curricular Approach more open for modification by YMCA Staff. One of the main purposes of this study was to evaluate the curriculum guide as a means of meeting state-suggested learning objectives in the areas of social studies, science, language arts, and mathematics, while, at the same time, presenting energy education. YMCA Professionals, therefore, were included as a means of gathering further information for possible revisions within the YMCA Environmental Education Program, not the main purpose of this study. Where appropriate, YMCA respondent comments are included in patterns examined in Chapter V.

Without the 17 YMCA Professionals responses, 47 participants are noted. All totals in Table II, a report of data collected from returned surveys, should equal 47 in number.

Note in Table II that Question Numbers 3, 6, 37, and 40 are not tallied. The responses for these questions do not comply with Table formats. Question #3 asks participants what portion of the EACCA Manual presented them with new ideas. The response 0-25% received four checks. The number of participants claiming 25-50% was thirty five. The remaining eight participants stated that 51-75% of the manual presented them with new ideas.

Question #6 read as follows: On a scale of one to ten, one being the simplest, ten being the most difficult, what overall rating would you give the activities in this guide? Responses were varied. The number four received two checks; the number five, twenty two; the number six, ten; the number seven, four; the number eight, four; the number nine, two; and the number ten, on a one to ten scale, received three.

Question #37, Does the layout add to or detract from your use of this guide?, received an overall neutral response. Under the response "adds", twelve participants were counted. "Detracts" as a response received three checks. "Does Neither" received twenty eight checks. Four respondents failed to answer this particular question.

Question #40 asks "Do the illustrations clarify or confuse activity directions?" Of the forty seven participants, 17 claimed that illustrations helped to clarify activity directions. One respondent claimed that illustrations confused directions; twenty six responded that illustrations did "neither", while three participants did not answer this particular question.

Questions 41-43, asking questions related to classroom habits, are listed here. Question #41 asks, "Before being trained to use the EACCA curriculum, how much classroom time, per year, did you devote to the teaching of energy-related issues?" The response "0-5 hours" was selected forty five times. The response "6-10 hours" was selected twice. No one claimed more than ten classroom hours per year.

The question "How much time per year do you devote now?" was Question #42. The response "0-5 hours" was checked forty four times; three participants chose the response "6-10 hours". Again, no one claimed more than ten classroom hours.

When the participants were asked to list the three activities that were used most often with their classes (Question #43) the following activities were noted: (Numbers in parentheses indicate frequency of response) Energy Pathways (41), Interview a Light bulb (23), Muffin Mining (17), Which Material Stores Energy The Best (14), Oil Embargo (12), Well-Versed in Energy (9), Renew-A-Bean (5), Energy Mapping (5), Commuter Report (4), Water, Water, Everywhere (2), Popcorn Pass (2), Energy Debate (2), Whether Weather (1), Sunlight Serenade (1), Energy Bank (1).

Descriptive data obtained in each section throughout the survey instrument is not reflected here. It has been omitted to protect the confidentiality of respondents and for the reader's ease in assimilation of information. Certain patterns of responses do exist, and the issues raised by these patterns are addressed fully in the next chapter. Interpretation of data, noted patterns of responses, and implications for future revisions and further study are also addressed in Chapter V.

CHAPTER V

INTERPRETATION OF RESULTS AND IMPLICATIONS FOR FURTHER STUDY

This study's intent, as described earlier, was to develop instructional materials dealing with energy issues and concepts, to train teachers in the classroom use of these materials, and to obtain descriptive feedback on the design and use of the text, Energy: A Cross-Curricular Approach. This text, along with three-hour training sessions in its use, has been available since November, 1993. The main recipients have been New York City School Teachers (both public and private) and YMCA Professionals (Environmental Educators and Youth-Program Coordinators).

Of the teachers contacted, sixty percent (47 out of 78) responded and were considered for this survey; seventy seven percent (17 out of 22) of the YMCA professionals also responded. As explained in Chapter IV, the information obtained from these seventeen YMCA Professionals was sought with different goals in mind. Their responses were, therefore, not included in the tabulation of survey results. Where appropriate, patterns highlighted by their responses have been noted. Data was tabulated using frequency of response percentages. Interpretation of data appears below, divided into sections, corresponding to sectioned survey questions.

ACTIVITIES

Certain findings are quite clear cut, and as equally as promising. In question #4, a total of ninety percent of the respondents (35 of 39) agreed that the included activities kept the attention and interest of their students. The response quoted most often referred to the hands-on nature of the activities. This distinction was made consistently among both classroom teachers and YMCA Professionals. A like eighty nine percent (35 of 38) felt that the activities included in Energy: A Cross-Curricular Approach adhered to New York State Syllabi's stated objectives for the upper elementary grades (question #1), making these activities interchangeable with a teacher's existing activities. This is a promising find, indeed, for the purpose of introducing energy-related concepts to the classroom. Adding to this prospect is the fact that all of the respondents answering question #14 (44) felt that the activities chosen can "stand alone."

Question #3 shows a large majority of responsdents, ninety one percent or 43 out of 47, agreeing that new ideas in the field of energy education were presented in at least 25-50% of the EACCA Manual. The number of respondents claiming a higher 50-75% was eight, equalling seventeen percent of respondents.

All respondents to question #8 expressed satisfaction with the relevancy of the background information presented with each activity. Fewer, though, showed confidence in responding to questions regarding the accuracy and quantity of background information (questions #7 and #9). The number of respondents failing to answer each of these two questions was ten; 5 of 37 (fourteen percent) claimed a need for more background information, while 7 of 37 (nineteen percent) said they didn't know if the background information presented is accurate. If anything, this finding reinforces the findings of Greenkill's original needs assessment described in Chapter I of this thesis: the average person is energy "unknowledgeable".

Materials and equipment selected for use in the text's activities gained high overall merits as well. Ninety four percent of the respondents found no fault with obtaining, replacing, maintaining, or purchasing on budget, those materials suggested for use (questions 18-21).

CONTENT

A confusing find concerns questions # 27 and #30. While 29 of the 37 classroom teacher respondents (seventy eight percent) claimed that the follow-up questions were helpful, only 6 of 46 (thirteen percent) of these had had students use the "Extensions for Further Research" included with most activities. Time constraints were listed as a reason for not spending more time on "Extensions".

Among concepts reported as missing (question #24) were the use of wind power as an alternative power source, the practical aspects involved in the production of electricity and comparison of the use of energy by other nations. Also noted was the difficulty in adapting activities to the special needs of special education classes. Of the 64 educators who responded, eight of those dealt, either exclusively of for a majority of their teaching time, with special education populations. Information about the degree of level of functioning of these special education populations was not gathered.

LAYOUT

The physical layout of the guide, however, did not fair as well. Only twenty eight percent (12 of 43) of those answering this survey reported that the layout adds to the use of this guide (question #37). Sixty five percent (28 of 43) reported being neutral in opinion.

GENERAL INFORMATION

An interesting phenomenon noted was the fact that a respondent was likely to list as one of the three activities used most often in their classes (question #43) at least one of the activities presented to them in their training session (question #45). This finding serves to reinforce other findings in the field of education that suggest teachers do in the classroom what they experience first hand. Since training sessions are not subject-specific, it has been assumed that, overall, participants will be exposed to at least one activity within their subject area. That this be the one chosen to then present to students may speak of familiarity with the activity. This finding gives legitimacy to the suggestion for further research in the area of correlations between teacher training and classroom lesson content.

One major disappointment (questions #41 and #42) was the reported time spent teaching energy-related concepts or activities. Before receiving Energy: A Cross-Curricular Approach, 45 of 47 classroom teacher respondents (a full 95 percent) claimed to have spent from 0-5 hours per year in the teaching of energy-related concepts. While two respondents (representing four percent of the respondents) claimed 6-10 hours of classroom time devoted to the same concept. After one full year in possession of the text, the number of participants claiming 6-10 hours of energy education per year increased by only one (representing an increase of only two percent). This data, however, may not adequately reflect most changes. A survey design flaw leaves a five-hour per year window of inaccuracy. For example, an increase from one hour per year to four and one-half hours per year (a considerable increase) would not be recorded as a change on the current survey instrument. Likewise, a decrease from five hours to one-half hour (again a considerable change) would also go unnoticed. Further research might look once more at classroom lesson content after teacher-training workshops, using, instead, smaller hourly increments.

On a positive note, however, if one examines the activities teachers reported as being among the three used most often in their classrooms, calculating the average time spent on each activity, it becomes clear that the 0-5 hour time selection is not representative of all that is taking place in the classroom. From the usage reported, it can be inferred that the quality of energy education being presented in these classrooms has increased, changing from predominantly conservation education, to those activities listed which deal with energy issues, concepts, and action strategies.

Interesting questions raised by the responses to the referred-to survey instrument, worthy of further research, would include the role of administration support in the introduction of new curriculum to a classroom, and the relationship between perceived teacher knowledge of a subject area, and the classroom time devoted to this same subject. Van Koevering and Sell (1983) touch upon these topics in their analysis of effective energy education workshops for teachers. Comments from this survey instrument ("The background information provided is the only information I have to work with. Hard activities, like Oil Embargo, need more!") would indicate that follow-up research might be warranted.

SUMMARY

In summary, this study reveals several points worth reiterating. Energy education activities, dealing with values, concepts, issues, and decision-making strategies, in usable form for classroom teachers, are low in number, and in availability. Teacher-training workshops that emphasize the use of these activities, may be beneficial in establishing these activities within the classroom teacher's repertoire of activities.

Energy: A Cross-Curricular Approach, designed, printed, and distributed with financial help from the Environmental Protection Agency, Region II, New York City, holds a promising future for the direction of energy education in New York City Schools, and others across the nation. Introducing students to hands-on activities that keep their interest while allowing them to explore issues and decision-making strategies will, according to study findings, increase the quality of energy education in school classrooms.

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APPENDIX A

SURVEY INSTRUMENT

ENERGY: A CROSS CURRICULAR APPROACH (EACCA)
Summative Evaluation

Activities:

Do the EACCA activities meet New York State Syllabi's stated objectives for grades 4-6?
☐ yes ☐ no

Do the stated objectives of EACCA activities adhere to New York State Guidelines for the same grades?
☐ yes ☐ no

If you've answered no to either of these questions, please explain: ____________________

What portion of the EACCA Manual presented you with new ideas?
0-25% ___ 25-50% ___ 51-75% ___ 76-100% ___

Do you have any suggestions for alternative methods of presentation? ☐ yes ☐ no
If yes, please summarize:

Do the activities keep the interest and attention of your students?
☐ yes ☐ no

Are the activities age-appropriate? ☐ yes ☐ no

If you've answered no to either of these questions, please explain: ____________________

On a scale of 1-10, one being the simplest, ten being the most difficult, what overall rating would you give the activities in this guide? ___

Is there enough background information presented with each activity? ☐ yes ☐ no
If no, please list specific activities where more background information is needed:
____

Is the background information relevant? ☐ yes ☐ no
If no, please list specific activities: ____________________

Is the background information accurate? ☐ yes ☐ no ☐ don't know
If no, please list specific activities: ____________________

Are the "skill" objectives achieved? ☐ yes ☐ no
If no, please list specific activities: ____________________

Are the suggested times listed for each activity accurate? ☐ yes ☐ no
If no, please list specific activities of concern, and whether more or less time is suggested:
____

Are the suggested times for preparation and follow-up adequate? ☐ yes ☐ no
If no, please list specific activities of concern, and whether more or less time is suggested:
____

Is the procedure section of each activity easy to follow? ☐ yes ☐ no
If no, please give suggestions for revisions: ____________________

Can each activity "stand alone"? ☐ yes ☐ no
If prerequisite knowledge is needed, please list specific activities.

____

Is there coherent flow from activity to activity? ☐ yes ☐ no

Is the information presented in EACCA activities relevant to the lives of your students? ☐ yes ☐ no
If no, please list specific activities of concern: ______________________________

Are the skills which the activities profess to develop relevant to the lives of your students?
☐ yes ☐ no
If no, please explain: ______________________________

Materials:

Are the required materials or equipment easily obtainable? ☐ yes ☐ no
Please make suggestions for more easily obtainable materials: ______________________________

Are the required materials or equipment easily replaced? ☐ yes ☐ no

Are the required materials or equipment easily maintained? ☐ yes ☐ no

Are the required materials or equipment within your budget? ☐ yes ☐ no

Are the required materials or equipment safe for classroom use? ☐ yes ☐ no
If you've answered no to any of these questions, please explain: ______________________________

Is there any question or controversy of use of the required materials or equipment within your school or district?
☐ yes ☐ no
If yes, please explain: ______________________________

Content:

Are concepts or activities missing that you feel are important for a general energy guide?
☐ yes ☐ no
If yes, please explain: ______________________________

Are there concepts or activities included that you feel should **not** be?
☐ yes ☐ no
If yes, please list specific activities, and explain: ______________________________

Are the general directions for using the curriculum guide easy to follow? ☐ yes ☐ no
If no, please explain: ______________________________

Are the follow-up questions valuable to you? ☐ yes ☐ no
Please explain ______________________________

Are the follow-up questions self-explanatory? ☐ yes ☐ no

Do the follow-up questions allow students to explore ideas on their own? ☐ yes ☐ no

Have any of your students used the "Extensions For Further Research"?
☐ yes ☐ no
If yes, please list the titles here: ____________________

If no, please explain why: ____________________

Is the index usable? ☐ yes ☐ no
If no, please give suggestions for revisions: ____________________

Is the glossary usable? ☐ yes ☐ no
If no, please give suggestions for revisions: ____________________

Is the glossary accurate? ☐ yes ☐ no
If no, please explain: ____________________

Is the cross-reference of related activities helpful? ☐ yes ☐ no

Is the cross-reference of related activities accurate? ☐ yes ☐ no
If no, please list specific examples: ____________________

Layout:

Is the layout visually appealing? ☐ yes ☐ no
Please give suggestions for revisions: ____________________

Does the layout add to, or detract from, your use of this guide?
☐ adds ☐ detracts ☐ does neither

Is the layout helpful in the use of this guide? ☐ yes ☐ no

Are the illustrations relevant? ☐ yes ☐ no

Do the illustrations clarify or confuse activity directions?
☐ clarify ☐ confuse ☐ neither
Please give suggestions for improvements: ____________________

General Information:

Before being trained to use the EACCA curriculum, how much classroom time per year did you devote to the teaching of energy-related issues?
☐0-5 hours ☐6-10 hours ☐11-15 hours ☐16-20 hours ☐21-25 hours ☐more

How much time per year do you devote now?
☐0-5 hours ☐6-10 hours ☐11-15 hours ☐16-20 hours ☐21-25 hours ☐more

If this is a change, please list any factors affecting your change: ____________________

List the three activities that you use most often with your class:
1) ____________________
2) ____________________
3) ____________________

If there are specific reasons for using these particular activities, please list here:

1) ______________________________

2) ______________________________

3) ______________________________

What activities were presented at your training?

1) ______________________________

2) ______________________________

3) ______________________________

What subject area do you spend the majority of your time teaching? ______________

What grade level do you spend the majority of your time teaching? ______________

(Optional).

Your Name: ______________

School District: ______________

or Organization: ______________

Address: ______________

____

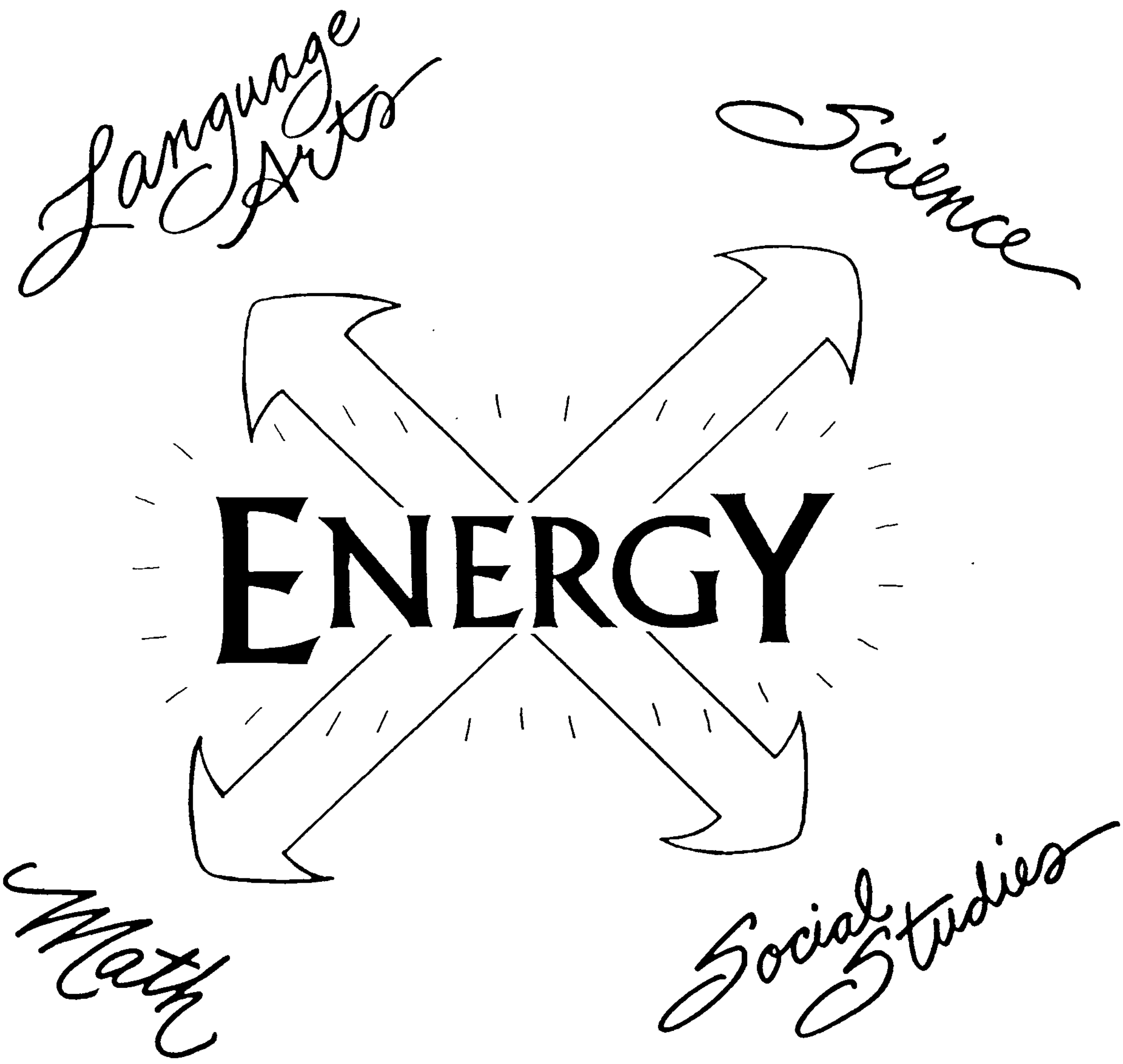
Phone Number: ______________

Please use the space below for any additional comments you may have:

Thank you for your time and thoughts!

APPENDIX B

ENERGY: A CROSS-CURRICULAR APPROACH



A Cross-Curricular Approach

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Outdoor Environmental Education Center
YMCA of Greater New York

ENERGY

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Greenkill Outdoor Environmental Education Center
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All primary sources of information have been recognized within the text when used. Further bibliographical information can be found under **References and Resources.**

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To paraphrase John Muir, "When we try to examine any one thing by itself, we find it hitched to everything else in the universe!" This sentiment aptly applies here as well To construct an activity guide such as this, in any usable form, one finds out just how many "hitchings" are necessary. From all directions I need to acknowledge help and support. A thank you to

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Preface

When picturing a city, we most readily think of tall buildings, streets full of cars, and lots of people; after all, that's what makes it a city, full of energy and energy use, powered by people and fossil fuels. These fuels keep us moving and productive, they also fill our city with smog and toxic air emissions, and contribute to a rising global temperature when we use them Our urban students are surrounded by it all, a challenge to their health and the health of the earth.

Nationwide, urban and rural alike, our country uses more energy than any other per capita. By using the most energy, we have a responsibility to raise youth who know what it is they're using and what effects it has.

Few students know how energy works or where it comes from. They can rattle off types of environmental problems like ozone depletion, acid rain, and global warming with little idea of how it's caused or what the connection is to their light switch. Most know how they're dependent on oil or gas, but are unsure that they use coal at all.

The National Energy Education Development Project (NEED) polls students and teachers to discover where students lack information about energy and how they feel about the issues. The poll at the secondary level showed that most students characterize themselves as energy-savers, yet few showed the knowledge needed to make them informed consumers and make wise choices about energy situations facing citizens. NEED found that K-6 teachers spend 0-2 hours per year on Energy Education, this increasing only slightly at the secondary level. (The NEED Project, March 1990).

Reconnecting conservation of energy to fuel and power generation, energy use, and environmental effects is needed to help ground the value of conservation and help youth justify it in their future decision-making.

As this handbook neared completion, the author was affirmed as to the need to help teachers in all subject classrooms to integrate energy education. Asking a group of seventh grade students if they could name the nuclear reactor which had a meltdown in the former Soviet Union, the answer came in the form of a question. "What's a nuclear reactor?" Are we missing something? Would that be the answer from the students in Byelorussia who will live forever with Chernobyl? This book is a first step to help teachers answer these questions and begin the move towards an energy literate classroom and country, so we can begin to make decisions that help the world.

Nancy Reichert
Director of Outdoor
Environmental Education,
YMCA of Greater New York

Foreword

It's a complicated world in which we live To translate this concept into an educator's frame of reference: Reading, Writing, and 'Rithmetic alone will no longer suffice But what, then, are the alternatives? To litter the school curriculum with disjoined topics (all extremely vital in their own right!) at the expense of time spent on the basic educational foundations? This approach won't do, either The solution? To create a truly interdisciplinary curriculum--one that demonstrates the interconnectedness of all peoples, all places, all things, while at the same time focusing on the age-old "basics".

We have worked long and hard on this formidable task--and hope that you will be as pleased with the results as we are. The end product? An interdisciplinary, cross-curriculum approach. The theme tying all of it together? Energy Education!

This guide is based on the premise that our lives (and lifestyles) revolve around the production, consumption, and conversion of energy--in all forms. Yet for such an all-encompassing concept little accompanying factual knowledge exists at the grade-school level. (See Nancy Reichert's preface on the preceding page.) We hope to begin the process of creating an energy-literate population, one prepared to confront the difficult and challenging decisions that await our country--and our world--as finite sources of energy are exhausted.

This guide is divided, for ease of use, into four main subject areas: Math, Language Arts, Science and Social Studies. The Table of Contents will guide you to each section in turn. Once you have arrived at each section, an individual Table of Contents will allow you to reference activities by the skill or concept that you would like to teach. For example, are you a math teacher looking for lesson plans for a graphing unit? Simply turn to the Math Section Table of Contents on page 2, find graphing under the skill/concept column, and you will find the six activities dealing with graphs and graph construction listed there.

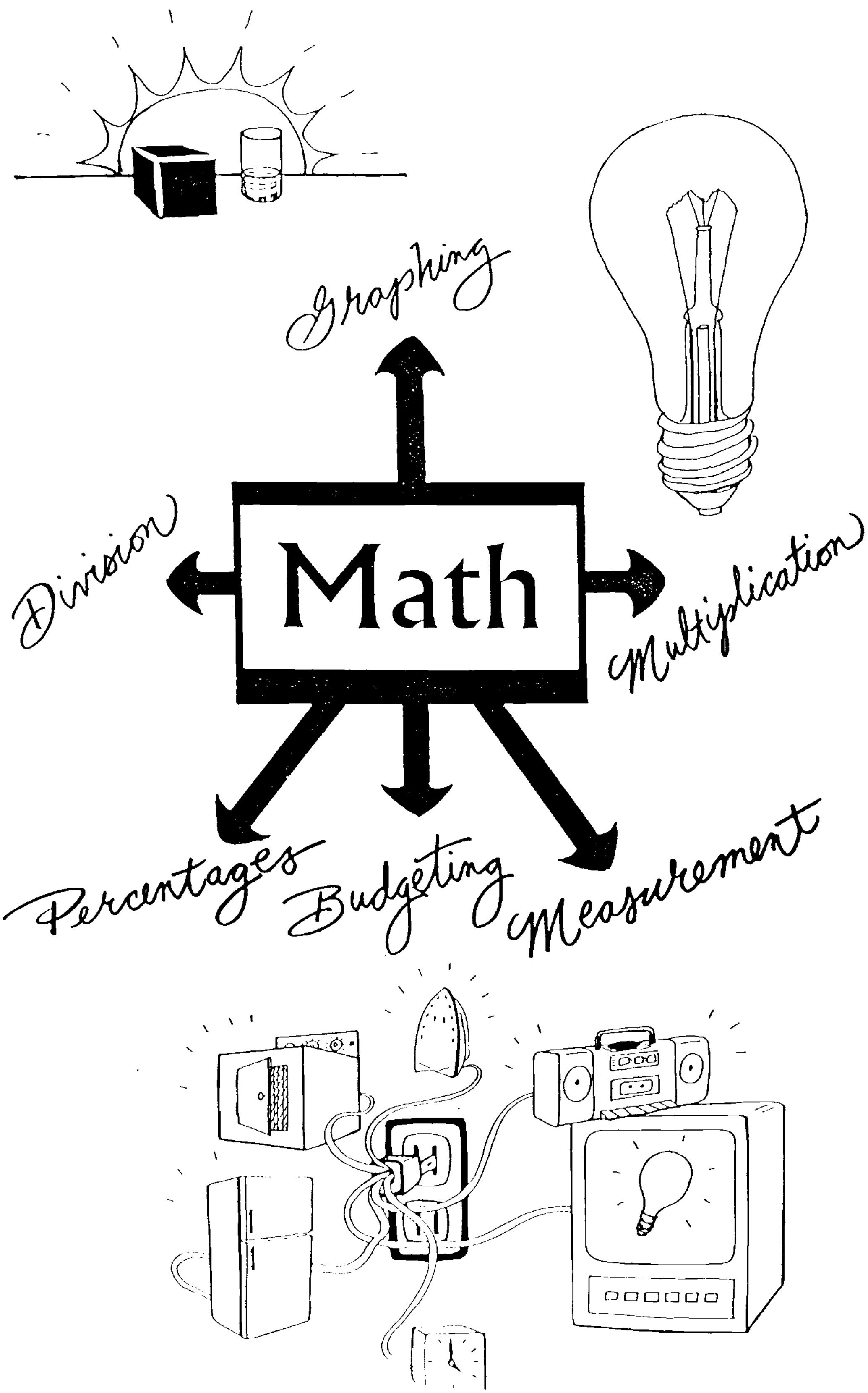
We have focused our objectives (and the resulting activities and extensions) on the needs of the upper elementary student. Learning objectives from the New York Sate Department of Education and the City of New York Department of Education for grades 4-6 have been referenced and incorporated. You may find, though, that some activities may be appropriate for slightly younger or slightly more mature classrooms. The ultimate judgement is yours.

