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