Most importantly, the activities enclosed were designed or modified to convey certain key concepts. Does the play area called for not correspond with your available facilities? Is the time required too long? Not long enough? Don't let that deter you! Feel free to experiment...to change variables to suit your needs...to play...to learn...to excite...to grow together with your students!

We wish you luck in your efforts, and encourage your feedback A form for suggestions for revisions can be found on page 99. Let us know how you are doing, or what we can do further to help. More importantly: Enjoy!

Christine Lalonde

Table of Contents


Graphing
Division
Math
Multiplication
Percentages
Budgeting
Measurement

Math

Energy Bank

Objectives:

Students will be able to 1) compute the amount of "energy" that they use in their daily activities, 2) demonstrate ways in which they can "conserve" their energy, and 3) apply this information to the larger population of their classroom, school, or community.

Related Activities:

Personal Energy Survey (page 17), Energy Mapping (page 82)

Skills Developed:

problem solving, application, computation, planning, budgeting, conservation, economics, current events
(extension: graphing, percentages)

Time Required:

one preparation period of 30-45 minutes,
ongoing for ??? You decide!

Key Vocabulary:

conservation: controlled use and protection of natural resources; the act of using carefully to avoid waste

Materials:

50 energy tickets per student (Make a point! Use recycled or scrap paper for the tickets!)

Background:

It's no secret. Today, the United States contains approximately 6% of the world's population. (About 1/20th). Yet, remarkably, we consume over 30% of the world's resources! (Close to one third!) The disparity between these numbers is, at times, quite discouraging. The reasons for this gap are complex...political, economic, social, etc. This activity is meant to demonstrate to your students concrete conservation methods that may then be carried over to their actions outside the classroom.

Procedure:

1) Prepare (or have the students prepare) 50 energy tickets per student. Have the students place their names on each of the tickets. (You may then wish to ration the tickets, distributing a certain amount per day. Giving the students all fifty at once, however, could also yield very interesting learning results. Why not try each method and have the students compare the results at the end of each session.)

2) Brainstorm with the students for a list of all the places they go during an average school day. (Lunch, recess, the bathroom, the water fountain, the pencil sharpener, music or gym class, the principal's office, etc.) To "travel" to all of these locations requires energy. Discuss the various sources and types of energy used. Explain that they are now going to see for themselves just how much energy they actually use!

3) Each time a student takes a trip, it will now cost him or her one energy ticket. Place a large collection envelope

3

on or near the door, or near your desk, for collection of these tickets Once a student runs out of energy tickets, they may make no more trips. (A loan, or an exception may, of course, be given for the bathroom.)

4) Have the students keep a running tally of the number of tickets they use each day. Which students are conserving energy? How? Which students are wasting energy? How? What might they want to do to start conserving tickets? (Stress the idea that several tasks can be accomplished with one trip: For instance, at recess, or on the way to lunch, a student could sharpen his or her pencil, go to the rest room, **and** get a drink. All for only one ticket--WOW!)

5) At some point before you end the activity, discuss the idea of running out of energy tickets. There are no more left for the rest of the week! How will this effect the class? What changes will have to be made? What can be done about it now?

Questions:

How did conservation (or lack of conservation!) effect the quality of life in the classroom?

How did the "energy shortage" effect classroom energy use? Now would be a good time for a discussion of the gas rationing lines of the 1970's. What political or economic events led to the gasoline shortage of the 1970's? Have students research this time period to find out.

It takes energy to supply the things that people use to make their lives easier, more comfortable, or enjoyable. How might energy conservation or an energy shortage effect a person's everyday life?

How might energy use decisions affect standard of living and quality of life? Ask for examples from around the world.

What If...???/Extensions:

...students were asked to label each ticket with the "destination" of the student. At the end of each day, use could be graphed. Conservation possibilities could be discussed.

...students were each given **a different number** of energy tickets, to represent the different countries around the world, or different economic situations? Try this scenario for a day. Have students display flags representing their "countries" and the energy use policy or percentage of world energy that they will be following. Use the following chart to divide energy realistically. Better yet, have your students calculate the percentage of total energy tickets that they should receive based on their country's actual percentage of world energy use.

How do the students react to one another, as representatives of different countries? Do countries or municipalities do the same? Why, or why not? Have students locate their country on a map. Are some having difficulty? Why are the students who have been assigned Yugoslavia and Czechoslovakia having more difficulty than others? Discuss why this might be!! (Remember that the chart below contains figures from 1987!)

...students were asked to compose a story? "The Day There Was No Energy," or some similar theme.

...you wanted to apply this lesson to home life? Have students discuss how they use energy at home. Are there possible actions they could take to conserve more of this energy?

...you had a contest? See who can **productively** complete the school day (or week) using the least amount of energy tickets! (Note the word "productively" in the above sentence!)

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World Energy Consumption, 1987, by Country

Country	Total (mil. metric tons)	Per Capita
Algeria	33.3	1,441
Argentina	59.5	1,912
Australia	110.6	6,845
Austria	30.1	4,018
Bahrain	6.8	14,680
Bangladesh	6.9	64
Belgium	55.1	5,560
Brazil	108.5	767
Bulgaria	53.1	5,912
Canada	256.5	9,915
Chile	11.8	938
China	800.8	749
Colombia	24.5	817
Cuba	14.5	1,442
Czechoslovakia	98.2	6,311
Denmark	27.4	5,346
Ecuador	6.2	627
Egypt	33.8	674
Ethiopia	1.2	28
Finland	28.1	5,692
France (1)	206.9	3,720
Germany, East	131.3	7,891
Germany, West	342.0	5,624
Greece	24.5	2,452
Hong Kong	10.6	1,891
Hungary	40.5	3,819
India	220.5	275
Indonesia	47.2	274
Iran	65.9	1,285
Iraq	12.5	735
Ireland	12.5	3,462
Israel	12.2	2,794
Italy	204.4	3,570
Japan	456.1	3,741
Korea, North	57.9	2,708
Korea, South	74.2	1,760
Kuwait	17.1	9,191
Libya	11.0	3,023
Malaysia	20.8	1,283
Mexico	140.9	1,697
Morocco	7.8	336
Myanmar	2.7	68
Netherlands	106.0	7,265
New Zealand	12.7	3,858
Nigeria	16.9	166
Norway (2)	28.3	6,782
Pakistan	27.8	250
Peru	11.7	564
Philippines	15.4	265
Poland	181.5	4,810
Portugal	13.6	1,329
Romania	106.1	4,624
Saudi Arabia	79.4	6,322
South Africa (3)	107.6	2,816

Soviet Union	1,867.2	6,634
Spain	81.9	2,106
Sudan	1.5	64
Sweden	41.8	5,004
Switzerland (4)	24.8	3,794
Syria	11.5	1,025
Tanzania	9	38
Thailand	26.3	493
Trinidad and Tobago	7.1	5,770
Tunisia	5.0	651
Turkey	52.4	998
United Arab Emirates	27.4	18,832
United Kingdom	290.8	5,107
United States	2,322.9	9,542
Venezuela	55.1	3,018
Vietnam	7.4	118
Yugoslavia	56.7	2,423
Zaire	2.1	64
Zambia	1.9	248

World Total 9,653.6 World Average 1,921

(1) = includes Morocco
(2) = includes Svalbard and Jan Mayen Islands
(3) = includes Botswana, Lesotho, Namibia, and Swaziland
(4) = includes Liechtenstein

Percentages of World Energy Consumption, 1987

(calculated from preceding figures)

Country	Percentage	Country	Percentage
Algeria	.35	Libya	11
Argentina	.62	Malaysia	.22
Australia	1.15	Mexico	1.46
Austria	.31	Morocco	.08
Bahrain	.07	Myanmar	.03
Bangladesh	.07	Netherlands	1.10
Belgium	.57	New Zealand	.13
Brazil	1.12	Nigeria	18
Bulgaria	.55	Norway	.29
Canada	2.66	Pakistan	.29
Chile	12	Peru	.12
China	8.30	Philippines	.16
Columbia	.25	Poland	1.88
Cuba	.15	Portugal	.14
Czechoslovakia	1.02	Romania	1.10
Denmark	.28	Saudi Arabia	.82
Ecuador	.06	South Africa	1.12
Egypt	.35	Soviet Union	19.34
Ethiopia	.01	Spain	.85
Finland	.29	Sudan	.02
France	2.14	Sweden	.43
Germany, East	.01	Switzerland	.26
Germany, West	3.54	Syria	.12
Greece	.25	Tanzania	.01
Hong Kong	.11	Thailand	.27
Hungary	.42	Trinidad and Tobago	.07
India	2.28	Tunisia	.05
Indonesia	.49	Turkey	.54
Iran	.68	United Arab Emirates	.28
Iraq	.13	United Kingdom	3.01
Ireland	.13	United States	24.06
Israel	.13	Venezuela	.57
Italy	2.12	Vietnam	.08
Japan	4.72	Yugoslavia	.59
Korea, North	.60	Zaire	.02
Korea, South	.77	Zambia	.02
Kuwait	.18		
Total	**96.77**		

ENERGY TICKET Good for one trip Name________	ENERGY TICKET Good for one trip Name________	ENERGY TICKET Good for one trip Name________	ENERGY TICKET Good for one trip Name________	ENERGY TICKET Good for one trip Name________
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Variations:

The concept of a "unit" of energy is often a difficult one for students of any age to deal with. Pairing it with a concept that may be more familiar to them is one way in which to work toward a more concrete understanding.

One variation that might be helpful is that of a "bank" theme. The bank would represent a power plant, with the ability to store, or save, energy units for a future demand. Students may "earn" energy units for doing various tasks or activities--using scrap paper for drawing, turning off the lights when leaving the room, keeping windows closed when the heat or air conditioning is on, etc. These "energy units" can then be deposited into their account, just like a true savings account. When energy is needed throughout the day, week, or month, students may make withdrawals based on their need and their account balance.

Not only does this variation allow students to develop a concept of how energy is stored and presented and used on demand, it also will give students a better understanding of what happens when there is too much demand for power (or insufficient funds for withdrawal!). Hopefully it will give students the opportunity, as well, to prioritize their wants and needs, conserving energy now, saving for future demand. (This can allow for an excellent discussion of the concept of money, and money management---foregoing a trip to the movies in exchange for a new shirt, for instance.)

Give the students a list of energy using activities (see below for examples), and ask each to prioritize for him or herself. Compare these lists. Are any two exactly alike? If not, do they find this unusual? Now prioritize the list as a class. This process may take some time, but will allow the students to experience the give and take of consensus rule. What does this say about individual priorities vs. the priorities of the group? Can they give examples from their family? Community? State? Country?

Sample List of Energy Using Objects or Activities:

1. Air conditioning (How will this differ on the lists of someone who lives in Alaska, vs. someone who lives in Phoenix? The city vs. the country?)
2. Electric Pencil Sharpener (Manual Pencil Sharpener!)
3. Electric Lighting
4. Refrigerator
5. Radio/Stereo System
6. TV/VCR
7. Video Games
8. Personal Car/truck/van
9. Mass Transit
10. Classroom Fish tank

(Keep adding as many as you can! See what adding more and more does to the process of group prioritizing!!)

Variation II:

The Energy Budget: Give students a predetermined amount of "energy units." Record this amount as their energy balance forward. Have the students brainstorm ways in which they might "make" more energy for themselves. Call this "income". Now, from the menu that follows, have students select activities and tasks that need to be done, and those that the students would like to do. Remind them to stay within their budget!

-- Energy Treats --

Appetizers:

Toasty Toes (includes one week of heat at 75 degrees F) . . . 25 Energy Units (EU)
Fancy Fingers (5 sharpened pencils) . . . . 05 EU
Stereo Salad
(three hours of your favorite music, lightly tossed) 04EU

Main Entrees:

Light bulb Linguini
(one week of electric lighting with incandescent light bulbs) . . . . 10 EU
Travel Here and There
(one trip from the classroom, walking, to anywhere) . . . . 02 EU
Refrigerator Blues, Take Out Style (one week of a nice chilled frig, plus freezer,
lots of air space, three nights take out, and a few cans of soda or juice) . 75 EU
Sweet and Sour Shower
(20 minutes of hot water, refreshingly served over a bed of bubbles) . . 50 EU

On The Lighter Side:

Thirst Quencher
(one recycled aluminum can filled
with the soda or fruit juice of your choice) . . . . 03 EU
Fluorescent Fettucini
(one week of lighting with fluorescent light bulbs) . . . . 05 EU
Sweater Special
(one week of heat at 65 degrees F) . . . . 12 EU
optional side order of sweater or sweatshirt, your choice . . . . 03 EU

Refrigerator Blues

(one week of a nice chilled frig, plus freezer, if filled with food) . . . . . 50 EU

Prefer a smaller portion? (one day) . . . . 10 EU

Shower Sucy

(10 minutes of hot water served with a garnish of shaved soap) . . . . . . 20 EU

Dessert:

Recess (one day, includes basketball) . . . . 08 EU

Recess (one day, no organized sport included) . . . . 04 EU

Movie Medley (a showing of any two-hour movie of your choosing) . . . . 08 EU

Beverages:

One aluminum can filled with the soda or fruit juice of your choice . . . . 15 EU

Water

(unlimited drinking supply for one 24-hour period,
pumped fresh from the well) . . . . 08 EU

Please Enjoy Your Meal!

--Prices Include Taxes and Gratuities--

Bright Ideas

(adapted from the California Energy Extension Service's "Conserve & Renew")

Objectives:

Students will be able to 1) describe and compute the energy used to operate various forms of lighting, and the monetary cost of this energy and, 2) list electromagnetic as a form of energy.

Skills Developed:

multiplication, division, problem solving, critical thinking
(extensions: creative composition, letter writing)

Time Required:

one 45-50 minute period

Key Vocabulary:

efficient: producing effectively with a minimum of waste or unnecessary effort
watt: a unit of power
lumen: a measure of the amount of light given off by an object, equal to the light intensity of one candle
filament: a fine wire heated to incandescence (a glow) in an electric lamp
fluorescent: a light generated by the output of electromagnetic radiation (In a fluorescent light bulb, the inner tube is coated with a material that fluoresces, or glows, when in contact with radiation from a gas discharge within the tube.)
fuse: a device containing an element that protects an electric circuit by melting when overloaded
kilowatt-hour (Kwh): a unit of energy

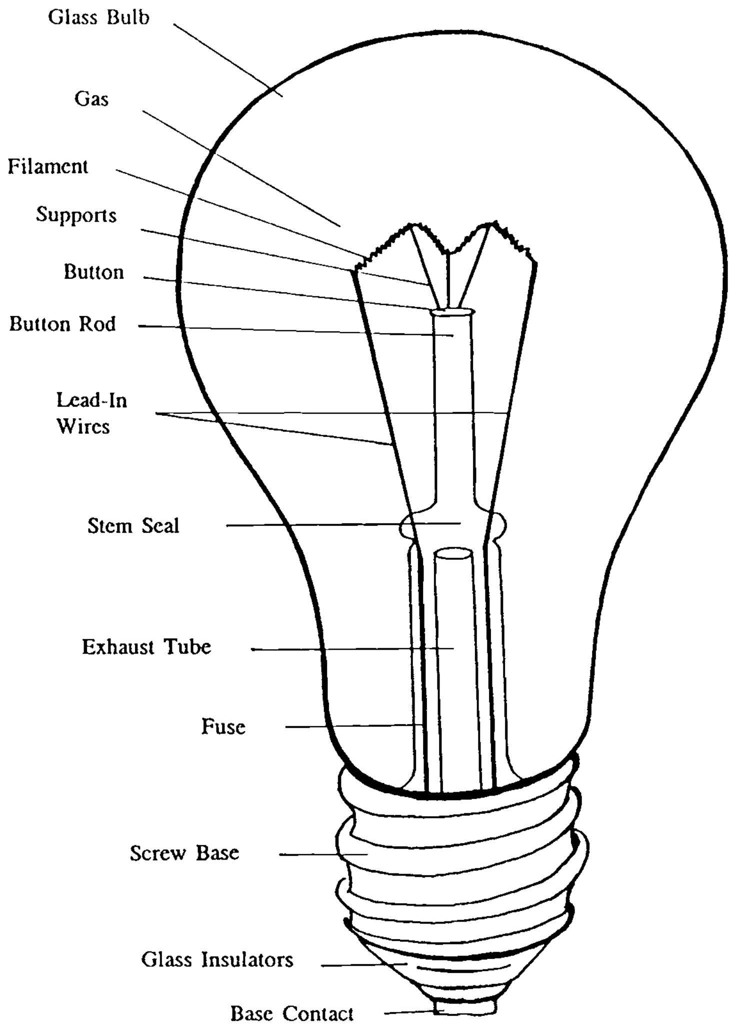
Materials:

copies of the lighting survey sheet
a reproduction of the light bulb diagram (enlarged on the board, or copied and distributed)
as many of the light bulb types listed on the survey sheet as you can find and borrow, (try the school's maintenance department!) hopefully with the boxes they came in (Here's an idea: save blown bulbs instead of throwing them away...just be sure to save the packaging, too!)
the rate charged for electricity in your area (easily obtainable with a call to your local utility company...see the Resources and References Section for the address and phone number of your local utility)
light type information guide (use this only if you can't find different bulb types)

Background:

Collect all of the materials to be used and familiarize yourself with the "anatomy" of a light bulb (see diagram) and the Light Type Information Guide. Incandescent bulbs work by applying electricity to a filament. The filament slows the progress of the charge, thus emitting light and heat. Fluorescent bulbs apply the electricity to a contained gas; its electrons use electrical energy to jump up, then re-emit that energy as light, when they fall back towards their nuclei. Recently developed compact fluorescent bulbs have the ability to replace ordinary incandescent bulbs and operate much more efficiently. They have been improved so they give good color rendition and don't flicker or hum (all problems reported with the original prototypes). The compact fluorescent lasts about nine times as long and uses a fourth of the energy as

Light Bulb Logic



The Workings of
an Incandescent Light Bulb:

Incandescent bulbs work by
applying electricity
to a filament.
The filament slows the
progress of the charge,
thus emitting
light and heat.

incandescents! (They do, however, cost more initially to purchase.)

Try to get at least one of these compact fluorescents, a rough-duty incandescent, a fluorescent tube, and a regular incandescent, each with the packaging material so the students can read the information from the actual package. Make a note of the various bulb prices on the "Light Type Information Guide." (If compact fluorescents are not available through local stores try calling your local utility, or The Seventh Generation, an alternative-energy company at 1-800-456-1197.)

Procedure:

1) Use the picture of the light bulb to explain to students how different light bulbs work.

2) Split the class into groups and have a couple of bulb types at several different stations.

3) Have each group move from station to station, filling out the lighting survey sheet for each bulb type. They will complete the type, wattage, lumens per watt, and lifetime columns. Ideally, they will have an actual bulb in its packaging from which to collect the information. If the bulbs are not available, you might have students go shopping and look at different bulb types at a building supply or lighting store. As a last resort, you can use the "Light Type Information Guide."

4) Demonstrate for the students how to compute electricity consumption:

Kwh=hours of use x (wattage of bulb divided by 1000);

and Lifetime Cost:

cost of bulb + (electric rate x Kwh)

5) Have students finish the survey sheet by doing the computations with their data.

For your information, according to the Rocky Mountain Institute, if everyone in the United States replaced one, 100-watt bulb with a compact fluorescent, it would save as much energy as is produced by one, Chernobyl-sized nuclear power plant!

Questions:

Which bulbs use the most energy? Which use the least?
Which bulb has the shortest lifetime? Which has the longest?

What If...???/Extensions:

...you had the students do the same computations on their home lighting? Have them estimate the results beforehand.

Do a comparison of cost between existing lighting in the classroom (or home) and what might be spent with different bulbs. If you discover a potential savings, present your findings to the principal and/or board members. Each student could draft a letter presenting their findings, or the class could work together to do so.

Compute how much energy your class can save over the school year by turning off lights next to the windows during bright times of day.

Compute how much energy it takes to light the classroom over the lunch hour if the lights get left on every school day. Have the students write an essay about how the school might spend the savings if the lights are turned off.

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Light Type Information Guide

Bulb Type	Wattage	Average Lumens per watt	Average Lifetime in hours
Compact Fluorescent	7w-32w	65	10,000
Cool White Fluorescent	40w	46	16,000
Warm White Fluorescent	40w	46	16,000
Incandescent	20w-1500w	18	1,025
Rough Duty Incandescent	20w-1500w	10	750
High Pressure Sodium	70w-1000w	104	22,000
Low Pressure Sodium	18w-180w	100	14,000
Mercury Vapor	50w-1000w	33	20,000

Lighting Survey Sheet

Bulb Type	**Wattage**	**Average Lumens per watt**	**Average Lifetime in hours**	**Electricity consumption in Kwh** = hours x $\frac{\text{wattage}}{1000}$	**Lifetime cost = cost of bulb + (electric rate x Kwh)**

Personal Energy Survey

Objectives:

Students will be able to: 1) compute the percentages of monthly and annual energy use for various home appliances and energy users, 2) construct bar and pie graphs of energy uses, 3) observe and measure their own (or their family's) energy use, 4) construct their own graphs based on their personal information, and 5) list ways in which they (or their family) could save energy.

Related Activities:

Energy Mapping (page 82), Bright Ideas (page 13)

Skills Developed:

computing percentages, graph construction and interpretation, observation, data recording, extrapolation, measurement

Time Required:

one 45-50 minute period

Materials:

graph paper
straight edges
drawing compasses
copies of the attached energy profile

Background:

Many local utility companies, well aware of the amount of energy used as well as wasted by their clients, offer services to custumers to help them reduce the amount of energy that they use. This may seem a bit confusing...after all, isn't the utility in business to sell us energy? Why would they want to *reduce* the amount of energy that we, as consumers, use? The answer is simple. The utilities know that efficient energy usage saves us all in the long run. (Consumers save valuable money on energy bills. Utilities save on the demand put on their equipment and personnel in trying to provide power at peak usage times. And we all save the consumption of resources, many of them finite, that are best saved for another day.)

The Personal Energy Profile attached represents one family of four's (The Smith's) actual energy evaluation for the month of June, 1993. If your local utility offers this service, it would be a wonderful learning experience for your students (as well as their families) if real surveys could be conducted and analyzed for later classroom use. The Consumer Affairs Division or Education Department should be able to tell you if such a service is provided for its utility customers. (See the end of this activity for the address and phone number of the utility company in your area.)

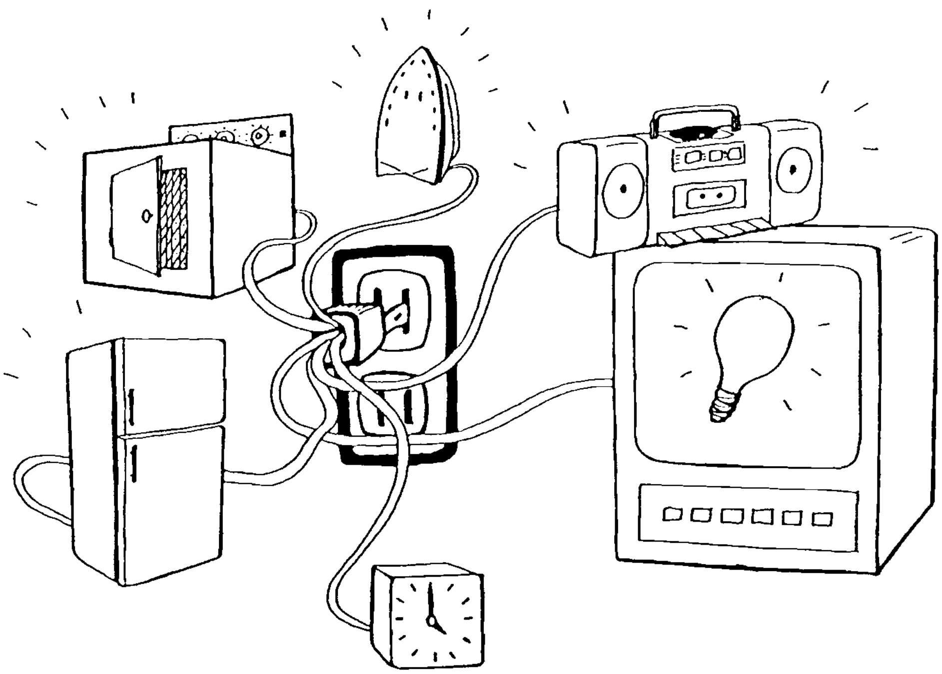
Procedure:

1) Copy th attached monthly and annual energy usage charts. These tables represent the actual energy usage of a family of four. Discuss the ways in which this family (The Smiths, residents of New York State) spent their $1,221 electricity budget for the year. Is this family typical? Poll your class to find out.

2) Using the dollar amounts given, have your students calculate the percentages of the Smith's yearly budget for each use category. Do the same with the monthly figures for the month of June. How would figures for the month of August differ? How about November? December? January? Explain why this might be.
Why is it important to know that the Smiths live in New York? Can you tell this from their energy bill? What

information would tell you this?

3) Using the dollar amounts given, have your students construct bar and/or pie charts depicting the information.



What If...???/ Extensions:

If available from your local utility company, have students (with the help of their families) survey their own energy usage. They would then receive a monthly and annual breakdown of where their energy dollars are spent. (This service typically takes 3-4 weeks turn around time, so plan well in advance!) YES! It takes some organization and some groundwork, but what a WONDERFUL teaching tool!! A word of advice: LILCO sends an energy auditor to customers' homes to inspect attics and basements, etc, and to help fill out the forms...this auditor is a mandatory part of the Energy Audit, and permission must be obtained from the home owner before the inspector can enter. On a positive note, their inspectors do work evening and weekend hours for the convenience of their customers.

Contact the following for assistance in obtaining Home Energy Audits for your students:

LILCO
Consumer Affairs Division
15 Park Drive
Melville, NY 11747
(516) 755-6031

ConEdison
Education Department
4 Irving Place
New York, NY 10003
(212) 460-4600

Annual Energy Usage

Heating System	$154.00
Air Conditioning (this family has none; they rely on the placement of trees outside their windows and the actual placement of their windows within the house to keep their house cool. This is called "passive" cooling.	$ 0.00
Refrigerator (One)	$ 94.00
Water Heater (this family has an old system that requires no gas or electrical input)	$ 0.00
Pools and Spas (This family has neither)	$ 0.00
Lighting (all incandescent)	$115.00
Clothes Dryer (Electric)	$126.00
Freezer (One upright)	$270.00
Range, oven, microwave	$103.00
TV, Stereo, VCR, Home Computer	$ 78.00
Dish/Clothes Washer	$ 23.00
Waterbed heater (this family has no waterbed)	$ 0.00
Small Appliances (hair dryers, coffee pots, vacuum cleaners, toasters, blenders, irons, clock radios, portable fans, etc.)	$ 44.00
Extra Energy Users (this would include the water pump, any wood shop or power tools, fish tanks, portable heaters, answering machines, video games, dehumidifiers, etc.)	$214.00
TOTAL	$1,221.00

Monthly Energy Usage

for the month of June

Heating System	$ 0.00
Air Conditioning	$ 0.00
Refrigerator	$ 9.00
Water Heater	$ 0.00
Pools and Spas	$ 0.00
Lighting	$ 11.00
Clothes Dryer	$ 12.00
Freezer	$ 26.00
Range, Oven, Microwave	$ 10.00
TV, Stereo, VCR, Home Computer	$ 8.00
Dish/Clothes Washer	$ 2.00
Waterbed Heater	$ 0.00
Small Appliances	$ 4.00
Extra Energy Users	$ 21.00
TOTAL	**$103.00**

Commuter Report

Objectives:

Students will be able to: 1) count and graph the number of passengers (including the driver) in passing vehicles in a given time period, and 2) explain the implications of car-pooling vs. not car-pooling on the amount of greenhouse gases released into the air.

Related Activities:

Greenhouse Goof (page 45)

Skills Developed:

observation, measurement, data recording, graphing and interpretation, math skills (multiplication, division, and extrapolation)

Time Required:

one 15-30 minute observation period (depending on traffic patterns at the time)
one 45 minute graphing and interpretation period

Key Vocabulary:

greenhouse gas: any one of the known gases that are found to contribute to the greenhouse effect
car-pool: an arrangement whereby several commuters travel together in one car, sharing the costs and usually taking turns providing the car
carbon monoxide: a colorless, odorless, extremely poisonous gas formed by the incomplete burning of carbon substances, including gasoline
carbon dioxide: a colorless, odorless gas formed during respiration, combustion and organic decomposition and used in food refrigeration and aerosols

Materials:

paper and pencils
safe area from which to observe traffic (close enough to count the passengers)
graph paper and straight edges

Background:

(This activity is an ideal follow up to "Greenhouse Goof: Tea for Two".) According to the USDA Forest Service it is estimated that each person in the United States is responsible for the production of **2.3 tons** of carbon **per year**. About half of that (1.15 tons) comes from our cars and other motor vehicles! Production of electricity, home heating and cooling, and industrial processes also add greatly to the overall total. Conserving electricity, conserving the energy used in home heating and cooling, more efficient car usage, and the planting and care of vegetation, mainly trees, can all help to reduce our carbon input. The United States, not surprisingly, due to its industrial status, ranks number one in the world in the production of this greenhouse gas.

Here are estimates for selected countries worldwide:

Canada	1.8 tons per capita
Eastern Europe (formerly the U.S.S.R.)	1.6 tons per capita
Western Europe	.9 tons per capita
Japan	.9 tons per capita
China	.2 tons per capita
India	.1 tons per capita

Various health and agricultural departments, as well as the National Arbor Day Foundation, have all advocated the planting and care of trees in order to reduce the amount of carbon in our atmosphere. Why trees? Trees and other green plants grow using the carbon from atmospheric carbon dioxide. This carbon dioxide is broken down through the process of photosynthesis, with pure oxygen being an end product.

While municipalities and government agencies have from time to time encouraged car-pooling to cut down on traffic and auto emissions (the construction of car-pooling lanes has been a big enticement to some, so too, has the mandatory emissions inspections in certain parts of the country), car-pooling as a habit in the U.S. has not exactly lived up to promoters expectations; neither has the widespread use of bicycles, as can be seen in various other countries throughout the world. This activity is designed to help students examine our cities' driving and car-pooling habits, discovering ways in which energy can be conserved and carbon input reduced.

Procedure:

1) Introduce students to the concept of auto (transportation) emissions. These gases act as a trap once sunlight hits the surface of the earth. The light, changing to heat energy once it hits the earth, cannot escape through the layer of these gases. Of course, then, the more auto emissions, the more greenhouse gases, the more extreme the "greenhouse effect."

2) Divide students into work groups: one recorder, and at least two observers per group.

3) Arrange a safe observation area from which your students can observe traffic patterns and car-pooling habits. (The area, though, needs to be close enough that the students can actually count the number of people per vehicle.)

4) Have the recorder set up columns with the following headings: passenger vehicles (will be mainly cars); public transportation (mainly buses); delivery vans or other business trucks and vans; taxis or limousine services.

5) For the agreed upon time, have students observe and record the number of passengers (including the driver) per vehicle that passes. It is understandable that if traffic is heavy enough, it will be difficult for students to keep up with the flow of traffic. Prepare them for this possibility, while at the same time, encouraging them to keep up to the best of their ability. You may need to set some standards before beginning: for example, each public transportation bus will count as 15 people, or each passenger van will be 4. This helps in quick counting when it would otherwise be impossible for students to actually count the number of people riding. Granted, the exact numbers may not be accurate, but an average over time can be assumed.

6) At the end of the observation period, have each group organize the data that was obtained. Count and tally the number of passenger cars with only one passenger, two passengers, three....Do the same for each category. (If a standard number of passengers has been set for buses, this category will only need a count of the number of buses that passed.)

7) Have each group (student?) construct bar graphs showing the information they have just organized.

Questions:

If you were concerned enough to reduce the amount of carbon that you, your family, or your community puts into the atmosphere, where would you start? Brainstorm ways to accomplish this task...(Some major contributions to this list that you won't want your class to miss include: car-pooling, reducing the number of trips you make--for example, doing all of your errands on the same day), efficiently heating and cooling your home, office, school, or vehicle, and, of course, opting to walk or ride a bike instead of driving, whenever possible.)

What If...???

...instead of bar graphs, you were to do pie charts? Have one chart represent the percentage of passenger cars with only one person, the percentage of passenger cars with two passengers, the percentage of passenger cars with three people, etc.

Renew-a-Bean

(adapted from California Energy Extension Service)

Objectives:

Students will be able to: 1) describe the eventual depletion of nonrenewable resources, 2) describe the effect on the future of changing rates of use of nonrenewable resources, 3) describe the role of conservation, and 4) defend the need to develop renewable resources.

Skills Developed:

calculating percentages

Time Required:

one 45-50 minute period

Key Vocabulary:

depletion: the act of using or exhausting an energy source
development: the act of making more available or effective; the act of bringing into being
rate of use: the speed with which a resource is being used, expressed in relation to the total amount available
renewable resource: Non-depletable resources: typically viewed as a source of energy that can be easily and relatively quickly replenished or restored. (Water is replenished with new rain, sunlight comes again with the rotation of the earth, and trees or biomass is grown anew within our lifetime. These are all examples of commonly thought of renewable resources.)
nonrenewable resource: the opposite of a renewable resource, a source of energy that, once used, cannot be replaced as quickly as we use it (or even within our lifetimes). (Coal and oil, formed under intense pressure for possibly millions of years, are prime examples of a nonrenewable resource. Radioactive elements used in nuclear fission would be another.)

Materials:

5 clear jars
LOTS of beans-- 93% one color
7% another color
(pinto and garbanzo beans, or peanuts and almonds)

Background:

The 93:7 ratio is used to represent the ratio of nonrenewable to renewable energy consumption in the United States. Prediction of how long various energy resources will last is, at best, risky. In the early 1970's, it was predicted that we would run out of natural gas by the late 1980's. Obviously, that fateful day has come and gone with reserves still plentiful enough for natural gas to be considered a major fuel source. Does this miscalculation mean that we should no longer concern ourselves with conservation efforts or the development of efficient alternative energy sources? Not at all! Given the nature of nonrenewable resources, at best, this missed deadline can be seen as a brief reprieve.

In the 1950's, utilities predicted we would need a nuclear power plant every 10 miles along the California coast to meet our electrical energy needs!! It is important to know whether a rate assumes that more resources will be found or it assumes use of only known reserves. It is also important to consider if foreign resources are included.

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The point of this activity is not so much to show the actual numbers, but rather to demsonstrate the concept that nonrenewable resources will be depleted and that conservation (reduction of use/waste), together with the development of renewable resources, can extend the availability of non-renewables. The "Draw Chart" on the next page tells you how many beans to draw if you want to adapt for changes in rate of energy use. For example, if use remains constant from year to year each person draws 10 beans. If you want to simulate a 4% per year increase in energy use, go to the column designated for 4% increase, and proceed from there.

See the accompanying fact sheet for the rate of energy consumption.

Procedure:

1) In each jar mix the beans together using a 93:7 ratio. (For every 93 beans of one color used to represent nonrenewable resources, add 7 beans of a different color to represent renewable resources.) Discuss with the class the differences between non-renewable and renewable resources, what those resources are, and how fast they think we, as a country and as a world, are using them. Ask if they think the world will use more or less energy in the coming years.

2) Discuss and estimate rates of energy use, and increases in energy use over time. Try to elaborate on various reasons for the increase or decrease of energy usage. Encourage students to consider social changes, as well as technological advances. The Industrial Revolution, for instance, saw a mass movement of population from rural to urban settings, with the resulting upswing in energy use.

3) Break into groups and have each group take turns drawing the beans at a rate chosen from the chart on the next page.

4) After drawing out the beans (representing one year's energy use) have students record the number of renewable beans and nonrenewable beans drawn for that year. Record these numbers on a graph. Calculate the percentages of renewables and nonrenewables that remain after each drawing.

5) When nonrenewable beans are drawn, they are considered used up; set them aside. When renewable resources are drawn, return them to the jar, thus illustrating the nature of renewables. As the drawing progresses, the renewable resources become more predominant, just as they must if we are to continue using energy as we do today.

Questions:

What kind of energy will people be using in the future? Why?
Why don't people in the United States use more renewable energy now?
Are there reasons to use more renewables now rather than wait until the nonrenewables run out?
Name ways in which you can start using more renewable energy sources.
(sunlight vs. electricity; bike or walk vs. riding or driving; etc.)
What consumption level will allow the energy supply to last the longest?

What If...???

...Count the number of beans, TOTAL, at each level of energy consumption. Why are the totals different?
Try calculating another row to insert in this table. How many beans would you have to draw each year (and how many years would your supply last) if you wanted to simulate an increase of 10% per year? 12%? 15%
How about a decrease of 10% per year? 12%? 15%?

DRAW CHART

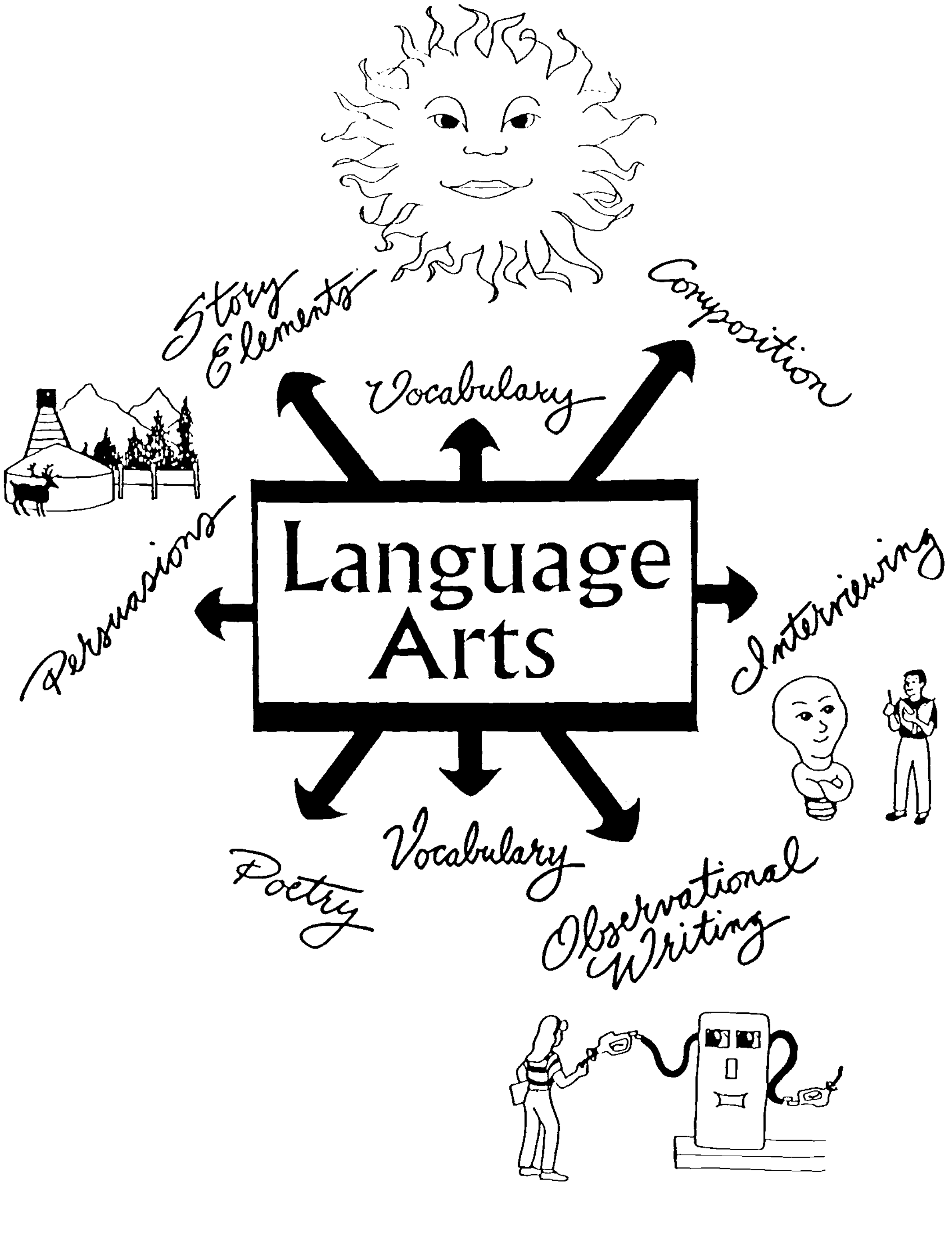
This chart tells you how many beans to draw out of your jar, depending on the energy consumption rate you choose to simulate with your class. It also shows how long the nonrenewable energy will last. (See below for examples.)

Years Energy Supply Will Last

Consumption Level	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Energy-use Level Constant (1990 level)	10	10	10	10	10	10	10	10	10	10	10						
Use Increases at 4% per year	10	10	11	11	12	12	13	13	14	14							
Use Increases at 6% per year	10	11	11	12	13	14	15	16	17								
Use decreases by 4% per year	10	10	9	9	8	8	8	8	7	7	7	6	6	6			
Use decreases by 6% per year	10	9	9	8	8	7	7	7	6	6	5	5	5	5	4	4	3

(Example: Assume that you and your class wanted to determine how long energy resources would last if your energy use remained constant. Go to the column marked "Energy-Use Level Constant, 1990. Follow this chart across. For the round representing year 1, each participant should draw 10 beans. For the year representing year 2, each participant should again draw 10 beans. Likewise for each of the years remaining.

If you wanted to chart the use of energy if energy use were to increase at a rate of 6% per year, start on the row labelled "Use increases by 6% per year". For the round representing year 1, each participant should draw 10 beans. For the year representing year 2, each participant should then draw 11 beans. For the third year, each participant should take out another 11 beans. For the fourth year, 12 beans should be drawn. And so on.)


Story Elements
Vocabulary
Composition
Language Arts
Persuasions
Interviewing
Poetry
Vocabulary
Observational Writing

Language Arts

Sunlight Serenade

Objectives:

Students will be able to: 1) compose a story using the sun (or a sunbeam, or a ray of sunlight) as the main character (or if agreed upon, as a peripheral character), 2) define the elements of a composition, and 3) identify these elements within their own story.

Skills Developed:

composition

Time Required:

from one class period to several periods

Key Vocabulary:

composition: a short essay following certain structure and organization patterns
introduction: the opening part of a composition in which readers are introduced to the characters and their situations
main character: the principal person (or thing) about which a story is written, or to whom events unfold
plot: the outline or plan of action of a story
conclusion: the ending of a composition in which conflicts are resolved and outcomes are exposed.
conflict: a state of disharmony or opposition between characters or objects within a composition
moment of resolution: (denouement): the outcome of a conflict; the act or action during which conflict is resolved
personification: the act of giving an inanimate object personality, thought, movement, and other elements of a living being.

Materials:

writing materials (paper and pens or pencils)
construction paper, scissors, glue, crayons

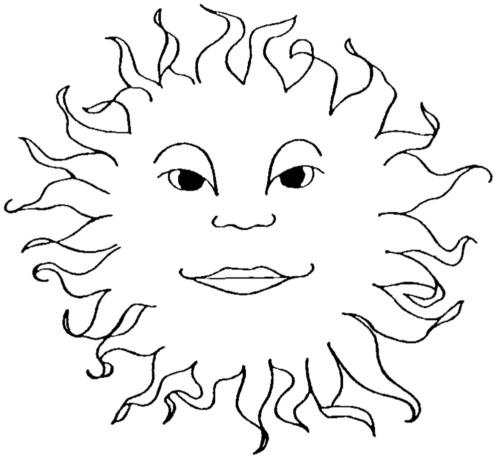
Procedure:

1) Introduce your students to the elements of composition. The main character, the introduction, plot, conflict, denouement (or conclusion). Explain the significance of each of these elements.

2) **Instruct your students to be creative.** Simply invent a character using the sun as a starting point, and then construct a story! Is their sun a benevolent, happy sun, or an evil, mean-spirited sun? Why? With whom or what does your sun come in contact? What effects on the sun, or the other characters, does this meeting have? How do they meet? What time do they spend together? Doing what? Is your sun powerful? Or weak? How does it use its power? Or weakness? What setting is your sun in? City? Country? Commuter? Does he/she like to swim? Roller skate? Play beach volleyball? Tease the pigeons on the stoop?

3) Now that your story is done, construct a model (picture, cut out, sketch) of your story's main character. Be sure to add facial features that will allow others to detect the mood of your character.

4) Display these "suns" for all to see. Have students make up spontaneous stories about each other's suns. For a fun group activity, allow the whole class to participate in an "Add-a-story" progression. Have one student begin a story, telling it verbally. Each student, in turn, (or spontaneously picked from the group) gets to add actions and/or characters. You decide the length of the session. Why not continue it, perhaps ten minutes each day, for a week?



What If...???

...you were to assign your students to research the sun's place in myths and legends of different cultures? They might just be surprised!! And inspired!!

References and Further Readings:

Keepers of the Earth: Native American Stories and Environmental Activities for Children, by Michael Caduto and Joseph Bruchac. (Golden, Colorado: Fulcrum, Inc.) A series of Native American stories and activities celebrating various elements of the earth, and its surroundings. It includes a wonderful section on Native American sun lore.

Ask a Light Bulb!

Objectives: Students will be able to demonstrate questionsing and writing skills as they "interview" and record a conversation with an energy source.

Skills Developed: creativity, information gathering, composition, grammar, vocabulary

Time Required: length of time to be determined by you (several classroom periods, plus homework time, or any combination of the two)

Key Vocabulary: **interview:** a conversation in which information is obtained from another
personification: to give personality, thoughts, or characteristics of a living being to an inanimate object

Materials: writing paper
pens or pencils
(optional: tape recorders)

Background: Energy comes in a variety of sources. Some of these sources are easily recognizable, such as the gas pump, or the wall socket. Other sources are more subtle, such as the sun, or running water. It is important that students recognize all of these energy sources as being important in their lives. The purpose of this activity is to have students examine closely different energy sources, or objects that produce energy.

Procedure: 1) Ask students to pick an energy-producing item or an energy source for an interview. Examples would be: a light bulb, a space heater, a refrigerator, an electric fan, a candle, a fireplace, a gas pump, a piece of coal, etc.

2) Have students research this item or energy source. Useful information would be the source of the item's energy, the materials needed for its manufacture, the materials or energy needed for it to run properly, its relationship to other objects in the house or classroom, its life span, the amount left on earth for consumption, where it can be found, etc.

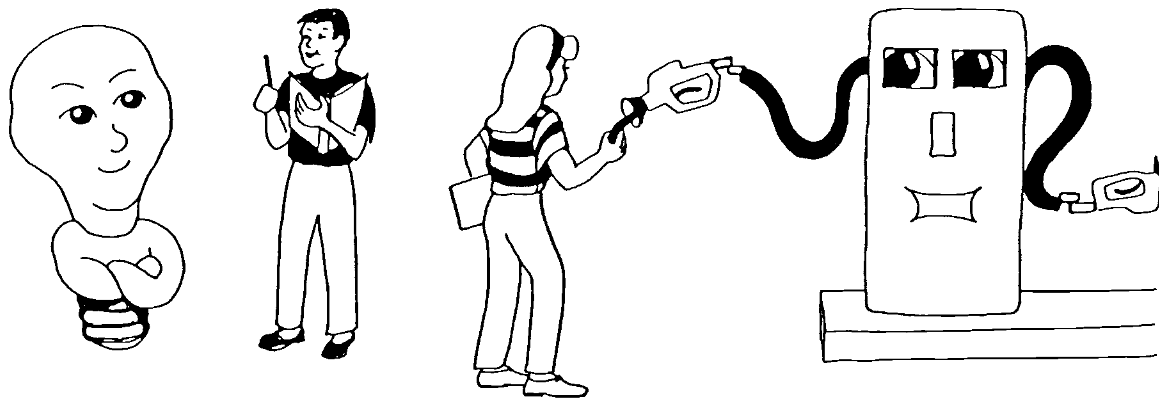
3) Students should now develop a list of questions they would like to "ask" this object. What information would they like to know about it? What information do they think that other people would like to know, or should know about it?

3) Have students conduct an "interview" with this object or energy source. Encourage your students to use their imaginations and actually "think" like this object or source.

4) Students should now record, in final form, their interview. It can either be presented to the class verbally, or handed in, in written form.

Questions:

What information surprised you about your energy-producing object or energy source? Are there questions that you have that your "interviewee" would not or could not answer?



Extensions:

Have students pair up. Each should then take on the role of an object that consumes energy, or an energy source itself. Students should then follow the same process as above, except this time they will be interviewing each other, answering as if they were that energy source or object. Let's see how creative your students really are!

If possible, ask a local reporter to come to your class to describe their job. (If a local reporter is not available, why not try a reporter from the local high school newspaper.) Have students write descriptions of the reporter's visit before doing their energy interviews.

Put together a classroom "newspaper" of all the interviews. (Make sure that the school staff gets a copy!)

Energy Debate

Objectives:

Students will be able to: 1) research the pros and cons of available energy sources, 2) organize this information into usable form, 3) debate the merits of each energy source, and 4) reach a conclusion based on the information obtained and presented.

Related Activities:

Muffin Mining (page 57), Oil Embargo (page 85), What's In Our Air? (page 55), Policy! Policy? (page 36), Greenhouse Goof (page 45)

Skills Developed:

information gathering, organization of ideas, analysis, conclusion formation, public speaking

Time Required:

information gathering: at least 3 classroom periods, or homework time
debate: one classroom period of 45-50 minutes, or longer, depending on the level of your students

Key Vocabulary:

nonrenewable resource: the opposite of a renewable resource, a source of energy that, once used, cannot be replaced as quickly as we use it (or even within our lifetimes). (Coal and oil formed under intense pressure for possibly millions of year, are prime examples of a nonrenewable resource. Radioactive elements used in nuclear fission would be another.
renewable resource: non-depletable resources; typically viewed as a source of energy that can be easily and relatively quickly replenished or restored. (Water is replenished with new rain, sunlight comes again with the rotation of the earth, and trees or biomass is grown anew within our lifetime. These are all examples of commonly thought of renewable resources.

Materials:

reference Texts (or encyclopedias)
writing materials (pens or pencils, and paper)

Background:

Since man has began harnessing energy other than man or animal power with which to do his work, debate has raged over which available source was the most effective, the most accessible, or the least harmful for him to use. Today, still, various peoples the world over, advocate certain sources over others, for as many reasons as there exist energy sources. The purpose of this activity is to allow your students the time and structure with which to explore the wide array of energy sources available to mankind, and to start them thinking about the effects of their energy use.

Procedure:

1) Assign students in your class to research particular energy sources. Sources not to be forgotten include: Coal, Petroleum, Natural Gas, Nuclear Power, Hydro Power, Wind Power, Solar Power, Wood (or biomass) Power, and Geothermal Energy.

2) Instruct students to gather as much information about their assigned energy source as possible. Their ultimate goal will be to persuade others that their assigned energy source is the better suited for your classroom.

3) Allow time for students who have been assigned the same source to coordinate and organize their information

4) Select a panel of judges. These judges will listen to information presented, and, based on this information, will decide which energy source the classroom should adopt.

5) Organize a debate of the resulting information. Allow each group an equal amount of time to present their information to the classroom. Questions from the other groups should be allowed. Opening and closing statements should be encouraged.

6) After all the information has been presented, have the panel announce their decision, and the reasons for this decision.

7) Follow up with discussion about the possibilities and any questions that may have arisen throughout the debate.

Questions:

Did the groups presenting information present the classroom with all of their knowledge about their energy source? Why of why not? Was any negative information purposely omitted from their presentation? How realistic do you think this action is? Does the public always receive all pertinent information from energy advocates?

Did the panel of judges have a difficult time deciding on an energy source? Discuss why this might be.

Extensions:

Arrange for a visit to a local energy producing facility. Power plants will often give guided tours, and provide information about their operation. Students should be encouraged to ask relevant questions.

Well-Versed in Energy

Objectives: Students will be able to: 1) describe at least three different forms of poetic verse, and 2) construct an energy-related poem using one of these forms.

Skills Developed: observation, creativity

Time Required: one classroom period, or a combination of classroom and homework time

Key Vocabulary:

poem: a composition designed to convey a vivid or imaginative sense of experience; written in verse rather than prose
meter: a specific rhythmic pattern of verse
rhyme: a poem or verse with a regular correspondence of sounds, especially at the ends of lines
free verse: a poem with no determined meter or rhyme
song: a lyric poem (for example, sonnets and odes)
haiku: an unrhymed Japanese lyric poem having a fixed three line form, containing five, seven and five syllables respectively
cinquain: a five-line poem

Materials Needed: writing paper, pens or pencils

Background: It is a very common human occurrence that we walk past objects and events every day without being acutely aware of details. Energy (its production, use and effects) is no exception where our powers of observation are concerned. Who among us has not flipped a light switch, taking for granted the fact that the light will then instantly light? What a shock to our systems when the bulb blows, or, for one reason or another, the light bulb does not light. This activity was designed to allow students the opportunity to observe closely the sources, uses, and effects of energy consumption.

Procedure: 1) Introduce your students to the concept of poetry. A wonderful way to do this would be to obtain books of poetry from your school library. Read several to the class. Select a wide variety of forms and content, from free-verse to cinquain to rhyme, from love sonnets to poems about man-made objects. Begin a discussion on the feelings evoked from these readings. Ask each student to select his or her favorite form with which to work.

2) Ask students to use their powers of observation--looking for or thinking about details pertaining to energy use. (This activity would be a wonderful follow-up to "Energy Debate" found on page 33.)

3) These details or observations should then be used in developing individual poems. Below are examples of poems, in haiku form. Encourage your students to experiment with a variety of forms and subjects for their poems.

Daylight fades
One flip of a switch
Dark no more

Coal seam found
Deep beneath the earth
Miners go

Policy! Policy?

Objectives:

Given a real (and a fabricated) governmental policy statement regarding energy production and use, the student will be able to: debate the merits and disadvantages of the policy upon the a) U.S. economy, b) U.S. environment, and c) foreign affairs.

Related Activities:

Oil Embargo (page 85)

Skills Developed:

reading comprehension, analysis, debate
(extension: governments)

Vocabulary:

environmental impact statement: a detailed statement required by the National Environmental Policy Act when an agency proposes a major federal action significantly affecting the quality of the human environment; an impact statement must include an analysis of reasonable alternatives to the proposed action

Materials:

copies of the following policy statements

Time Required:

one 45-50 minute period for discussion
homework or other reading time

Background:

The Policy Statement that appears below was first written in 1969, and published to take effect on January 1, 1970. The two main mandates set forth within it are 1) the necessary writing and filing of **environmental impact statements**, and 2) the establishment of the Presidential Council on Environmental Quality. The Policy Act was amended July 3, 1975, August 9, 1975, and again on September 13, 1982. It appears here in its amended form.

Environmental Impact Statements require proposed developers, farmers, or other land users to examine the result of their actions **before** these actions are approved by the governing council to whom they must answer (whether that is the local Town Board, Zoning Committee, City Council, or the State or Federal Government itself). Branches of the Federal Government that participate in construction and development (such as the Army Corps of Engineers, or the Bureau of Land Management) must also file such a statement before continuing with their projects.

These environmental impact statements have been criticized by both land developers and environmental organizations alike. Land developers claim that they are costly, time consuming, and merely an exercise in bureaucratic paperwork. Environmentalists have stated that these statements are not given the consideration that they deserve, and are merely a formality to calm public outcries against unchecked land use, while having no real consequences on development or land use.

The second policy statement involves the potential drilling for crude oil in the Arctic National Refuge, a nationally protected wildlife area in the northern area of Alaska. (See "Oil Embargo" on page 85 for a more detailed discussion of the United States' demand for crude oil.)

Procedure:

1) Distribute copies of The National Environmental Policy Act of 1969. Be prepared to walk students through the legislative language. **WHAT??** Exactly! Policy statements are often, at their best, difficult to decipher. At their worst, they are confusing and contradictory. Taken one sentence, or paragraph, or Section at a time, though, you will find that the above Policy Statement is not all that daunting!

2) Have students answer the questions below with regard to the National Environmental Policy Act.

3) Distribute copies of the fabricated policy statement found on page 41. Have students read and debate the actions called for in this policy.

Questions:

Outline the main points of the National Environmental Policy Act of 1969. In your opinion, are the actions called for in the policy valid? Do they serve a purpose? Support your answer with specific examples from the text of the document.

Define an Environmental Impact Statement.

Pretend that you are a developer. Choose a specific area of land on which you would like to build. Write an environmental impact statement, detailing 1) a description of the land as it now exists, 2) your proposed development, 3) any adverse effects that your actions might have, and 4) any alternatives to your development that may exist. Submit this impact statement to your teacher for consideration.

Extensions:

Have students research environmental impact statements that have been filed locally. Discuss the statements, and any effects that the proposed or accepted project has had on the area.

Invite a local politician to come to your classroom. Have him or her discuss the process by which government policies, or acts, are developed and made into law. A local environmental officer could be asked to discuss proposed development projects in your neighborhood.

Ask students to act as a mock Congress to write their own energy policy for your classroom. What energy source should be used? For what length of time? At what expense?

The National Environmental Policy Act of 1969

(as Amended 1)

An Act to establish a national policy for the environment, to provide for the establishment of a Council on Environmental Quality, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "National Environmental Policy Act of 1969."

Purpose

Sec. 2. The purposes of this Act are: To declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality.

TITLE I

Declaration of National Environmental Policy

Sec. 101 (a) The Congress, recognizing the profound impact of man's activity on the interrelations of all components of the natural environment, particularly the profound influences of population growth, high-density urbanization, industrial expansion, resource exploitation, and new and expanding technological advances and recognizing further the critical importance of restoring and maintaining environmental quality to the overall welfare and development of man, declares that it is the continuing policy of the Federal Government, in cooperation with State and local governments, and other concerned public and private organizations, to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.

(b) In order to carry out the policy set forth in this Act, it is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may-

(1) fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;

(2) assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings;

(3) attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences;

(4) preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity, and variety of individual choice;

(5) achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and

(6) enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

(c) The Congress recognizes that each person should enjoy a healthful environment and that each person has a responsibility to contribute to the preservation and enhancement of the environment.

Sec. 102. The Congress authorizes and directs that, to the fullest extent possible: (1) the policies, regulations, and public laws of the United States shall be interpreted and administered in accordance with the policies set forth in this Act, and (2) all agencies of the Federal Government shall-

(A) Utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decision making which may have an impact on man's environment;

(B) Identify and develop methods and procedures, in consultation with the Council on Environmental Quality established by title II of this Act, which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decision making along with economic and technical considerations;

(C) Include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on-

(i) The environmental impact of the proposed action,

(ii) Any adverse environmental effects which cannot be avoided should the proposal be implemented,

(iii) Alternatives to the proposed action,

(iv) The relationship between local and short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and

(v) Any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

Prior to making any detailed statement, the responsible Federal official shall consult with and obtain the comments of any Federal agency which has jurisdiction by law or special expertise with respect to any environmental impact involved. Copies of such statement and the comments and views of the appropriate Federal, State, and local agencies, which are authorized to develop and enforce environmental standards, shall be made available to the President, the Council on Environmental Quality and to the public as provided by section 552 of title 5, United States Code, and shall accompany the proposal through the existing agency review processes;

(D) Any detailed statement required under subparagraph (c) after January 1, 1970, for any major Federal action funded under a program of grants to States shall not be deemed to be legally insufficient solely by reason of having been prepared by a State agency or official, if:

(i) the State agency or official has statewide jurisdiction and has the responsibility for such action,

(ii) the responsible Federal official furnishes guidance and participates in such preparation,

(iii) the responsible Federal official independently evaluates such statement prior to its approval and adoption, and

(iv) after January 1, 1976, the responsible Federal official provides early notification to, and solicits the views of, any other State or any Federal land management entity of any action or any alternative thereto which may have significant impacts upon such State or affected Federal land management entity and, if there is any disagreement on such impacts, prepares a written assessment of such impacts and views for incorporation into such detailed statement.

The procedures in this subparagraph shall not relieve the Federal official of his responsibilities for the scope, objectivity, and content of the entire statement or of any other responsibility under this Act; and further, this subparagraph does not affect the legal sufficiency of statements prepared by State agencies with less than statewide jurisdiction.

(E) Study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources;

(F) Recognize the worldwide and long-range character of environmental problems and, where consistent with the foreign policy of the United States, lend appropriate support to initiatives, resolutions, and programs designed to maximize international cooperation in anticipating and preventing a decline in the quality of mankind's world environment;

(G) Make available to States, counties, municipalities, institutions, and individuals, advice and information useful in restoring, maintaining, and enhancing the quality of the environment;

(H) Initiate and utilize ecological information in the planning and development of resource-oriented projects; and

(I) Assist the Council on Environmental Quality established by title II of this Act.

Sec. 103. All agencies of the Federal Government shall review their present statutory authority, administrative regulations, and current policies and procedures for the purpose of determining whether there are any deficiencies or inconsistencies therein which prohibit full compliance with the purposes and provisions of this Act and shall propose to the President not later than July 1, 1971, such measures as may be necessary to bring their authority and policies into conformity with the intent, purposes, and procedures set forth in this Act.

Sec. 104. Nothing in section 102 or 103 shall in any way affect the specific statutory obligations of any Federal agency (1) to comply with criteria or standards of environmental quality, (2) to coordinate or consult with any other Federal or State agency, or (3) to act, or refrain from acting contingent upon the recommendations or certification of any other Federal or State agency.

Sec. 105. The policies and goals set forth in this Act are supplementary to those set forth in existing authorizations of Federal agencies.

TITLE II
Council on Environmental Quality

Sec. 201. The president shall transmit to the Congress annually beginning July 1, 1970, an Environmental Quality Report (hereinafter referred to as the "report") which shall set forth (1) the status and condition of the major natural, manmade, or altered environmental classes of the Nation, including, but not limited to, the air, the aquatic, including marine, estuarine, and fresh water, and the terrestrial environment, including but not limited to, the forest, dryland, wetland, range, urban, suburban and rural environment; (2) current and foreseeable trends in the quality, management and utilization of such environments and the effects of those trends on the social, economic, and other requirements of the Nation; (3) the adequacy of available natural resources for fulfilling human and economic requirements of the Nation in the light of expected population pressures; (4) a review of the programs and activities (including regulatory activities) of the Federal Government, the State and local governments, and nongovernmental entities or individuals with particular reference to their effect on the environment and on the conservation, development and utilization of natural resources; and (5) a program for remedying the deficiencies of existing programs and activities, together with recommendations for legislation.

Sec. 202. There is created in the Executive Office of the President a Council on Environmental Quality (hereinafter referred to as the "Council"). The Council shall be composed of three members who shall be appointed by the President to serve at his pleasure, by and with the advice and consent of the Senate. The President shall designate one of the members of the Council to serve as Chairman. Each member shall be a person who, as a result of his training, experience, and attainments, is exceptionally will qualified to analyze and interpret environmental trends and information of all kinds; to appraise programs and activities of the Federal Government in the light of the policy set forth in title I of this Act; to be conscious of and responsive to the scientific, economic, social, esthetic [sic], and cultural needs and interests of the Nation; and to formulate and recommend national policies to promote the improvement of the quality of the environment.

Sec. 203 (a) The Council may employ such officers and employees as may be necessary to carry out its functions under this Act. In addition, the Council may employ and fix the compensation of such experts and consultants as may be necessary for the carrying out of its functions under this Act, in accordance with section 3109 of title 5, United States Code (but without regard to the last sentence thereof.)

(b) Notwithstanding section 1342 of Title 31, the Council may accept and employ voluntary and uncompensated services in furtherance of the purposes of the Council.

Sec. 204. It shall be the duty and function of the Council--

(1) to assist and advise the President in the preparation of the Environmental Quality Report required by section 201 of this title;

(2) to gather timely and authoritative information concerning the conditions and trends in the quality of the environment both current and prospective, to analyze and interpret such information for the purpose of determining whether such conditions and trends are interfering, or likely to interfere, with the achievement of the policy set forth in title I of this Act, and to compile and submit to the President studies relating to such conditions and trends;

(3) to review and appraise the various programs and activities of the Federal Government in the light of the policy set forth in title I of this Act for the purpose of determining the extent to which programs and activities are contributing to the achievement of such policy, and to make recommendations to the President with respect thereto;

(4) to develop and recommend to the President national policies to foster and promote the improvement of environmental quality to meet the conservation, social, economic, health, and other requirements and goals of the Nation;

(5) to conduct investigations, studies, surveys, research, and analyses relating to ecological systems and environmental quality;

(6) to document and define changes in the natural environment, including the plant and animal systems, and to accumulate necessary data and other information for a continuing analysis of these changes or trends and an interpretation of their underlying causes;

(7) to report at least once each year to the President on the state and condition of the environment; and

(8) to make an furnish such studies, reports thereon, and recommendations with respect to matters of policy and legislation as the President may request.

Sec. 205. In exercising its powers, functions, and other duties under this Act, the Council shall--

(1) Consult with the Citizens' Advisory Committee on Environmental Quality established by Executive Order No. 11472, dated May 29, 1969, and with such representatives of science, industry, agriculture, labor, conservation organizations, State and local governments and other groups, as it deems advisable; and

(2) Utilize, to the fullest extent possible, the services, facilities, and information (including statistical information) of public and private agencies and organizations, and individuals, in order that duplication of effort and expense may be avoided, thus assuring that the Council's activities will not unnecessarily overlap or conflict with similar activities authorized by law and performed by established agencies.

Sec. 206. Members of the Council shall serve full time and the Chairman of the Council shall be compensated at the rate provided for Level II of the Executive Schedule Pay Rates (5 USC 5313). The other members of the Council shall be compensated at the rate provided for Level IV of the Executive Schedule Pay Rates (5 USC 5315).

Sec. 207. The Council may accept reimbursements from any private nonprofit organization or from any department, agency, or instrumentality of the Federal Government, any State, or local government, for the reasonable travel expenses incurred by an officer or employee of the Council in connection with his attendance at any conference, seminar, or similar meeting conducted for the benefit of the Council.

Sec. 208. The Council may make expenditures in support of its international activities, including expenditures for (1) international travel; (2) activities in implementation of international agreements; and (3) the support of international exchange programs in the United States and in foreign countries.

Sec. 209. There are authorized to be appropriated to carry out the provisions of this chapter not to exceed $300,000 for fiscal year 1970, $700,000 for fiscal year 1971, and $1,000,000 for each fiscal year thereafter

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(The following is a fabricated policy statement. It should not be interpreted as representing the United States' or any other government's policy on The Arctic National Refuge, or energy development.)

THE ARCTIC REFUGE DRILL-ALL ACT OF 1993

An act to establish a national policy for obtainment of an energy self-sufficient nation, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Arctic Refuge Drill-All Act of 1993".

Purpose

Sec. 2. The purpose of this Act is: To declare a national policy which will encourage the development of domestic energy sources with the goal of lessening our dependency on foreign energy sources.

TITLE I

Declaration of Arctic Refuge Drilling

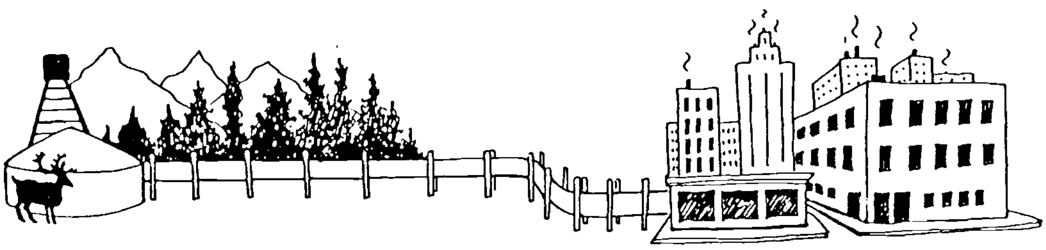
Sec. 101 (a) The Congress, recognizing the profound impact of our nation's dependency on foreign energy sources, namely crude petroleum from politically unstable Middle Eastern sources, declares that it is the continuing policy of the Federal Government, in cooperation with State and local governments, and other concerned public and private organizations, to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain domestic energy sources and supplies of crude petroleum.

(b) In order to carry out the policy set forth in this Act, it is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may-

(1) explore all possible areas of petroleum production, to supersede all policies of national protection of lands;

(2) attain the widest range of energy sources within our domestic areas, with a concentration on crude-oil drilling and production;

(3) support the opening, drilling and development of all Nationally owned lands, to include, but not to be limited to, the Arctic National Refuge, in the pursuit of energy independence.



We're not as removed from the Arctic Refuge as we may think...from drill site to pipeline, to transportation, to refinery, to your city!

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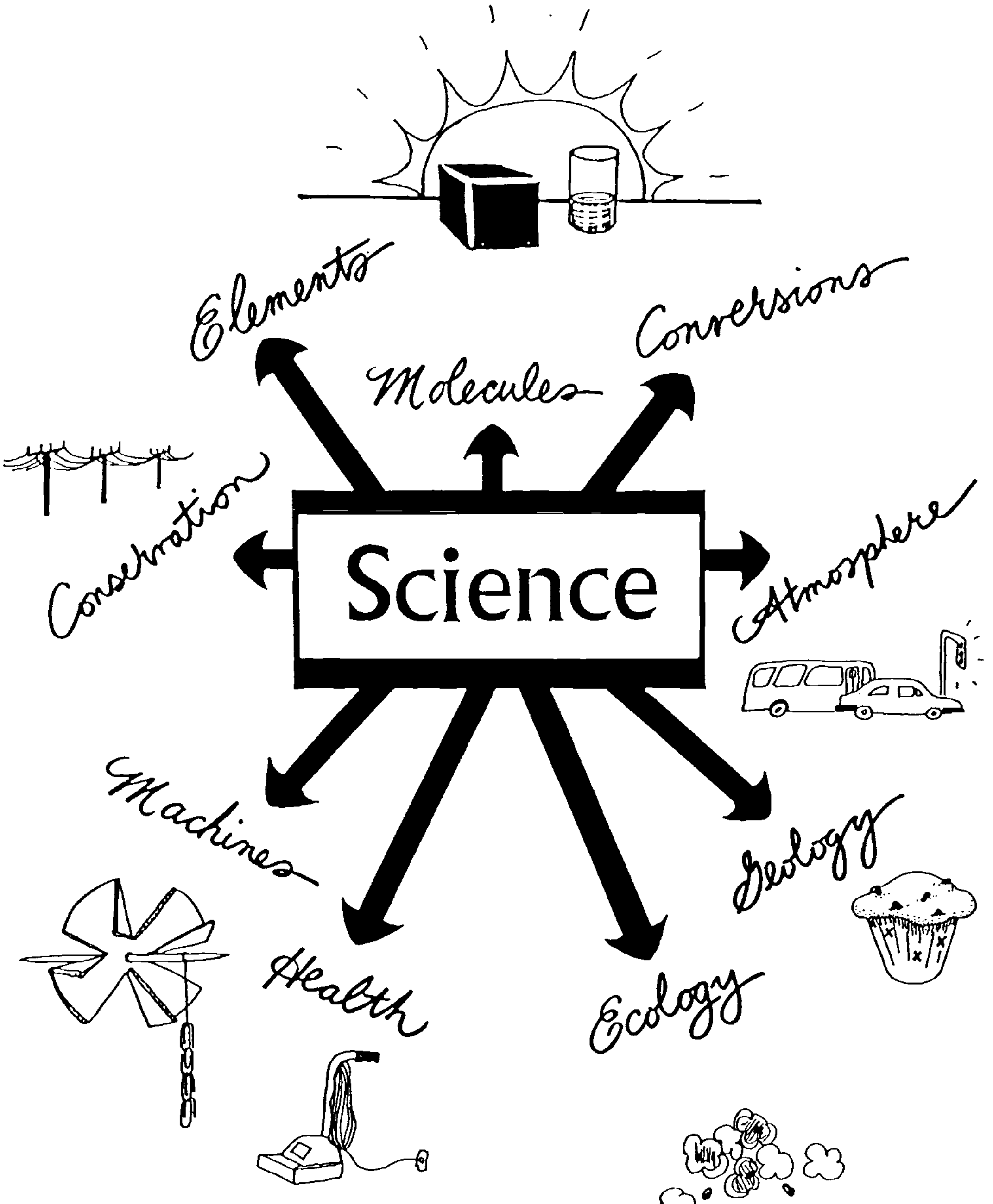

Elements
Molecules
Conversions
Conservation
Science
Atmosphere
Machines
Geology
Health
Ecology

Science

Greenhouse Goof
(Tea for Two)

Objectives: Students will be able to: 1) explain how a greenhouse works to collect solar energy, 2) construct and measure the success of their own "greenhouse", (this can include the charting or graphing of temperature change if so desired), 3) define the term "greenhouse effect", explaining how or why it got its name, 4) name two commonly found gases responsible in part for the "greenhouse effect", and 5) explain the implications of the "greenhouse effect" on our environment, health, and lifestyle.

Related Activities: "What Material Stores Energy The Best?" (page 53), "Sunlight Serenade" (page 29), "Commuter Report" (page 21)

Skills Developed: extrapolation, measurement (thermometer readings), graphing, experimentation, conversions, health awareness

Time Required: three 40-45 minute activity periods of sunny weather
one 20-30 minute follow-up session, weather irrelevant

Key Vocabulary: **solar collector:** a device for absorbing solar radiation to be used in producing electricity or in heating buildings or water
greenhouse gas: any one of the known gasses that are found to contribute to the greenhouse effect
carbon monoxide: a colorless, odorless, extremely poisonous gas formed by the incomplete burning of carbon substances, including gasoline; One of the commonly referred to greenhouse gases
sulfates: chemical compounds commonly found in greenhouse gases
ozone: (not to be confused with ozone layer) a common gas, related to pure oxygen, found in the air
ozone layer: (remember--its different from ozone!) also known as the ozonosphere, a region of the upper atmosphere that absorbs and protects the earth's surface from damaging ultraviolet radiation
greenhouse effect: the sequence of events involving the absorption of solar radiation by the earth, its change and re-emission in the form of infrared radiation (This infrared radiation is absorbed and prevented from escaping the atmosphere by water vapor and certain gasses. The absorption results in the steady gradual rise in temperature of the atmosphere.)
experimental control: a comparison used for checking the results of an experiment
closed system: a self-contained system, one that contains all of its needs (Even though the earth gets sunlight from outside its atmosphere, it is technically considered a closed system.)
open system: a system that relies on the exchange of elements or materials from other systems (A car's engine, relying on the input and output of fluids and parts, is an open system.)

Materials:

two large large-mouthed glass jars with tight-sealing lids (pickle jars work well, as do large-mouthed canning jars) for each group of students
three liquid-immersible thermometers per group
ten small (or two family size) tea bags for each group
an undisturbed outside spot, or a sunny window ledge large enough to set large glass jars
a source of water
globe with plastic covering (or saran wrap to cover it yourself)
graph paper and straight edges
drinking cups
ice

Procedure:

1) If not already done, clean jars both inside and out.

2) Place one thermometer in each of two jars per group. Be sure that the thermometer is visible and readable from the outside. Tightly seal the first jar. **Leave the second jar open, without a lid.** Read the internal temperature of each jar. Record this data.

3) Place both jars in the same sunny spot. Place the third thermometer in this sunny spot as well. Measure and record the temperature at 5 minute intervals for at least 30 minutes. 45 minutes is preferable.

4) Graph the data from each of the thermometers on separate graphs, or use three different colors on one graph. (You decide.)

5) Discuss any differences in jar temperatures. Ask for speculations as to the differences in thermometer readings.

6) Fill both jars with water. Regular tap water --not too hot or too cold-- will be fine. Place the thermometers in the water so that they are readable without opening the jars or disturbing the water. Repeat the above steps. (Record beginning temperature, and then take measurements every five minutes. Don't forget to set the third thermometer in the sun along with the two jars of water.)

7) Graph the data from each thermometer.

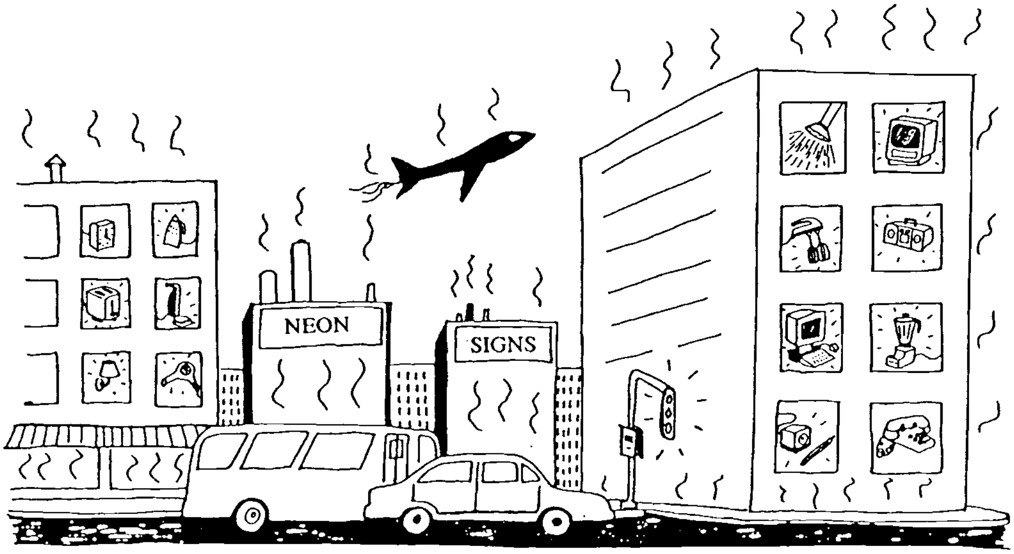
8) Discuss the differences between readings with the empty jars and the jars filled with water. Which medium (air or water) heats more quickly. Which, do you suppose, will **cool** more quickly. Which will **retain heat** for a longer period of time. **Why?** Why was the water temperature so drastically different from the temperature of the thermometer just sitting in the sun? Was there a difference between the jar with a lid, and the jar without a lid? What, do you think, would cause this difference?

9) It would be absolutely fantastic to take your class to a local greenhouse, or nursery, or hothouse. Why is the temperature inside so different from outside? If this is not possible...try to find other examples. Closed cars in the summertime (or even the winter) will have a drastically different inside temperature than the outside air temperature, if it is sitting in the sun. (Sunlight is not only light energy, but also **heat** energy. Glass, or a similar clear medium will allow light **in**, where the sunlight also **heats**, but this clear medium will not allow heat **out**. Heat becomes trapped, and builds up. Sometimes this result is desirable: greenhouses or hothouses, rooms in the winter when extra heat is needed, etc. Sometimes this result is NOT desirable: rooms in the summer when extra heat is not needed or comfortable, earth's atmosphere where sunlight is allowed to enter, but then is trapped by atmospheric pollutants contributing, as some theorize, to global warming, etc.)

10) This time, fill both jars, again with luke-warm water, but also add the tea bags. Bags on strings, tied together and taped to the lip of the jar, allow for the study of water flow. Be careful to keep the bags from falling to the bottom. Temperature measurements will allow the students to chart the change in temperature, but the addition of tea bags in the water will also allow students to SEE a temperature increase. They will also be able to follow the

movements of the warmer/cooler water as the brewed tea moves around the jar. (Somewhat like following hot air/cold air movements in weather patterns. Why not follow this activity with one on weather patterns and the movement of air pollution?)

11) After the class has measured and charted air and water temperature changes in both the sealed jar (representing a closed system), and the open jar (representing an open system), introduce a classroom globe. Is the earth a closed system, or an open system? In a closed system, no exchange of gases or elements occurs; in an open system, these things pass freely. Although the earth is heated from an outside source, and re-radiates heat at night, the earth, technically speaking, is a closed system. (Picture a terrarium. A water balance is maintained; minerals and elements cycle within the system. No outside presence, with the exception of sunlight, is needed. The earth, metaphorically, is a giant terrarium.) With the presence of the ozone layer, the earth is protected from harsh and damaging sunlight, and heat is kept in. Without the ozone layer, we would burn in the presence of the sun, and literally freeze to death when the sun was not present. The addition of more and more greenhouse gases, however, is disrupting the amount of heat re-radiating from the earth. These gases, acting much like the glass jar in the closed system, are trapping in heat. Try to picture the globe surrounded by glass. Better yet, wrap it in plastic wrap to help the students visualize the presence of these gasses. Expanding from what was just observed and measured with the glass jars, what effect would these gasses (the plastic wrap) have on the globe? On the living things beneath the layer of gasses (plastic)? On the temperature underneath? What effect does man's burning of fuels have on our atmosphere? Why are cities typically warmer than their outlying areas? (There are several reasons---THINK!!)



What If...???

...instead of letting the sunlight shine in through your front window in the summer, you were to close the drapes? How would this effect the temperature of the room? Why?

...the open jars were turned on their sides to allow for a different pattern of air flow? Would the temperature reading be different if the jars were placed this way? Why or why not?

...the jars were of a different color glass? Green? Why not try the same experiment with green soda bottles?

...you **did** end up opening the jars at 5 minute intervals to take temperature readings? If time and equipment allow, try the experiment again, with **three** jars: One sealed with the thermometer visible, one sealed and opened once every five minutes to take the thermometer's reading, and one open container with the thermometer visible. Make sure that you theorize, beforehand, what results will be expected. Do the actual results match your expected results? Why or why not?

...the experiment had been conducted on a sunny **winter** day, as opposed to a sunny **spring, or summer, or fall** day? Would the results differ? In what ways? In what ways would the results be similar? Give reasons or examples to back up your answers.

...the experiment had been conducted on an overcast, or hazy day?

...in a jar of water (or air), you were to place **two** thermometers? One at the top and the second at the bottom? Would there be a difference in temperature in the sealed jar? In the open jar? Why, or why not?

Extensions:

Looking for a long-term project? How about constructing a class terrarium to represent the earth as a closed system? Plants, soil, nutrients, water, closed lid, and a partially sunny windowsill should model the earth perfectly. Does it get too much sun? How does the earth protect itself from this possibility? What if a pollutant were to be introduced to the terrarium? Would it be able to dissipate, or disappear? Now relate this to the earth!

Energy Pathways

Objectives:

Students will be able to: 1) analyze the energy flow and resources used in everyday products, and 2) develop at least two "energy shortcuts", to conserve energy.

Skills Developed:

analysis, comparison

Time Required:

at least one 45-minute period

Key Vocabulary:

origin: a point of origination; source
ingredient: one of the parts of a whole
disposal: the act of throwing out or away

Materials:

objects for analysis (BE CREATIVE!): For example,
- a disposable diaper, and a cloth diaper (compare the two)
- an aluminum can, and a recycled aluminum can
- an article of clothing (a sneaker, a jacket, a pair of jeans, wool socks)
- any "natural" food item (apple, head of lettuce, an egg)
- a boxed food item
- a tire (or picture of one)
- a pen or pencil

large pieces of paper--one piece for every 1-6 students
crayons or colored pencils for every group

Background:

Discuss how we use many things in our everyday life, but do not think about what goes into making them, delivering them to us, and disposing of them when we are finished using them. Choose an object with a short "history" as an example. With the whole group, discuss the raw materials used, the collection process, the machinery used in manufacturing, the transportation, marketing, delivery, and disposal of the item. Trace the energy flow and resources used on the board.

Procedure:

1) Break the class into groups of no more than six students.

2) Give each group a large piece of paper and an assortment of crayons or pencils.

3) Pass out an object to every group and have them draw a map using arrows, lines, and anything else to connect the energy pathways. Don't be afraid to spend time thinking through the entire pathway! Consider **all** possible energy uses and paths that make up or lead to your item.

4) Have the students share their pathways with each other when they are finished. (P.S. Don't forget about the truck drivers--where do **they** get their energy? How about the fuel for the truck that he drives? And then, of course, there's the store clerk, and the factory worker, and the electricity into the factory, and how did **you** get to the store to purchase the item? Did you take a bus, or a train? If not, and you walked, where did you get the energy to walk to the store?; Is there wood or another natural fiber in the item? Where did that plant get the energy with which to grow? Who cut it down? Or harvested it? Where did they get **their** energy? Watch the pathways just grow and grow as the class thinks more and more....)

Questions:

Could you figure out **all** the energy that went into your object? Why or why not?

Can you think of something in the classroom that has lots and lots of energy inputs, the longest energy path? How about something with very few energy inputs, the shortest energy path?

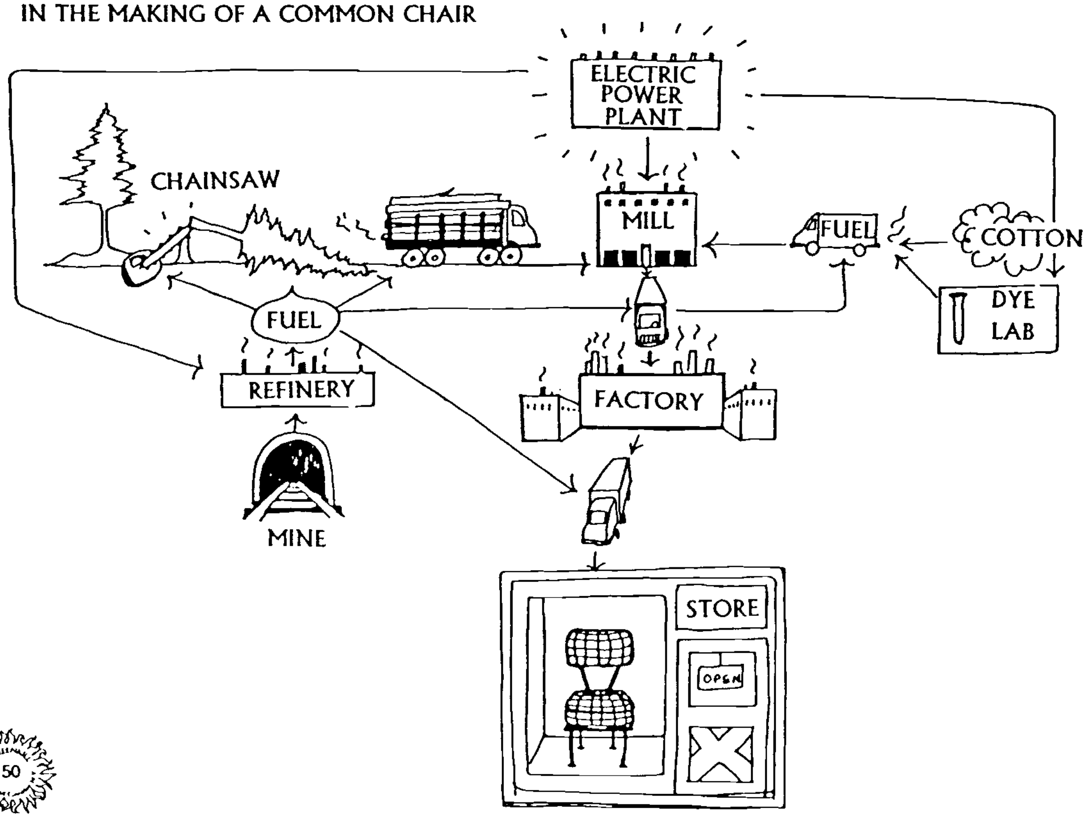
Which item from the question above costs more? Why?

What If...???

...a certain energy source was taken away? Suppose there was an oil spill that exhausted your city's oil supply for one month (or the coal miners supplying the power plant went on strike for a month...or the natural gas supply were to be exhausted?...or any similar scenario). Have the students search for alternative energy sources.

...you were concerned with reducing the amount of energy used? Study your energy paths. Find at least two ways in which you could do so. Draw these changes into your sketches.

ENERGY
IN THE MAKING OF A COMMON CHAIR



The Cleaner Fuel?

Objectives:

Students will be able to: 1) describe the differences in the burning of gas vs. the burning of petroleum products such as wax candles, 2) set up, conduct, and break down a simple experiment, 3) observe and record data from a simple experiment, 4) draw conclusions from the data obtained and 5) describe the effects of combustion on the composition of the air.

Skills Developed:

observation, examining data, forming conclusions, extrapolation, comparison

Related Activities:

What's In Our Air? (page 55), Greenhouse Goof (page 45)

Time Required:

one 30-minute period

Vocabulary:

experimental control: a comparison used for checking the results of an experiment

by-product: a substance formed as a side result (not the main goal or desired product) of an action or chemical reaction

Materials:

a wax candle and candle holder for each group of students
matches or lighter
two white ceramic heat dishes for each group (an aluminum pan will do in a pinch)
a bunsen burner or other gas flame stove such as a camp stove (You may choose to just have one that you use as the whole class observes the results.)
hot mitts and heat-proof tongs
safety goggles

Background:

For years various fuel industries have bombarded our airwaves and billboards with advertising meant to sway the energy consumer toward one form of fuel or another. The natural gas industry, among others, is notorious for these advertisements. Are their claims founded? Is natural gas a cleaner fuel, better for the environment than the coal and oil or petroleum energy sources that are still more of the non-renewable alternatives? This simple experiment is meant to test (in part) the claims of the natural gas industry, while helping students study the effects of combustion on our atmosphere and objects having contact with the by-products of combustion.

Procedure:

1) Light the bunsen burner or gas stove. (Be sure to demonstrate the proper wear of safety goggles!) Observe any noticeable flame, smoke, or evidence of combustion. Record your observations.

2) Using the hot mitts with the tongs, hold the ceramic dish over the gas flame. Observe any deposits that form on the plate. Record your observations.

3) Extinguish the burner and observe any discharge or smoke. Carefully set aside the ceramic dish. DO NOT PLACE THE HOT DISH ON UNPROTECTED SURFACES OR IN WATER!

4) Light the candle. (Remember those goggles!) Again, observe any flame, smoke, or evidence of combustion. Note any differences between the burning candle and the gas flame.

5) Using the tongs, hold the ceramic dish over the candle flame. Observe any deposits that form on the plate. Record your observations.

6) Extinguish the flame and observe any discharge or smoke. Carefully set aside the ceramic dish.

7) Discuss the differences in observations.

Questions:

Did one dish contain more residue than the other?
Which one? Why?
What implications does this have for the burning of gas as a fuel vs. the burning of petroleum products?
What are some of the by-products of combustion of any material or fuel?

What If...???

...a wood fire was available? How would the residue from a wood fire compare to the residue from gas? From petroleum products?

Which Material Stores Energy The Best?

Objectives:

Students will be able to: 1) set up, measure, observe, and record the results of a scientific experiment, and 2) describe the best material, of those studied, for energy collection and storage, giving reasons for their choices.

Skills Developed:

hypothesizing, measurement, observation, graphing, data interpretation

Time Required:

one 30-minute prep period
one one-hour experiment period
one follow-up period

Key Vocabulary:

Solar Energy: radiation from the sun which can be used to heat and cool (Just for information's sake, did you know that 4200 TRILLION kilowatt hours worth of energy in the form of sunlight shine on the earth daily?)
Heat: A form of energy associated with the motion of molecules (not the same as temperature)
Conduction: the movement of heat through a solid material, or from solid to solid
Convection: the movement of heat through a fluid or liquid
Radiation: the movement of heat waves through a gas
Heat Capacity: A property of a material, known as the quantity of heat required to raise 1 cubic foot of a material 1 degree fahrenheit
Temperature: The degree of hotness or coldness of anything (Temperature and heat are NOT the same.)
Collector: Any of a wide variety of devices used to collect solar energy and convert it to heat
Absorption: Taking in by chemical or molecular action (Darker colors absorb heat and light waves better than light colors which reflect them; thus, the surface for a collector is always dark.)

Materials:

Cardboard Box (needs to be big enough to allow all four cans below to fit comfortably without touching each other)
Black Paint (Spray paint is NOT advised due to the fumes and propellants)
4 small metal cans (Anything that can be found around the house will work well--just be sure that the cans are made of the same material. Coffee cans work , as well as smaller vegetable cans.)
4 thermometers (Again, it would help to be consistent. Use the same type thermometers if at all possible.)

Equal volumes of Sand
Salt
Water
Torn-Up Paper

Procedure:

1) First, paint the cardboard box black. This can be done as part of your preparation, or you may choose to have your students follow through the process. Allowing for drying time will make the set up of the rest of the experiment much easier.

2) Next, using an equal volume of sand, salt, water and torn-up paper, fill each of the four cans with one of the above materials. When the box is dry place all four cans in the closed box. Make sure the cans do not touch each other. Place a thermometer in each can and record the temperature of each. Remove the thermometers. Set the box in the sun for at least one-half hour.

3) At the end of this time, remove the cans from the cardboard box, and from the sun altogether. Note and record the temperature of each of the four materials.

4) At five minute intervals again note and record the temperature of each of the four materials. Continue this for at least one-half hour.

5) Graph the temperature (each in a different color) of each of the four materials, over the course of the half-hour.

Questions:

What material was able to heat the quickest in one-half hour's time? The slowest? Why do you think that is?
What material lost heat the quickest? The slowest? Again, why do you think that is?
What material stored (retained) heat the most efficiently?
Why shouldn't the cans in the box be allowed to touch each other?
What "material", or "heat absorber" is actually being tested along with the torn-up paper in that can?
Of the materials used, which had the greatest **heat capacity**? The least?

What If...???

...the box were painted white, instead of black?
...the cans were of different materials? One glass? one tin? one aluminum? one stone? one wood? one copper?
...the volumes of the materials were different?
...the cans were left in the box for one hour? Two hours? All day?
...the box were placed outside on a cloudy day? A rainy day? A cold day?
...the torn-up paper were taken away to leave an empty air-filled can? How would the temperature graph for that can change?

What's In Our Air?

Objectives: Students will be able to: 1) describe the composition of atmospheric air, 2) identify particulates as small particles in the atmosphere that contribute to air pollution, and 3) identify sources of atmospheric pollutants, both natural and manmade.

Related Activities: Whether Weather (page 88)

Skills Developed: analysis, comparison

Time Required: two 45-50 minute periods, plus collection time

Key Vocabulary:

particulate: small particles in the atmosphere that contribute to air pollution; these particles can be both naturally occurring and man-made
contaminants: substances that make something impure by contact or mixture
noble gases: inactive or inert (those gases that display no chemical activity)
natural pollution: pollution that has a naturally occurring source
man-made pollution: pollutants that are a direct result of man's activities

Materials:

vacuum cleaner with removable beater bar (a small box fan may be used if a vacuum is not available)
pieces of white cloth or strong white paper toweling
coffee can (not needed if you are using a box fan)
duct or electrical tape
tinsnips or other cutting device (also not needed if you are using a box fan)
microscopes or hand lenses

Background: Pure, dry, atmospheric air contains approximately 21% Oxygen (20.92%), 78% Nitrogen (78.14%), 0.04% Carbon Dioxide and 0.9% Argon, with trace amounts of other noble gases. For practical purposes the inert gases are usually grouped together with Nitrogen to reach a total of 79%. Water vapor may also be present. All other substances such as gases, vapors, and solid particles are considered contaminants.

These contaminants are grouped into two categories: naturally occurring, and man-made. Natural pollution consists of such things as pollen and mold spores, and natural dust picked up and transported in the wind. Volcanos, earthquakes, and other natural disasters are frequently responsible for the presence of naturally occurring pollutants. Man-made pollution, on the other hand, is the direct result of man's activities. Combustion (industrial, as well as motor vehicles) is a primary source of man-made pollutants. **(It is important to note that these visible particles**

are much too large to serve as rain nuclei! The addition of man-made pollution to the atmosphere is not beneficial!)

Both types of pollutants have varying effects on atmospheric quality, human health, and vegetation. The first step in controlling the quantity of these pollutants is to detect and measure their presence.

Procedure:

1) Using the vacuum hose as a guide, cut a hole in the bottom of the coffee can large enough for the vacuum hose to fit comfortably. Edge the hole with tape to prevent exposure to the sharp metal. Tape or tie a piece of white cloth or paper towel to the open end of the can. Insert the vacuum hose into the other end, and seal the hose to the can with tape. Expose the filter end to the air to be tested.

2) Leave the vacuum to run for an hour.

3) Carefully examine the filter at the end of this time.

(If using a box fan instead, cover the **backside** of the fan with the filter cloth. Cheesecloth works well. Be sure not to place the filter too close to the fan blades. Turn the fan on for one hour. Carefully examine the filter at the end of this time.)

4) Place clean filters on the vacuum or fan, and collect other samples at different locations, or at different times of the day. Compare the samples collected.

NOTE: If looking for a more energy-efficient way in which to collect samples, a small plate (or floor tile) can be used. Simply cover the surface with a thin layer of a sticky substance such as Vaseline. Set the plate out for a day. Examine the surface under a microscope.

What If...???

...the height of the filter were varied? Would the distance from ground level effect the results?

...the time of year (season) were changed? What differences would you expect between Winter and Spring? Between Summer and Fall?

Muffin Mining

Objectives:

Students will be able to describe the advantages and disadvantages of two different methods of coal mining.

Related Activities:

What's In Our Air? (page 55), The Cleaner Fuel? (page 51), Energy Debate (page 33)

Skills Developed:

comparison/contrast, hypothesis formation, geology
(extension: graphing, geography, maps)

Time Required:

one 45-minute session

Key Vocabulary:

strip mining: a mining operation in which the coal seams run close to the ground and are reached by the removal of topsoil and overburden (rock, groundcover, including grasses and trees, or any other material that may cover the coal deposit)
underground mining: a mining operation in which tunnels and supports are constructed below the surface of the earth, leading to a coal seam (Disturbance of the surface of the earth occurs only at tunnel entrance sites, and mining headquarters.)
BTU: (British Thermal Unit) a commonly used measure of energy

Materials:

one muffin (chocolate chip/ raisin/blueberry) for every student
(large soft cookies can be substituted if necessary)
1 toothpick per student
scissors or tweezers for each pair or group
a paper plate for each pair or group

Background:

According to the New York State Energy Master Plan (1983), in 1982 coal comprised 23.8% of the total energy consumed in the United States (and 9.5% of the energy consumed in New York State). Today's figures are not much different. It would seem quite imperative, then, to understand a bit more about the fuel source that makes up close to one-fourth of the United States' collective energy.

Almost one-half of the electricity generated in the United States comes from the burning of coal, considered a fossil fuel. (The remaining electricity is produced in fairly equal amounts by oil, natural gas, hydropower and nuclear energy.)

More than 250 million year ago, according to certain scientific theory, vast swamp lands of giant ferns, trees, and grasses covered large areas of the earth. This vegetation, of course, acted as a storehouse for solar energy, converting and storing it as chemical energy. When these plants died, they formed a layer of rotting vegetation known as peat This process was repeated, layer after layer, for thousands of years. As the surface of the earth changed over geologic time, seas covered parts of this land, depositing layers of sedimentary rock on top of the peat. Once the seas again receded, heat and pressure from the layers of rock began changing (metamorphosing) the peat into coal.

Today, coal is separated or identified by grade, depending on its heat content, that is, the amount of heat given off when it is burned. The grades, from lowest to highest, are lignite, subbituminous, bituminous, and anthracite.

Procedure:

1) Explain to the students that they will conduct an experiment to find out how coal is mined and the effects of mining on the environment.

2) Read the facts about coal, below, and then as a group, list those facts which are **advantages** or **disadvantages**.

Coal Facts:

The coal supply, like all nonrenewable energy sources, will eventually run out.
Underground mines can cause respiratory diseases (such as black lung) from the buildup of coal dust in a confined area.
Coal can be burned to produce electricity.
Mining provides jobs.
The burning of coal causes air pollution and contributes to acid rain.
There are more coal reserves left than there is oil or natural gas.
Strip mining damages the local ecosystem, at a rate of 1000 acres per week.
(Can you or your students think of, or research, any more to add?)

3) Describe the two types of coal mining. **In strip mining,** large areas of land are scooped up by bulldozers and power shovels and then sorted through. These mines are used to retrieve coal from relatively shallow seams close to the earth's surface. In **underground mining**, tunnels or shafts are dug underground in an area where they think there is a large deposit of coal, sometimes many hundreds of feet below the surface. Miners then retrieve the coal through these supported shafts. Each student is going to have an opportunity to try both methods of mining and decide which they think is the best method.

4) Tell students that no one is to touch their muffin until you have told them to do so. They may eat their muffin only **after** the experiment.

5) Pair students up. Pass out a chocolate chip muffin to each pair of students (oatmeal raisin, or blueberry work just as well).

6) Have students examine their muffin (**without damaging it!**) and estimate how many chips/raisins/berries are in it. Record each group's predictions on the chalkboard. The students will now **strip mine** their muffin. Demonstrate that they do this by taking a section and breaking up until they find every chip/raisin/berry. They are **NOT TO EAT ANY OF THEIR MUFFIN OR COOKIE YET!** Record (for the whole class to see, perhaps on the board or on a flip chart) the actual number of chips/raisins/berries found in each muffin. The actual number of chips/raisins should be higher in most cases. Discuss with students the "condition" of their muffin. Equate their muffin crumbs with what the land would look like after strip mining (devastation). Explain that while strip mining is the better method for retrieving large percentages of available coal, it damages the land tremendously.

7) Ask students to set the strip mined muffin crumbs and chips aside. Give each group a second muffin. Again remind them **not to eat any part of the muffin until the experiment is finished**. Now the students will do the underground mining to get the chips/raisins/berries. First record the estimated number of chips/raisins. This time students are to carefully remove the chips **without damaging the muffin**. (KEEP IT IN ONE PIECE). If the

students see a chip/raisin and they can get it without breaking their muffin then they should try to mine it If a student breaks their muffin they must stop mining because they have done too much damage to the land Again, record the number of chips found. (There should be a smaller yield, but much less "environmental" damage.)

8) As students **underground mine** their muffin for more chips, talk with the group about the advantages and disadvantages of the two mining methods.

Questions:

Which method does each group think is best, overall? Why?
Which finds more coal (chips?), or a higher percentage of available coal?
Which takes more time? More care?
Which does more damage to the ecosystem?
Which do you think is safer for the miners?
Is there any difference in the resulting coal?
If you were asked to select one mining method based on **economic** considerations, which would it be? Why?
If your main consideration were **environmental**, which method would you select? Why?
Can you think of a compromise situation?

What If...???

Often, with strip mining practices, government regulations call for "reclamation" of the mined land. That is, mining companies are required to "replace" the land that has been mined. Before letting students eat their muffin, see if any of the students can successfully "reclaim" their strip mined muffins. Does it look like the original muffin? In what ways does it? It what ways does it not? What about the "ground cover" or top crust of the muffin? Where is it? How much energy did it take to try to put the muffin back together? How much time? What if there were no "reclamation" policies? (See the activity "Policy! Policy?" on page 36 for further discussion of governmental policies.)

Extensions:

(1) Using the following charts, students may be asked to graph the resulting coal production from both underground mining and surface mining. The charts show a noticeable increase in the amount of coal that the United States mined through surface mining between the years 1950 and 1990. From their experience with the above activity, ask students to hypothesize why this increase might have been. Why has the amount of anthracite mined from 1950-1990 decreased so dramatically? Why has the mining of lignite, the lowest grade of coal available, increased?

(2) On a topographic map, have students locate and identify the areas in the United States with which coal mining is associated. (Point them in the general directions of West Virginia, Pennsylvania, and Wyoming, for starters.)

U.S. coal production, by rank and mining method, 1950-1990

		Rank			Mining Method	
Year	Bituminous	sub-bituminous	Lignite	Anthracite	Under-ground	Surface
			(million metric tons)			
1950	468.29	i	i	39.98	381.85	126.42
1955	421.42	i	i	23.77	324.67	120.52
1960	376.87	i	i	17.07	265.37	128.56
1961	365.50	i	i	15.82	253.55	127.77
1962	382.89	i	i	15.32	261.16	137.05
1963	416.25	i	i	16.57	280.24	152.58
1964	441.71	i	i	15.59	297.22	160.07
1965	464.46	i	i	13.48	306.53	171.42
1966	484.23	i	i	11.74	310.75	185.22
1967	501.23	i	i	11.12	319.62	192.73
1968	494.54	i	i	10.40	314.36	190.57
1969	496.29	7.55	4.55	9.50	316.76	201.12
1970	524.67	14.90	7.29	8.82	308.86	246.82
1971	472.86	20.09	7.89	7.92	251.40	257.36
1972	505.06	24.99	9.97	6.45	276.68	269.78
1973	492.98	30.78	12.95	6.19	272.17	270.73
1974	494.94	38.31	14.04	6.00	252.12	301.18
1975	523.81	46.35	17.97	5.63	266.17	327.58
1976	533.65	58.81	23.11	5.65	267.99	353.23
1977	526.96	74.48	25.61	5.32	241.80	390.57
1978	484.36	87.76	31.16	4.57	220.19	387.64
1979	555.34	110.18	38.59	4.39	291.05	417.44
1980	570.29	133.98	42.77	5.49	306.12	446.42
1981	551.44	144.84	45.96	4.92	287.06	460.10
1982	562.49	145.98	47.54	4.16	307.61	452.56
1983	515.73	137.00	52.92	3.71	272.44	436.91
1984	589.09	162.53	57.20	3.77	319.31	493.29
1985	556.92	174.82	65.68	4.26	318.24	483.35
1986	562.55	172.00	69.31	3.90	326.95	480.72
1987	577.42	181.59	71.11	3.27	338.23	495.15
1988	578.78	205.90	79.46	3.18	359.37	524.72
1989	598.47	209.71	78.37	2.99	357.19	532.34
1990	633.02	222.41	81.27	2.81	377.69	561.82

Source: U.S. Department of Energy, Energy Information Administration, Annual Energy Review 1990, table 82, p. 187, DOE/EIA-038490, Washington D.C: DOE, EIA, 1991

Note: i=included in bituminous coal. Previous year data may have been revised. Current year data are preliminary and may be revised in future publications.

Heat Content of Major Coal Types

(From Energy: Sources and Issues, Science Syllabus for Middle and Junior High Schools, The New York State Education Department)

Type	6	8	10	12	14	16
		(in thousands of BTU's per pound)				
Lignite	....					
Subbituminous		....				
Bituminous				....		
Anthracite					....	

Popcorn Pass

The Energy-Transfer Game

Objectives: Students will be able to: 1) describe how energy is "lost" when transferred from one system to another (that no energy conversion is 100% efficient), 2) state that energy can neither be created nor destroyed, but can be changed from one form to another, 3) identify the sun as the ultimate source of energy in most ecosystems, 4) describe how the sun provides the vast majority of energy used by living organisms on earth, 5) describe the process whereby life is based on the conversion, use, storage and transfer of energy (food chains), and 6) list solar, chemical, kinetic, and thermal as forms of energy, giving examples of each.

Skills Developed: analysis

Time Required: At least one 45-50 minute session
(Each round of play requires only 5-10 minutes; But don't forget clean-up!)

Key Vocabulary:

energy transfer: the movement of energy from one place or system to another
system: a group of interdependent elements forming a complex whole
herbivore: a plant eater
carnivore: a flesh or meat eater
net energy: the amount of energy left to a system or individual after all transfers and uses
First Law of Thermodynamics: A scary title for the physical law that simply states "Matter can neither be created nor destroyed, only changed from one form to another"
Second Law of Thermodynamics: An equally scary name for the physical law that says "No energy transfer is 100% efficient"; energy is always "lost" (changed into a non-usable form) along the way
thermal energy: energy that is in the form of heat, or due to the presence of heat
kinetic energy: energy due to motion or movement
chemical energy: energy obtained from the breakdown or combining of bonded substances (the digestion of food releases chemical energy)
solar energy: energy obtained from the sun (in the form of light, or heat)
food chain: the progression of energy from its source (the sun) through green plants, to varying levels of consumers

Materials: enough dry material (popcorn, dry leaves, sawdust, sand, beans, peanuts, etc.) for each group of five students to have a giant armful or handful, depending on the material selected. (Edible material is suggested, but not absolutely necessary)
An open, fairly flat area
A broom and dustpan!

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Background:

You will want to review energy in natural systems with the class before the activity. For example, the sun gives off energy that is used in plants. However, the plants do not use all the energy the sun produces. Less than 1% of the sun's energy is actually used by green plants for the process of photosynthesis! Of the remaining 99% of the sun's energy reaching the earth's atmosphere, approximately 30% is reflected back into space, 20% is absorbed by the atmosphere, and close to 50% is absorbed as heat by the ground, surface water, buildings, asphalt, or various vegetation and wildlife. (This provides one example of solar energy being converted to thermal energy.)

Plants use this 1% of the sun's energy to photosynthesize, obtaining chemical energy with which to grow and reproduce. A fraction of this energy is stored. Animals then eat plants to get their energy. However, not all of the energy that was captured by the plant is still in the plant, since the plant had to use some for its own growth and reproduction. What fraction of energy the animals do obtain from the plants is further used for the animals needs (body heat, respiration, movement, growth and reproduction, among others). Excess is stored as fat. You can follow this through with the transfer of energy when an animal is eaten by another animal. At each transfer (sun to plant, plant to herbivore, herbivore to carnivore) energy is "lost", that is, used or changed in form so that it is no longer available for further transfer.

In short, plants convert solar energy to chemical energy used in growth. Animals that eat plants use part of this stored energy for their own growth and life functions, (kinetic energy, among other forms) while some is "lost" as heat (thermal energy).

The same is true with energy made by humans. With each transfer, energy is lost. For example, in mining uranium, 5% of the potential energy in the uranium is used. In processing and transporting the ore, another 43% of the energy that uranium represents is used up. At the nuclear power plant, when the uranium is used to make electricity there is a loss of 69%! Transmission of the electricity entails a loss of 15%. Once the electricity is in the house, in an incandescent (usual type) light bulb, 5% of it becomes light, the other 95% is lost as heat. In fact, if you started with 100 kilowatt-hours (Kwh, a unit of energy) worth of uranium, you would end up with a net of .7 kilowatt-hours worth of lighting for your home. The rest of the energy, 99.3%, was used for uranium mining, transporting, refining, operating the power plant and the light bulb. Help your students understand: **It takes energy to get energy!**

Procedure:

1) Place whatever material you're using to represent energy at one end of the site in a pile (or preferably a large bowl or bucket). Form teams of five.

2) Have each team line up in a parallel line, with 2 to 3 feet separating each person, and several yards separating each group. The teams should be lined up 100 to 200 yards away from the "energy pile". (Having the groups in a large circle surrounding the "pile" of energy allows everyone to see what is happening, but it has to be big!)

3) Quickly review food chains, and assign a role to each of the students. Review the functions of living things that require energy: respiration, adaptation, locomotion, digestion, reproduction, defense, etc. The first person in line will be the sun; the second, a plant; the third, a herbivore; fourth, a carnivore; and fifth, a human. (For a more "produced energy" effect, have the first be a fuel at its source (mine, pump, etc.), have the second in line be that fuel at a power plant; the third being an electric line from the plant; the fourth, a lamp in a house; the fifth, a light bulb--vary the wattage for an interesting effect!. Or, design your own category!)

4) Have each player, except the sun, mark their spots. Have the suns stand behind the "energy pile" facing their group.

5) Explain that the sun provides the energy needed in each of the food chains. Have the suns scoop up as many leaves as they can hold in their arms, or as much of the other materials as they can hold in their hands.

6) At the "go" signal, the suns "beam down" on the plants (race to the plants) who grab (GENTLY) as much of the sun's energy as they can. (If you use popcorn or some other edible material, at this point, the plants may begin to actually "consume" the energy passed to them from the sun--remember, they need energy to respirate, grow, and reproduce!)

7) The plants pivot (they do not run; remember, they are "rooted"!), and the herbivores race up to grab as much energy as they can hold. The herbivores return to their spot. As soon as the herbivores return to their spot,(and begin "consuming" the energy gotten from the plants), the carnivores run up and capture the energy from the herbivores. Continue with the humans. When the humans return to their spot, have them raise the remaining energy above their heads to signal that they are through. This process may be repeated as many times as desired to achieve an "average" pattern of energy usage.

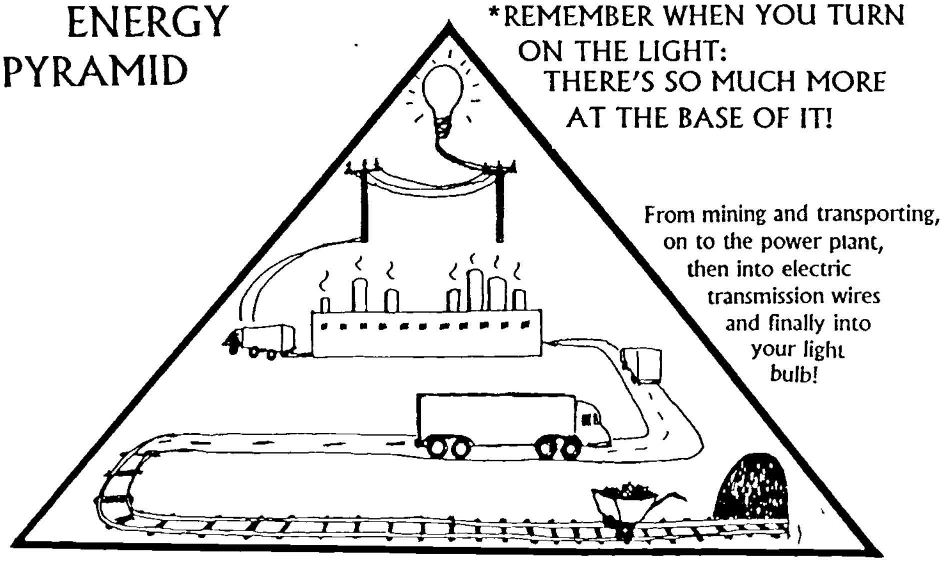
Questions:

Look on the ground. What has happened to the energy during transport and transfer? Is this typical? What physical law explains what is seen on the floor?
Compare the amount held by the first and last person.
If there were fewer transfers, how much energy would the last person have?
How could we make fewer transfers in obtaining energy in our lives?

What If...???

...the carnivore stage were taken out? How much energy would be left over? Why?
...an environmental disaster--like pesticides, floods, oil spills (or power plant explosion, or meltdown) were to occur? How would this effect the flow of energy?
...you were to reenact this energy transfer, changing the circumstances? Increase the atmospheric pollution level (thereby decreasing the amount of original energy from the sun!), or have a non-renewable energy source (a coal mine, or an oil well) become exhausted. **Now What??**

ENERGY PYRAMID



Water, Water Everywhere

Objectives:

Students will be able to: 1) list water power as a form of energy, 2) compare and contrast waterwheel styles giving advantages and disadvantages of each, and 3) determine an ideal site for waterwheel placement, defending their decisions with facts.

Skills Developed:

problem solving, reasoning skills, manipulation of ideas, calculation (extension: mapping, current events)

Time Required:

two 40-45 minute sessions

Key Vocabulary:

energy: the ability to do work

hydroelectric power: power generated by the conversion of the energy of running water

renewable resource: typically viewed as a source of energy that can be easily and relatively quickly replenished or restored. (Water is replenished with new rain, sunlight comes again with the rotation of the earth, and trees or biomass is grown anew within our lifetimes. These are all examples of commonly thought of renewable resources.)

nonrenewable resource: the opposite of a renewable resource, a source of energy that, once used, cannot be replaced within our lifetimes. (Coal and oil, formed under intense pressure for possibly millions of years, are prime examples of a nonrenewable resource. Radioactive elements used in nuclear fission would be another.)

Materials:

cardboard
scissors
toothpicks
heavy thread
paper clips
miscellaneous weights (metal nuts of the same size and weight are suggested)
water source (a sink is not necessary, but is extremely helpful)
lengths of strong wire (coat hanger wire works well)
electric or duct tape to cover sharp edges of wire
wire snips, or cutting pliers
a stopwatch, or watch with a second hand

Background:

The waterwheel, as a concept, dates back to the first century B.C. (The windmill followed seven centuries after.) Since that time, countless peoples in various cultures have made only minor alterations to the design to suit their situation and their needs. Both the waterwheel and the windmill have played an essential part in American history. As late as the middle 1900's windmills still supplied a major portion of rural America with their only known electrical power, while waterwheels were used in grist mills to turn raw crop into usable flour for baking needs. Modern turbines are the result of the Industrial Revolution which required a more efficient output of energy. (This increased output was a result of a change in the angle of the wheel blades.)

A hydroelectric power plant uses the power of falling water (kinetic energy) to spin these modern turbines for generating electricity. Have students demonstrate the ability of falling water to do work.

Procedure:

1) Define energy. (Commonly defined as the ability to do work.) Using this definition, brainstorm energy sources and some of the "work" that each does. (One of the goals of this brainstorming session is to have the students begin thinking of the endless "work" that is done, coupled with the more limited list of energy sources--many of which are nonrenewable. Another goal of this session is to bring out the differences in renewable vs. nonrenewable energy sources, and to ultimately settle on hydro power as the subject of a more in-depth study. Some students, of course, may need a little coaching to get them started.)

2) Divide students into working groups of, ideally, 2 or 3 students. An extremely hands-on approach is favorable. Give each group the following: one cardboard circle (or square, or rectangle from which to construct their own shape), an equal length of string, an equal length chain of paper clips, an equal length piece of wire, a toothpick, a pair of scissors, and two pieces of electric tape.

3) Explain to the students their challenge: to design and construct a waterwheel that will do work with the least amount of energy, that is, they must design a turbine that will turn and wind up the string of paper clips that must be attached to the shaft. Some restrictions: the students may not (yet) borrow any unused materials from other groups. They must work only with the given materials. The chain of paper clips must stay together (they will be the ultimate test of the waterwheel's ability). Do not limit the shape of the "wheel". It is often confining to hand a student a "circle" of cardboard. A square and a pair of scissors yield much more interesting results. If you find that this unstructured approach is unsuitable to the needs and/or abilities of your class, you may wish to show the class a "sample" of what their wheel (and blades) might look like. See the diagram at the end of this section for ideas and suggestions.

4) Give the students an agreed upon amount of time (15-20 minutes is ideal) to design and construct their turbines.

5) Put them to the test!! Making sure that all string lengths are the same, and that each paper clip chain is the same distance from the top of the turbine, and that the water flow is the same for each test, time the turbine's ability to wind the paper clips around the shaft. Have the group defend their choice of design, and explain their logic to the rest of the class. (The assumption is that with an equal flow of water--volume/per second-- any differences in performance time will be caused by turbine design.)

6) Back to the drawing board! Give each group the opportunity to make modifications based on their turbine's performance at the "river". (This would be an ideal spot to break up the two sessions if time does not allow for one continuous session.) Instead of paper clips, why not add a heavier weight? Metal washers or nuts work well as long as the string being used is strong enough.

7) Test the new turbines in the same way. Again, have students explain any changes that they may have made.

8) Have the class calculate the rate of flow of the water at the faucet (or water source). What effect does rate of flow have on the waterwheel's ability to do work?

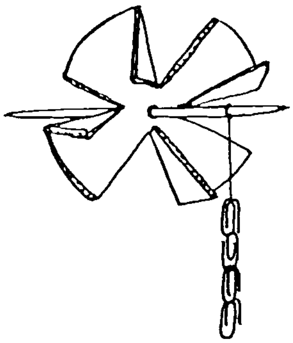
What If...??? ...the number of "blades" on the turbine were changed? What if there were more? Less? Is there an ideal number?

...the length of the shaft were altered? Shorter? Longer? Does it make a difference?

...the angle of the blade were changed?

...the direction of the blades were changed? Do they all have to point in the same direction?

...the volume of water were kept the same, but the rate of flow were to change? (Fill pitchers with an equal amount of water, and then vary the pour time over a sink, or better yet, a catch basin so that the water can be reused over and over again to test each turbine. Is there a point at which the flow of water is too slow or weak to do work? How would this knowledge effect your choice of location if you were asked to find a river on which to place your turbine? Keeping this in mind, use a map (preferably a topographic map) of the Eastern United States to select an ideal location for your wheel? How about the Western United States? What factors will effect your decision?



World's Largest Dams

Dam	Location	Volume (thousands/cubic yds.)	Year
New Cornelia Tailings	Arizona	274,015	1973
Poti (Chapeton)	Argentina	261,590	UC
Tarbela	Pakistan	159,203	1976
Fort Peck	Montana	125,628	1940
Ataturk	Turkey	110,522	1990
Yacyreta-Apipe	Paraguay/Argentina	105,944	UC
Guri (Raul Leoni)	Venezuela	102,014	1986
Rogun	U.S.S.R	98,750	1985
Oahe	South Dakota	92,000	1963
Mangla	Pakistan	85,872	1967
Gardiner	Canada	85,592	1968
Afsluitdijk	Netherlands	82,927	1932
Oroville	California	78,008	1968
San Luis	California	77,700	1967
Nurek	U.S.S.R.	75,861	1980
Garrison	North Dakota	66,500	1956
Cochiti	New Mexico	62,850	1975
Tabka (Thawra)	Syria	60,168	1976
Bennett W.A.C.	Canada	57,201	1967
Tucuruli	Brazil	56,242	1984
Boruca	Costa Rica	56,242	UC
High Aswan (Sadd-el-Aali)	Egypt	56,242	1970
San Roque	Philippines	56,242	UC
Kiev	U.S.S.R.	56,034	1964
Dantiwada Left Embankment	India	53,680	1965
Saratov	U.S.S.R.	52,843	1967
Mission Tailings 2	Arizona	52,435	1973
Fort Randall	South Dakota	50,000	1953
Kanev	U.S.S.R.	49,520	1976
Mosul	Iraq	47,086	1982
Kakhovka	U.S.S.R.	46,617	1955
Itumbiara	Brazil	46,563	1980
Lauwerszee	Netherlands	46,532	1969
Beas	India	46,325	1974
Oosterschelde	Netherlands	45,778	1986

UC = under construction
Year = Year completed

World's Largest Hydroelectric Plants

Dam	Location	Rated Capacity (MW) Present	Rated Capacity (MW) Ultimate	Year of Initial Operation
Itaipu	Brazil/Paraguay	1,400	12,600	1984
Grand Coulee	Washington	6,480	10,080	1942
Guri (Raul Leoni)	Venezuela	2,800	10,060	1968
Tucuruli	Brazil	----	7,500	1985
Sayano-Shushensk	U.S.S.R.	----	6,400	1980
Krasnoyarsk	U.S.S.R.	6.096	6,096	1968
Corpus-Posadas	Argentina/Paraguay	----	6,000	UC
LaGrande 2	Canada	5,328	5,328	1982
Churchill Falls	Canada	5,225	5,225	1971
Bratsk	U.S.S.R.	4,100	4,600	1964
Ust'-Ilimsk	U.S.S.R.	3,675	4,500	1974
Cabora Bassa	Mozambique	2,075	4,150	1974
Yacyreta-Apipe	Argentina/Paraguay	----	4,050	UC
Rogun	U.S.S.R.	----	3,600	1985
Paulo Afonso	Brazil	3,409	3,409	1954
Salto Santiago	Brazil	1,332	3,333	1980
Pati (Chapeton)	Argentina	----	3,300	UC
Brumley Gap	Virginia	3,200	3,200	1973
Llha Solteira	Brazil	3,200	3,200	1973
Inga I	Zaire	360	2,820	1974
Gezhouba	China	965	2,715	1981
John Day	Oregon/Washington	2,160	2,700	1969
Nurek	U.S.S.R.	900	2,700	1976
Revelstoke	Canada	900	2,700	1984
Sao Simao	Brazil	2,680	2,680	1979
LaGrande 4	Canada	2,637	2,637	1984
Mica	Canada	1,736	2,610	1976
Volgograd-22nd Congress	U.S.S.R.	2,560	2,560	1958
Fos do Areia	Brazil	2,511	2,511	1983
Itaparica	Brazil	----	2,500	1985
Bennett W.A.C.	Canada	2,116	2,416	1969
Chicoasen	Mexico	----	2,400	1980
Ataturk	Turkey	----	2,400	1990
LaGrande 3	Canada	2,310	2,310	1982
Volga-V.I. Lenin	U.S.S.R.	2,300	2,300	1955
Iron Gates I	Romania/Yugoslavia	2,300	2,300	1970
Iron Gates II	Romania/Yugoslavia	270	2,160	1983
Bath County	Virginia	----	2,100	1985
High Aswan (Saad-el-Aali)	Egypt	2,100	2,100	1967
Tarbela	Pakistan	1,400	2,100	1977
Piedra del Aquila	Argentina	----	2,100	UC
Itumbiara	Brazil	2,080	2,080	1980
Chief Joseph	Washington	2,069	2,069	1956
McNary	Oregon	980	2,030	1954
Green River	North Carolina	----	2,000	1980
Tehri	India	----	2,000	UC
Cornwall	New York	----	2,000	1978
Ludington	Michigan	1,979	1,979	1973
Robert Moses-Niagra	New York	1,950	1,950	1961
Salto Grande	Argentina/Uruguay	----	1,890	1979

Note: MW = Megawatts, UC = Under Construction.

Extensions:

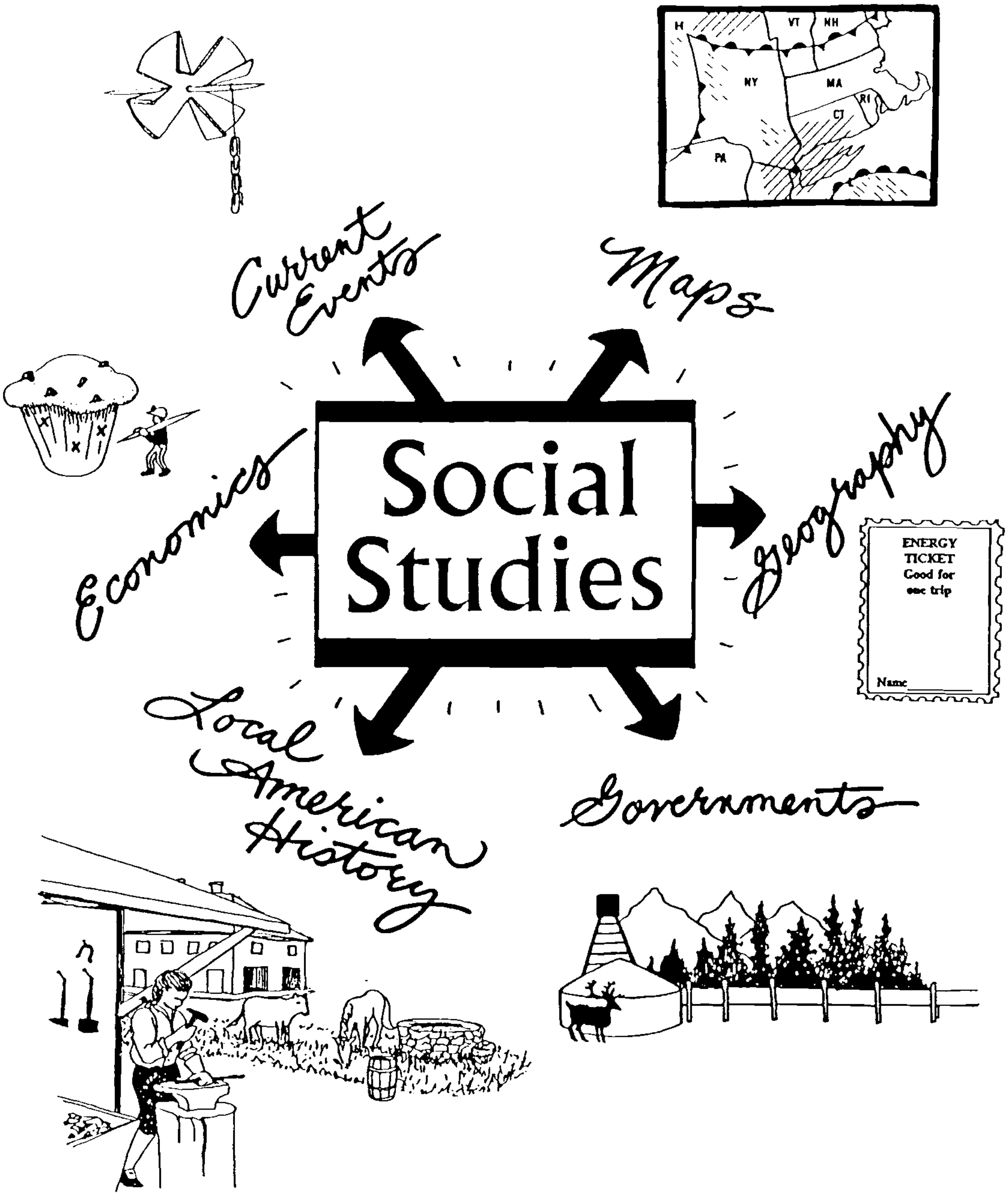
Using detailed maps of the world, or specific regions, have students locate the dams and/or hydroelectric plants, from the following charts (Note that the accompanying charts not list **all** plants in that area, just the largest). Using pushpins and a wall map, have students place pins at each of the dams/hydroelectric plants. What factors do these dams or plants share? Is there a pattern in their location? What information can you surmise from this pattern? (You will notice that several of the dams and hydroelectric plants are located in the U.S.S.R. as well as Romania/Yugoslavia. If you have current (1993 or later) maps, you and your students may have difficulty locating these countries. Now would be the perfect opportunity to discuss the political change that has made some of our older maps outdated!) Perhaps you can locate the countries on the older maps, then relocate the dam/hydroelectric plant on a newer map. Under what country's jurisdiction does the dam now fall?

Help your students understand that the presence of a dam is not synonymous with the capacity to produce hydroelectric power. Discuss other reasons for the planning or building of a dam. (Flood control, recreation, etc.) You may want to have your students compare the two charts. Do names of the same dam appear on both lists?

Using a map of New York State, have your class trace the path of the Marcy South Power line from New York City to its hydroelectric source in Canada. Define the term **import**. Ask your students to explain why municipalities in the Greater New York area "import" a percentage of their energy needs.

References for further reading:

David Macaulay's The Way Things Work, provides wonderful sketches, diagrams and explanations of the workings of everyday machines, waterwheels being among them.


Social Studies
Current Events
Maps
Economics
Geography
Local American History
Governments
VT
NH
NY
MA
RI
CT
PA
ENERGY TICKET
Good for one trip
Name

Social Studies

The Life Of A Colonist

(adapted from Energy: Sources & Issues, Science Syllabus for Middle and Junior High Schools)

Objectives:

Students will be able to: 1) describe the differences between energy sources used by 18th Century colonists and those used by people today, 2) identify the energy era during the Colonial time period, 3) identify the reason for the rise and fall of the Wood Era, 4) describe, giving examples, how the available sources of energy altered/effected the colonists' lifestyle, 5) identify lifestyle changes brought about by the changing pattern of energy use in America, and 6) describe what our life would be like without our current sources of energy.

Skills Developed:

comparison/contrast skills, composition, reading comprehension
local American history

Time Required:

One forty-five minute session
Additional time required for optional activities

Key Vocabulary:

adze: an ax-like tool with a curved blade that sits at a right angle to the handle, used for shaping wood
broad axe: a short-handled ax with a wide, flat head
stockade: a defensive barrier made of strong posts or timbers driven upright side by side in the ground
Whig: a supporter of the war against England during the American Revolution (opposed to the Tories)
Tory: an American who favored the English side during the American Revolution (opposition party to the Whigs)
cooper: a maker or craftsman of wooden barrels, tubs and casks

Materials:

copies of this reading
(The following materials are optional):
Ingredients for Cornbread
Ink Wells (or small glass bottles such as baby food jars) and India Ink
quills

Background:

In the 370 or so years since the first European settlement on American soil certain elements of the lifestyle of the so-called settlers has changed so tremendously as to be almost unrecognizable to today's inhabitants of America. Certain elements, conversely, are remarkably similar. Colonial America is defined loosely as that time period from first settlement by Europeans (1629) through the formation of the 13 British Colonies that were to form the original United States, up to and including the American Revolution, the Declaration of Independence and Britain's ultimate acceptance of America's sovereignty. During this time period, itself, drastic changes took place in the colonists' ability to reconstruct their lifestyle from Europe as more and more settlers and resources were sent to join them, and as cities and urban centers began rising. When the first settlers arrived, most of the Eastern seaboard was covered with old-growth forests, now only known in the United States on the Pacific Northwest. These trees were seen as an abounding and endless fuel source (not to mention building material). Trees were cut and cleared to make room for cities and urban centers, to build the countless buildings, homes, and shops that were needed, to clear farm fields and grazing areas for domestic animals, and eventually to make charcoal for craftsmen and tradesmen to use in their work in smelting ore. One result of this abundant fuel source was the rapid rise in lifestyle among the colonists. Another result, of course, was the depletion of American forests. Today, wood is not seen as a major fuel source in most areas of the United States. (Some rural areas do, however, still rely heavily on wood as fuel.)

Procedure:

Give students copies of the corresponding readings. The first describes the life of a colonial farmer. The second follows the thoughts and actions of an urban resident, a craftsman apprentice. Students should be asked to pay careful attention to any reference to energy sources or work done.

After students have completed both readings they should answer and discuss the related questions.

Several follow-up activities (and recipes!) are included.

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Reading:

5:00 a.m.
Woke up to feed the stock. Had to break the ice from the water trough it was so cold. The air stung to breathe it in. The pigs and wooly lambs and chickens and oxen all needed to be cared for. I think those oxen know that a hard day's work is in store for them. My wife started getting breakfast ready. She'll start the breakfast fire from the hot coals still left from last night's dinner fire. Without those coals starting a new fire sure would be difficult, what with flint and steel being as touchy as they are. She'll wake the children shortly and send the oldest out to the pump for fresh water. Will have to remind the children to bring in more wood today. Milked the cow.

6:00 a.m.
Had pork and buttered cornbread for breakfast. My wife will make more butter today from this morning's milk. Wish we had another cow. Those young one's can't seem to get enough fresh milk. Will have to remember to sharpen my adze sometime soon; I'll need it if I'm going to make another bed for the three youngest ones to sleep in.

7:00 a.m.
Hitched the oxen to the plow. Started to plow the field. It will soon be time to plant the wheat and corn and, after that, the potatoes. Hope to finish plowing before next week.

11:00 a.m.
The sun finally warmed the land up a bit. Soon it will be time to do most of the planting so the children spent the morning working at the garden. My wife sure had her hands full trying to look after all seven of them and churn the butter at the same time. We sure are a fortunate family that even the youngest is able to pitch in here and there. What a fine garden it should be in a few more years when they are older. Hope to keep the rabbits and woodchucks away from the lettuce and cabbage this year!

12:00 noon
Finally had dinner. Still thinking about that needed bed, and about picking up some gunpowder and shot next trip I make into town, most likely on market day, Wednesday. I'll have to ask around when I'm in town, but I heard from Dr. Stueben that there's talk in town about reinforcing the stockade soon. Seems that the Tories up in Boston have been making trouble. Can't be all too sure that they haven't been provoked, but folks are starting to get worried all the same. Whig, Tory, I say a man is a man and should be allowed to worry about his own business. Still, there's been lots of talk about forming a local militia. Better think about sharpening all my tools, my broad ax especially, if I'm going to be working with the grindstone for the adze anyway. Had salted pork and cornbread for dinner. The wife is saving the fresh butter for supper.

12:30 p.m.
Went back to plowing. The oxen sure were fussing a lot. Like they were trying to say that half an hour's rest didn't quite suit them. Can't say as I blame them. After cleaning the dinner dishes my wife started spinning thread. We all need some new clothes for the summer. I'm thinking about trading a pig for some new shoes for the family. I just haven't the time to make them myself. That new merchant in town said he'd fit the whole family if the sow I picked for him was fat enough! Gosh, how those young ones grow so quick. The younger ones can make do for a while yet wearing the shoes the older ones have outgrown. The children finally got a chance to go fishing.

3:30 p.m.
Stopped plowing to go work on the fruit trees. Have to hope that the birds don't eat too much of the fruit this summer. Had to cut off all the dead limbs. Dare say I didn't get to all of them...just too tired. Now I can say I truly know how those oxen feel. Had hoped to remove some tree stumps from the field. I'll have to remember to get to that before too long. Our neighbor, Rob VanWald, said he would help. Last week me and the boys helped him pull his stumps. Shouldn't be too long before we'll all be getting together to help his oldest and his new wife put up that barn they're planning on. He's married one of the VanEuwen girls from the next town up the

river. Sure do wish them the best just starting out like they are My wife began to fix supper I'm glad the children caught fish today We'll have them for supper with some boiled potatoes

5:00 p.m.
All of us had supper. I don't know how but my wife managed to find time to make a fresh loaf of wheat bread. How fortunate we were with last fall's crop that there is still grain enough left for bread, and how good that bread tasted still hot from the hearth with today's butter on it. It's amazing what a day's work will do to one's appetite. Those boys look like they could have just about eaten their plates! Still thinking about that bed. My wife and the children cleaned up after supper. Children brought in more firewood. I milked the cow and fed the livestock again. Looks like we're in for another cold night.

7:00 p.m.
Said evening prayers and sent the children to bed. They sure are growing fast. The oldest one, ten now, is certainly one for reading. Dare say she might make a good schoolmarm one day. My wife worked on her mending while I cleaned my rifle. That reminded me again about the shot and the wood for that bed.

8:00 p.m.
Used the remaining light from the fire to write my diary and read the Bible. We are saving the rest of the candles for the barn lanterns, and for emergencies. Will have to remember next fall to try to save as much slaughter fat as possible to make even more. This ink that my wife boiled from the walnut hulls last fall is starting to spoil. Will have to put more salt in the solution tomorrow to try to save it. Hate to use too much of the salt on ink, but without it the whole jug will be wasted.

9:00 p.m.
Daylight is just about gone. I'm getting tired just thinking about all the work that needs to be done tomorrow. My wife and I are turning in for the night.

Reading:

5:00 a.m.
Was woken by the mistress of the house--my master's wife. I'm an apprentice, signed on for seven years of work with Cooper Lane. In exchange for my years of work, Master Lane has agreed to teach me to be a cooper, too. Lots of boys, many much younger than me, sign on with craftsmen in the same way in order to learn a proper trade. Mistress Lane set about starting the morning fire after making sure that we were all up and dressed and on our way to morning chores. Had to take water buckets to the pump in the town square, a fair walk, I dare say, up to the North side of town. Recognized most other apprentices who were already on que. Watched others whose morning chore it was to drive milking cows to the town common, willow switch swinging from one hand, like they hadn't a care in the world...a little envious of them for not knowing the weight of these water buckets!

6:00 a.m.
Back with water. Waiting now for breakfast...will probably be sent back several times over the next couple of hours to collect water for our work. Will have to spend the next four years working with Master Lane, carrying plenty more water in that time, before calling the cooper trade my own--been here for three, already. Hoping for breakfast soon. It's cornbread and sausage, and I'm getting really hungry moving around the house smelling it.

7:00 a.m.
Walked with my master and his son to the work barn. It's not really that far of a walk--a few blocks from the house--but, gosh, it felt it this morning A cold front moved in last night, and the frost is thick on the cobblestone.

I dare say snow will follow soon enough. The barn is cold, too. My master's son, Zack, named for the Bible's Zechariah, I think they said, is working on the hearth fire. We have quite a large order of barrels to be made for some rich country farmer. Seems he presses most of his orchard apples and stores the juice in our barrels to winter over. Claims the cider that's left is some of the best in the land! Not much of it finds its way to our table, though. Will probably spend the hours until dinner trimming barrel staves for his order.

11:00 a.m.
The barn is warm, now. Steam from the soaking bin keeps rising. Plus, the sun has made its way to our front door. We can watch all sorts of people walking up and down the streets as we work. There goes old Mr. Gardener--he's one of the merchants from 'cross town. Looks as though he's been to the tailor lately, what with that new velvet frock he's got on. And just look at those buttons shine! You can tell the merchants from the tradesman from a mile away. No tradesman could go to work dressed in fancy clothes like that...the sweat and dirt of a day's work would ruin 'em for sure. Some day I'd like to be able to take some fancy velvet home to my mother. What a surprise that would be. I'd walk in on a Holiday, when she wasn't expecting it, carrying all sorts of presents. Dolls for the little ones, some good smoking tobacco for my father, and yards of velvet for mother, maybe some lace, too, so she could make a fancy new Sunday dress...how pretty she'd look, too! She'd fuss a fair bit at first..."Now, Ethan," she'd say, "you know that I can't wear velvet to stoke the fire, or feed the young ones, or cook dinner in." But inside, she'd be tickled pink...she'd rub her fingers on it softly, and dream of being a rich lady from town...then they'd know for sure that I was doin' alright! But see how my mind does wander! I suppose it doesn't hurt to dream, none, but it's not likely I'll be taking that stuff home any year soon...and these barrels don't seem to be making themselves. It's taken almost twice as long as we thought it might to bend the wood we brought in yesterday...oak it was...oak's a hard wood, hard to split, hard to bend or to shave...but good for cider barrels...its got a good taste that doesn't hurt the flavor of the cider...some say it even gives the juice a woodsy flavor that helps it along...so, 'cause it's a good cider barrel wood, we learn to be patient with it...we learn how she likes to be cut (always with the grain), and how she likes to be bent round the barrel form...the wood tells us how the barrel should be made. And, any cooper worth his weight in salt will listen to the wood. That's what master says...the wood knows...

12:00 noon
Master said we could stop for dinner. His wife has packed our meal in a pail, and covered it with a cloth, like she does most every day. Today it's potatoes...looks like they've been baked in the hearth. There's cornbread sticks, too. Zack and I are taking ours out to the street so we can eat and watch all the goings on. Shops are closing up for the mid-day meal, and other apprentices Zack and I have been known to meet here and there about town on errand day, are scattering home, or to the commons to lay in the grass under the sun. Master Lane tends to stay in near the steamer with his meal, but he doesn't seem to mind any that we leave him there.

12:30 p.m.
Got back to those staves right quick. Seems that Master feels that with the weather turning as quickly as it has been that that farmer will be quite anxious to be pressing his apples. He always says "Now boys, you know a good barrel's not to be rushed!" Today he says, though, that there's no harm in rushing the other parts (like our noon meal)! Will probably need to light the lamps and stay on tonight until the barrels are finished.

3:30 p.m.
Zack was sent to the metalwright not long ago to check on our order of barrel hoops. We'll be needing them before too long. We don't use 'em for the rich farmer's barrels--they need wooden staves and wooden rings that will give and take with the humidity and aging of the barrel wood. Master says that all barrels should have wooden hoops if it's to be called a proper barrel--that people don't know Eve from Adam when they insist on metal hoops--thinks they're just being haughty, thinking metal is better than wood 'cause it's shinier and more dear. Either way, Jeb went to check on 'em. My forearms are throbbing from the stave work, and the steam's making me drip even more. Wish that Master had thought to send me, instead of Zack. Zack's younger, though, only twelve. He can't quite get his arms around these big barrels--and they're quite heavy for him, too. Me being fifteen, I can move them around a might bit better.

5:00 p.m.
Master Lane says we can close for supper. Make no mistake, though, we'll be back as soon as we've helped Mistress Lane with the house chores. We all sat down for supper quite promptly. Master had Jeb say prayer before we could eat. I suppose tomorrow'll be my turn at it. Zack and I will need to bring in fire wood before we go back to coopering. Zack's older sister, Lorna, she's sixteen, was sent this afternoon for more water, saving Jeb or me from having to do it. She's betrothed to the son of Master West, the blacksmith Until then, though, she spends most every day helping Mistress Lane with the washing and mending and cooking, and caring for what little livestock will fit in the back barn--a few chickens, a hog, and that nice pony Mistress Lane uses for visiting her mother on Sundays. Her mother's out in the country, about ten miles south of town. Mistress often comes back with apples or freshly collected hickory nuts, or black walnuts, from her mother's. The sun is starting to disappear over the western hill already...feels like frost will be coming again tonight.

6:00 p.m.
Mistress said that Lorna would help her carry more water, for us to go back to the cooper barn. Guess she senses how anxious Master is to finish this order. If the farmer is pleased it could mean a lot more business for us next fall...that would certainly be a boost! It's true that there's only five of us here (Master, his family, and me) but it can be hard, especially over winter, to keep food on the table. Mother and Father arranged as part of my apprenticeship for Master to provide for me, too, but I still try to use up as little as possible. **Oh, darn it all!** Will you look at how that wood cracked! Now we'll have to put it in the scrap bin! Sometimes, if you're not careful in bending the wood over the barrel form, or if it hasn't been steamed just right, or if you haven't picked the right piece of wood to make a stave, it'll crack. How it wastes time after you've worked so long!!

7:00 p.m.
Am getting quite tired. It's almost dark out now. The lamplighter hasn't made it to our street yet, and it's almost ghost-like how lights from some of the windows are dancing on the cobblestone. Makes you think that the shadows have eyes! There goes my imagination with the talk lately about revolutionaries and soldiers. We're a far enough bit from Boston, but one can't help but wonder who is who lately. Master says it would be silly for anyone, Whig or Tory alike, to try pushing for either side with the promise of snowfall. Says we all have enough to fight in a New England winter, that it needn't be each other. He likens that if anything is going to happen folks would be wise to wait 'till springtime and snowmelt. Reckon maybe he's right. But still, those shadows!

8:00 p.m.
Master sent Zack home to bed. I'll be going, too, just as soon as I finish up this last barrel form. We'll need to fit wooden plugs for the drain holes tomorrow. I reckon that Master will spend the better part of the morning fetching more wood. He'll have to take a wagon out to the edge of town to the old oak stand, and then to the mill. Maybe he'll take Zack...maybe he'll take Mistress instead. She's been known to do her fair share of a man's work when she sees the need...

9:00 p.m.
Have just gotten back from the shop. Master stayed on to work some more. Zack is already asleep...I can see the covers moving slowly, and can hear his soft breathing. I'm trying not to wake him as I undress. The loft and bed that we share is above the kitchen and I know that we'll both be awakened soon enough to the sounds of morning. Our candle is burning down, and will most likely need to be replaced soon...I'll have to remember that in tomorrow's chores. The house is almost out of candles...fall being dipping time, and all. Soon a new stock will be brought in. Can hear Mistress getting ready for bed down in the main room. She'll leave a lantern burning in the front window for Master to find his way. I'm so tired I can feel the aches in every part of my body. Am turning in for the night.

Questions:

What sources of energy were available to the colonial peoples?

The following tasks were done by the colonists. What energy source was used for each of these tasks?

- *Producing food?
- *Preparing food?
- *Building homes and barns?
- *Lighting and heating homes and businesses?
- *Preparing clothing? Dyeing clothing?
- *Making furniture?
- *Getting water?

What differences existed between urban colonists and rural colonists?

Why is it no longer possible for wood to be a primary source of energy in the United States?

What energy is used **today** for each of these tasks?

List TWO jobs performed on a regular basis by each member of the colonial family: the 20th Century family:

- *Mother?
- *Father?
- *Male children?
- *Female children?

In the colonial period, what do you think made one family wealthier or better off than another?

Why are VanWald and VanEuwen not surprising choices of names for the farmer's neighbor, or a neighboring family?

How did the lives of colonial rural children differ from the lives of colonial urban children? Do these differences still exist today? Why or why not? In what form?

What use did the apprenticeship system serve? Is there an equivalent system today?

What If...??

...a family were to have no children?

...there was not enough wood available for the fireplace?

...winter was particularly harsh, cold and snowy?

...a family's mule or draft horse or oxen or carriage team should become ill or die?

...the planting and harvesting season were extremely dry?

...the weather was good, and crops abundant?
what would happen to the excess?

...the mercantile in town did not have the supplies that were needed?

...urban centers were cut off from outside supplies?

Extensions:

Write your own diary...a daily account of **your** life; be sure to include references to the energy sources you used or were concerned with...don't forget to add all of the details...write as if a total stranger, 150 years from now will be reading your account. Assume they know nothing of your life, or of your lifestyle.

References for further reading:

Laura Ingalls Wilder's Little House in the Big Woods, chronicles the life of the Ingalls Family, settlers in Wisconsin in the 1800's. (More literary than technical)

Laura Ingalls Wilder's Farm Boy, follows the childhood of Almanzo Wilder, her husband-to-be, as he grows up on an upstate New York farm. (Gives a better idea of early American farm life than other Wilder works.)

Eric Sloane's Diary of an Early American Farm Boy takes the reader through a year in the life of Noah Blake, a young farm boy growing up in the 1800's. (Gives a wonderful representation of the "technical" aspects of a working early American farm. Addresses lifestyle as well as tools and techniques available.)

Eric Sloane's America describes life at the end of the nineteenth century, noting tools, farm methods, and differences in lifestyle.

Johnny Tremain, by Ester Forbes, describes the life of a silversmith apprentice in Boston at the time of the Revolution. (John Newbery Medal Winner). Describes the political feelings of the time, as well as giving a wonderful account of the urban apprentice lifestyle. (Class differences are a prominent theme.)

John Hector St. John de Crevecoeur's Letters from an American Farmer chronicles American colonial life from the point of view of de Crevecoeur, a French settler in Orange County, NY in 1769. (Sketches of Eighteenth Century America, also by de Crevecoeur, gives snapshots of colonial life; first published in 1925 by Yale Press, this one is the more difficult to find--but worth the effort. Penguin Books, 1981, has published a joint volume of these two works that is still in print.)

Rip VanWinkle, by Washington Irving, as a tale, of course, is pure fiction. Details about the current Monarch, King George III, the current governor of the colony, Peter Styvescent, and the Dutch settlers of the Hudson River Valley, however, make it a wonderful time piece.

Recipe for Cornbread

1 cup whole wheat flour
1 cup yellow cornmeal
1/4 cup sugar
4 teaspoons baking powder
3/4 teaspoon salt
2 eggs
1 cup milk
1/4 cup cooking oil, *or* shortening, melted

Preheat oven to 425 degrees F.

Stir together flour, cornmeal, sugar, baking powder, and salt. Add eggs, milk, and oil or melted shortening. Beat just until smooth (do not overbeat). Turn into a greased 9x9x2 inch baking pan. Bake in a 425 degree oven for 20 to 25 minutes. Makes 8 or 9 servings.

For Corn Sticks: Prepare corn bread batter as above. Spoon batter into greased corn stick pans, filling 2/3 full. Bake in a 425 degree oven for 12 to 15 minutes. Makes 20 sticks.

Recipie for Walnut-Hull Ink

Fresh black-walnut hulls, mashed
(There is a difference between hulls, and shells. Hulls need to be collected from freshly-picked or dropped walnuts)
vinegar
salt
cheesecloth
large pan
air-tight storage containers (babyfood jars)
rubber gloves

Note: Walnut Hulls have been used throughout history as a foundation for dyes and inks. They stain both clothing and skin a dark brown. For your own sanity, please use gloves!

In a large pan place several mashed hulls. Cover with water. Add a few tablespoons of vinegar. Bring to a boil. Simmer for one hour, stirring occassionally. Strain mixture through cheesecloth. Add a teaspoon of salt to remaining solution. Stir until dissolved. Store in air-tight container. Shake well before using.

Quill Pens

Using turkey or chicken feathers, (which can be obtained in bulk from local poultry farms for a nominal fee), slice the end of the feather shaft at a 45 degree angle. A razor blade or pen knife works best. Now place a thin slit, approximately one-half inch in length from the point of the shaft, upward. These slits will allow the quill to soak up ink when dipped. Write away!

Energy Mapping

Objectives: Students will be able to: 1) identify those objects within their home or school that consume energy, 2) construct a map of their home or school building, to scale, placing the above mentioned objects in the appropriate positions.

Related Activities: Bright Ideas (page 13), Personal Energy Survey (page 17)

Skills Developed: classification, fractions (scale formation), measurement, mapping

Time Required: dependent on the access to various parts of the building that is given to students

Key Vocabulary: scale: a proportion used to determine the relationship between a representation of a distance or object on a map, and the actual distance or object (expressed, for example, as one inch = five feet)

Materials:

tape measures
graph paper
straight edges

Background: According to the California Energy Extension Service, typical schools spend a major portion of their energy budget on lighting (28%), heating (25%) and cooling (13%). Air circulation (15%), hot water (5%) and miscellaneous energy usage (14%) have also been targeted as categories within a school's energy budget. Students and staff can, and do, have a major impact on these costs. This activity is meant to help students (and teachers alike!) gain an understanding of the amount of energy they consume in an average school day.

It will be necessary for you to find your local utility rates, and the amount of money your school spends on energy. The school's utility bills should include this information. It will be helpful for you to use a bill for the same month from last year. Using your school's total bill (electricity + gas) and the percentages given above, determine what your school spends on energy in the different categories. (For example, the lighting percentage (28%) x your school's total utility bill = the approximate amount spent on lighting for one month.)

If students are to use the school building for their maps (the alternative would be their homes or apartment buildings) they will need supervised access to water heaters, space heaters, the cafeteria, etc. Of course, you can make the area mapped as large (whole school district) or as small (one room) as is reasonable for your situation.

Procedure: 1) Students will need to be introduced to maps, and the idea of drawing to scale (if they have not already had instruction in this topic). Large-block graph paper can help serve this purpose.

2) It may be necessary to divide your students into working groups. One group will then be assigned a specific

area of the school building, the cafeteria, for example. A second group would then audit the library, while a third inspects the locker room and the gymnasium. It may be possible in some instances for each student to map the whole school--the choice is yours, and will be based on the amount of time and access you, as a class, have.

3) Have each student (or group) measure the area to which they have been assigned. These measurements should then be recorded for later use.

4) Have each group convert their measurements to scale. Remember--if students are working in separate groups, using the same scale will allow you to later piece the maps together for a large map of the whole school.

5) Students should then tour the area to be mapped with the following worksheet. They should carefully make note of every energy user they can find, noting the placement of each. (Don't forget the office! Copy machines and computers are a large source of energy consumption!) Encourage students to be thorough, and specific. "two fluorescent lights" is much better than "lights". A sample line has been filled in on the worksheet to help your students with their beginning efforts.

6) Students should now be given time to complete their maps.

7) Have students come together and report their findings to the rest of the class.
(If you find it necessary to use students homes instead of the school building for your maps you may find it difficult to gain classroom consistency, or a standard of measure. But, it is possible!)

8) Brainstorm with your students about ways in which the school might save energy.

Questions:

Do you think the people in the school realize how much energy they use each day? Did you before the start of this exercise? What areas of energy use surprised you the most? Of which were you the most aware?

Homes typically use more energy for heating and cooling; schools typically use more for lighting. Try to explain this difference. (Schools are often not occupied at night, allowing them to turn the heat down much more so than a house, while during the day more bodies in a classroom help keep the room warmer. Schools, adversely, have larger spaces that require lighting for longer hours than those spaces within a home.)

How can you, as an individual, or a class, help save energy at school? At home?

What If...???/ Extensions:

Have students repeat the mapping process with their homes. Have them compare the energy uses in the school vs. the energy uses at home.

Make posters about energy conservation, and ways that other students can contribute to the savings, and post them around the building.

Have students design and prepare a pamphlet instructing other students (and staff) on ways to conserve energy.

Looking for a writing assignment? Ask students to use their imaginations and write a creative essay about how they would spend the savings from their new-found energy conservation actions.

Energy Users Worksheet

Name(s):

Area Mapped:

Things That Use Energy	Energy Source	Renewable? Yes/No	Alternatives or Replacements
refrigerator in staff lounge	electricity	no	insulated lunch bags, personal coolers

Oil Embargo

Objectives: Students will be able to: 1) describe the distribution of oil reserves on a global scale, 2) describe the economic, social and political implications of this distribution (for the United States, and other cultures around the world), and 3) define the term "embargo", giving an example from United States history or current events.

Related Activities: Energy Debate (page 33), Policy! Policy? (page 36)

Skills Developed: geography, current events, analysis

Time Required: one 30-35 minute period

Key Vocabulary:

embargo: a suspension of trade, especially with respect to a particular good (Embargoes are often imposed by governments or trade organizations.)

export: (as a verb) to send goods out of the country for trade or sale to a foreign country; (as a noun) the good or resource that is exported

import: (as a verb) to bring in goods from a foreign country for trade or sale; (as a noun) the good or resource that is imported

nonrenewable: the opposite of a renewable resource, a source of energy that, once used, cannot be replaced as quickly as we use it (or even within our lifetimes) (Coal and oil formed under intense pressure for possibly millions of years, are prime examples of a nonrenewable resources. Radioactive elements used in nuclear fission would be another.)

OPEC: the Organization of Petroleum-Exporting Countries, namely: Ecuador, Gabon, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates, and Venezuela

renewable: non-depletable resources; typically viewed as a source of energy that can be easily and relatively quickly replenished or restored (Water is replenished with new rain, sunlight comes again with the rotation of the earth, and trees or biomass is grown anew within own lifetime. These are all examples of commonly thought of renewable resources.)

Materials:

five large flat-bottomed pans
empty film canisters (or other similar objects to represent oil barrels)
    Note: Most photography stores will supply these canisters either free of charge or for a nominal fee.
construction paper or fabric with which to construct flags
poker chips, or other tokens for trade
a large wall map of the world
pushpins or thumb tacks

Background:

In 1991, the United States **produced** an estimated **2.8 billion** barrels (each with a 42-gallon capacity) of crude petroleum. This figure represents 12% of the world crude production in that year. Still, the United States then needed to import $61.5 billion worth of crude oil to satisfy its energy demand. The distinction, then, must be made clear between **oil-producing** countries, and ones with **oil reserves** to export. While we, as a nation, **produce** oil, we have no significant **reserves** and must import to meet our demands.

The Natural Gas Industry and the Nuclear Commission have often cited our dependency on foreign oil in their efforts to gain a more wide-spread acceptance for their own energy sources. Indeed, being a country that consumes between one-fourth and one-third of the world's energy, dependence on an outside energy source could have long-lasting ramifications on our economic, social and political systems. With so much at stake, it becomes important for students to fully understand the import/export system and trade problems which may arise. This activity has been designed to allow your students to participate in an exciting day of crude-oil trade.

Procedure:

1) On a map of the world, have your students locate the major oil-producing countries of the world. These countries, for the most part, can be found listed in the **Key Vocabulary** section under "OPEC". Other petroleum-exporting countries (not participating members of OPEC) are Canada, Mexico, the United Kingdom, and the Virgin Islands and Puerto Rico. To help your students visualize clusters of petroleum-exporting countries, try using pushpins to mark these countries. Discuss any regional similarities that these exporting-countries might share.

2) Divide your students into groups, each group representing the following countries or regions:

Group A:	The Middle East (to represent all of OPEC)
Group B:	The United States (to represent an importing country with a high demand for oil, but with an ability to produce for themselves a percentage of their oil needs)
Group C:	Japan (to represent an importing nation with a relatively high demand for oil)
Group D:	Italy (to represent an importing nation with a modest demand for oil)
Group E:	India (to represent a third-world nation with limited access to oil trade)

3) Have students from each group research and construct the flag of the nation that they have been assigned to represent. This flag will later become their "home base". If time allows, students may also be asked to research the country's importing habits. What goods or resources must they import? In what quantities? For what purpose? From whom? Do they export significant quantities of other goods or resources?

4) Give each "country" a flat-bottomed pan. This pan will represent their petroleum "warehouse". The pan given to the Middle East should be filled with film canisters to represent oil barrels. Have students position their flags so that their identity is clear. "Countries" should also be given currency with which to trade. The poker chips (or other tokens) should be distributed according to the wealth of each individual nation. Industrialized nations should be given the greatest amount of tokens; developing or third-world nations, the least.

5) Assign each "country" the following daily oil needs: (These figures have been designed for this activity only. They should not be taken to represent actual usage or demand. Actual usage or demand should be researched by students in the step above!)

Japan.	Demands 10 barrels
United States	Demands 15 barrels, but can produce three of their own
Italy:	Demands 4 barrels
India:	Demands only 2 barrels, but because of their Third-World status, and their inability to access the oil market, they must be blindfolded for their search

6) Place the "Middle East" at the center of the playing area. Students assigned the Middle East will now be oil sheiks. They are in charge of distributing the oil barrels. Each round, the sheiks must try to sell the optimum number of 20 barrels. (You will note that 20 barrels will not completely satisfy the demands of the countries listed above!)

7) During each round of play (lasting from three to five minutes, depending on your judgement and your class' success at obtaining oil) each country must take barrels from the Middle East, back to their warehouses, one barrel at a time. Have students who have been assigned to the same country take turns picking up the barrels. If tagged at any time by an Oil Sheik, that tag will signify a temporary reduction in exports; the tagged country must return home empty-handed for a count of ten before reentering the game. At any time during the round of play, the Middle East may call an "embargo" (a refusal to trade any further). A full thirty seconds must then pass before any trading may resume. Remind students of their individual goals: The Middle East is trying to sell 20 barrels of oil. Each country is trying to fulfill its own energy demands. To start, each barrel may only sell for **one** token.

8) At the end of the round, note and record the number of barrels with which each country has ended. Record the number of barrels traded by the Middle East. Have students pay particular attention to the countries whose demands were met vs. the countries not able to satisfy their own demands.

9) Repeat the round, if desired. This time, though, try making the price of each barrel a variable. Assume that OPEC has gathered to renegotiate the price of crude, and a country's ability to obtain energy will now depend on the money that each country is willing (or able) to spend. The oil sheiks still have the same goal: to sell an optimum number of 20 barrels, but this time, **for the most amount of money!**

10) As this round finishes, discuss any disparity between the countries' energy demands, and their ability to get these demands met.

Questions:

Why was the word "demands" used throughout this activity (i.e. Japan **demands** 10 barrels of oil) instead of the word "needs"?
How do needs, wants, and demands differ?
Do we, as a nation, really **need** all the crude oil that we **demand**?
Obviously, not all "demands" could be met if the Middle East (representing all oil-exporting countries) continued to sell 20 barrels per day. What alternatives exist for countries not able to satisfy their demands for crude?
What alternatives exist for the Middle East?
Assume that a country could not get its energy demands met. What effects (political, social or economic) would this have on that country?
Crude petroleum is a non-renewable resource. What implications does this have for the future of the Middle East (petroleum-exporting countries)? For the energy future of importing countries?

Extensions:

See "Energy Debate" on page 33 and "Policy! Policy?" on page 36.

Whether Weather

Objective:

Students will be able to: 1) interpret weather information from printed weather maps, 2) trace weather patterns from a collection of maps, 3) using the patterns discerned from this map collection, predict future weather patterns, and 4) identify the effect these weather patterns have on the movement of air-borne pollutants.

Related Activities:

What's In Our Air? (page 55), Energy Debate (page 33), Policy! Policy? (page 36)

Skills Developed:

observation, classification, inference development, predicting, mapping

Key Vocabulary:

front: the boundary between two masses of air that differ in temperature or density
cold front: the forward edge of a cold air mass advancing into a warmer air mass
warm front: the forward edge of an advancing mass of warm air replacing colder air
stationary front: a front that is not moving, or is moving slower than five mph
jet stream: any of several bands of high-velocity winds moving from west to east around the earth
high pressure system: a mass of moving air with a high barometric pressure; usually associated with fair weather
low pressure system: a mass of moving air with a low barometric pressure; usually associated with storm fronts

Time Required:

one week's collection time
one 30-45 minute period

Materials:

newspaper weather maps for a consecutive seven day period
a wall map (preferably a topographic map)
copies of blank maps of the United States
copies of blank maps of the East Coast
colored pencils or crayons

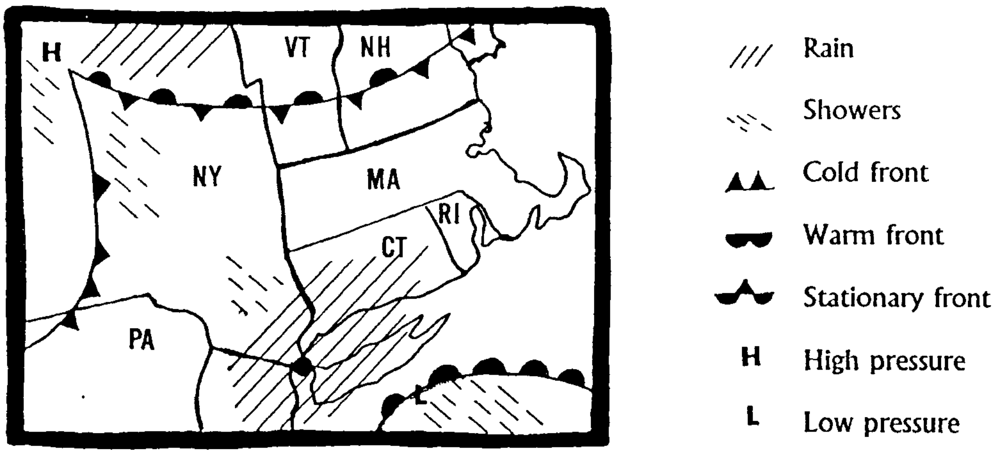
Background:

When the nuclear reactor technicians at the Chernobyl Nuclear Power Plant in the former Soviet Union lost control of the reactor's core temperature, leading to the worst nuclear disaster in world history, people, watching from every corner of the world, were justifiably concerned. Nuclear power has always carried with it a certain curiosity and a certain fear that warrants attention. When the nuclear fallout covered the town of Chernobyl, the world watched sadly. When this fallout was detected hundreds of miles away in other Soviet towns, the world was sympathetic. When this very same fallout was detected **thousands** of miles away along the coast of Sweden, however, the world was forced to take note once more. Weather patterns, much charted and easily predictable, had carried this fallout across governmental and cultural boundaries.

While the Chernobyl reactor accident is an isolated incident, the flow of air currents and movement of air-borne pollutants is not. Each day, as the jet stream moves from west to east in the United States (and in varying polar directions around the globe), air masses (and their contents) are being pushed along with it. There is a phrase among environmentalists that states: "We all live downwind". Simply put, our air has to flow from somewhere. Therefore, the actions of those who live "upwind" from us will directly affect the quality of the air we breathe. Likewise, our actions will have direct influence on the air of those "downwind" from us.

This exercise is designed to help your students accept the fact that their individual and collective actions will effect other people in other places. The RIGHT to clean air comes with the RESPONSIBILITY to keep it clean for others!

WEATHER MAP



Procedure:

1) Have your students locate and collect weather maps from area newspapers. These maps should cover a consecutive seven-day period for the same general location. (If it is not practical to have each st[illegible]nt make their own collection, try collecting one per group of students, or you, yourself can collect these map[illegible]d show them using overhead transparencies.)

2) Before beginning their study o[illegible]er patterns, students should draw land features on their blank maps of both the United States and the East Coast. Large bodies of water, mountains, large river valleys and other similar land features all have a tremendous effect on local weather. Locating and identifying these features will help students in their later predictions.

3) Once students have collected and ordered their maps, have them identify the symbols used. Cold, warm and stationary fronts all carry with them certain weather patterns, which can be detected on these maps.

4) Next, have your students chart the movement of weather from west to east. (Or from south to north if that is the case.) On their map of the United States (that should now contain their own placement of land features), have students draw the general movement of weather as they have discovered it to be.

5) Do the same with the local maps.

6) Using political maps have students identify towns and cities that are in the path of their weather flow pattern What cities are located **before** New York City (and its metropolitan area) on these maps? Which cities are located **after** New York City?

Questions:

Are there any major land features surrounding New York City that affect the city's weather pattern? If so, what are they?

What cities (or areas) are located "upwind" from New York City? What does this mean to the residents of New York City?

What cities (or areas) are located "downwind" from New York City? What does this mean for the residents of **that** city?

How will a stationary front affect the movement of air-borne pollution from New York City?

Extensions:

Have students locate Chernobyl on a map of the former Soviet Union. From newspaper and magazine articles, and weather maps, have your class chart the movement of nuclear fallout from Chernobyl to Western Europe. (Practically any city for which weather maps are available can be used as a substitute, or for additional map work.) Research the pros and cons of nuclear power. Stage a debate based on the information collected. (See "Energy Debate" on page 33). *For your consideration: the area currently known as Byelorussia (or Belorussia), the land mass northwest of the Ukraine, near which is located the city of Chernobyl, now has a land area 10% of its former size that is completely uninhabitable due to nuclear fallout. Estimates are given that it will stay in this desolate state for approximately 6000 years!* Discuss with your students the ramifications of the dissolution of the Union of Soviet Socialist Republics (U.S.S.R), and more recently, the break up of the country of Russia into smaller countries based on ethnic boundaries. Who is now left with the effects (economic, social, and health, among others) and consequences of the Chernobyl accident? With a current map, compare the old political boundaries with the new.

There is a similar phrase: "We all live downstream." Have students select a major river (studying the Hudson River will allow students a first-hand look!), following that river from source to mouth. What major cities or industrial centers are located along the way? Research any pollution problems associated with the river, as well as any clean-up efforts.

For a year-long project, have students follow the current events regarding the polluting and clean-up efforts associated with the Hudson River.

What If...???

...there were no governmental regulations regarding the amount or type of substances that individuals and companies could release into the air or water? Research these regulations (see The Clean Air Act, for one). Have students write essays, agreeing or disagreeing with these regulations. See "Policy! Policy?" on page 36 for further discussion on governmental policies.

Glossary of Energy-Related Terms

absorption: taking in by chemical or molecular action, typically associated with heat

BTU: (British Thermal Unit) a commonly used measure of energy, equal to the energy stored on one match tip

by-product: a substance formed as a side result (not the main goal or desired product) of an action or chemical reaction

carbon dioxide: a colorless, odorless gas formed during respiration, combustion and organic decomposition and used in food refrigeration and aerosols

carbon monoxide: a colorless, odorless, extremely poisonous gas formed by the incomplete burning of carbon substances, including gasoline

car-pool: an arrangement whereby several commuters travel together in one car, sharing the costs and usually taking turns providing the car

chemical energy: energy obtained from the breakdown or combining of bonded substances, such as the digestion of food

collector: any of a wide variety of devices used to collect solar energy and convert it to heat

conduction: the movement of heat through a solid material, or from solid to solid

convection: the movement of heat through a fluid or liquid

conversion: the changing from one form into another, such as the changing of running water (kinetic energy) into electricity (hydroelectric energy)

conservation: controlled use and protection of natural resources; the act of using carefully to avoid waste

contaminants: substances that make something impure by contact of mixture

depletion: the act of using or exhausting an energy source

development: the act of making more available or effective, or the act of bringing into being (as in "the development of new energy sources")

efficient: producing effectively with a minimum of waste or unnecessary effort

energy: the ability to do work

filament: a fine wire heated to a glow in an electric bulb

First Law of Thermodynamics: the name of the physical law that states "Matter can neither be created nor destroyed, only changed from one form to another."

fluorescent: a light generated by the output of electromagnetic radiation

fuse: a device containing an element that protects an electric circuit by melting when overloaded

greenhouse effect: the sequence of events involving the absorption of solar radiation by the earth, its change and re-emission in the form of infrared radiation. This infrared radiation is absorbed and prevented from escaping the atmosphere by water vapor and greenhouse gases. This absorption results in the steady and gradual rise in temperature of the atmosphere

greenhouse gas: any one of the known gases that are found to contribute to the greenhouse effect

heat: a form of energy associated with the motion of molecules (not the same as temperature, which is a measure)

hydroelectric power: electric power generated by the conversion of the energy of running water

kilowatt: a unit of energy, often a measure of the amount of energy used, expressed as kilowatt hours or Kwh

kinetic energy: energy due to motion or movement

lumen: a measure of the amount of light given off by an object, equal to the intensity of one candle

man-made pollution: pollutants that are the direct result of man's activities

natural pollution: pollutants that have a naturally-occurring source, such as a volcanic eruption spewing ash

net energy: the amount of energy left to a system after all of the transfers and conversions have taken place

nonrenewable resource: the opposite of a renewable resource, a source of energy that, once used, cannot be replaced as quickly as we use it (or even within our lifetimes). (Coal and oil formed under intense pressure for possibly millions of years, are prime examples of a nonrenewable resource. Radioactive elements used in nuclear fission would be another.)

ozone: (not to be confused with ozone layer) a common gas, related to pure oxygen, found in the air

ozone layer: also known as the ozonosphere; a region of the upper atmosphere that absorbs and protects the earth from damaging ultraviolet radiation

particulate: small particles in the atmosphere that contribute to air pollution; these particles can be both naturally occurring and man-made

radiation: the movement of heat through a gas

rate of use: the speed with which a resource is being used, expressed in relation to the total amount available

renewable resource: non-depletable resources; typically viewed as a source of energy that can be easily and relatively quickly replenished or restored. (Water is replenished with new rain, sunlight comes again with the rotation of the earth, and trees or biomass is grown anew within our lifetime. These are all examples of commonly thought of renewable resources.)

Second Law of Thermodynamics: the physical law that states "no energy conversion is 100% efficient". Energy is always "lost", that is, changed into a non-usable form, along the way

solar energy: radiation from the sun which can be used to heat and cool

strip mining: a mining operation in which coal seams run close to the ground and are reached by the removal of topsoil and overburden (rock, ground cover, including grasses and trees, or any other material that may cover the coal deposit

system: a group of interdependent elements (elements working and relying on each other) to form a complex whole

temperature: the measure of the amount of heat, or lack of (cold), of an object or substance

thermal energy: energy that is in the form of heat, or due to the presence of heat

transfer: the movement of energy from one position place, or system to another

underground mining: a mining operation in which tunnels and supports are constructed below the surface of the earth, leading to a coal seam. Disturbance of the surface of the earth occurs only at tunnel entrance sites, and mining headquarters

watt: a unit of power, often measured in the thousands, as in kilowatts

References and Resources

The Acid Rain Foundation, Inc.
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The Alliance To Save Energy
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American Council for an Energy Efficient Economy
1001 Connecticut Ave., NW Suite 535
Washington, D.C. 20036

American Forest Council
1250 Connecticut Ave, NW Suite 320
Washington, D.C. 20005
(202) 463-2455

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Golden, CO: Fulcrum, Inc.

California Energy Extension Services
Sacramento, CA
(916) 323-4388

ConEdison
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4 Irving Place
New York, NY 10003
(212) 460-4600

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22nd Annual Report
Superintendent of Documents
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Washington, D.C. 20402-9328

Department of Environmental Conservation
Region 3 Office
21 South Putt Corners Road
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Detroit Consumer Affairs Dept.
1600 Cadillac Towers Building
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Environmental Defense Fund
257 Park Avenue South
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Environmental Protection Agency (EPA), Public Information Center
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401 M. St., SW
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Federal Energy Regulatory Commission
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Global ReLeaf
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Washington, D.C. 20013

Global Tomorrow Coalition
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381 Park Avenue, South
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Boston: Houghton Mifflin Company

The Institute for Earth Education
P.O. Box 288
Warrenville, IL 60555

Long Island Lighting Company (LILCO)
Consumer Affairs Division
15 Park Drive
Melville, NY 11747
(516) 755-6031

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The National Arbor Day Foundation
100 Arbor Avenue
Nebraska City, NE 68410

The NEED Project (National Energy Education Development)
P.O. Box 2518
Reston, VA 22090

NYS Department of Health
Center for Environmental Health
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Orange and Rockland Utilities, Inc.
One Blue Hill Plaza
Pearl River, NY 10965

Renew America
1400 Sixteenth St., NW
Suite 710
Washington, D.C. 20036
(202) 232-2252

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1-800-456-1197

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26 Church Street
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U.S. Department of Education
Energy and Education Action Center
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U.S. Department of Energy
Office of Public Affairs
Washington, D.C. 20585

U.S. Environmental Protection Agency
26 Federal Plaza, Room 900
New York, NY 10278
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The University of the State of New York
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Albany, NY 12234

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The Worldwatch Institute
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Washington, D.C. 20036

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
HUMAN SUBJECTS REVIEW

Date: 06-02-95 **IRB#:** GU-95-008

Proposal Title: THE DEVELOPMENT OF AN ENERGY EDUCATION CURRICULUM GUIDE AND THE EVALUATION OF TEACHERS' PERCEPTIONS OF THE EFFECTIVENESS OF THIS GUIDE

Principal Investigator(s): Ted Mills, Christine Lalonde

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

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ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Reasons for Deferral or Disapproval are as follows:

Signature: John H. Wyckoff Date: June 5, 1995

Chair of Institutional Review Board

VITA

Christine Marie Lalonde

Candidate for the Degree of

Master of Science

Thesis: THE DEVELOPMENT OF AN ENERGY EDUCATION CURRICULUM GUIDE AND THE EVALUATION OF TEACHERS' PERCEPTIONS OF THE EFFECTIVENESS OF THIS GUIDE

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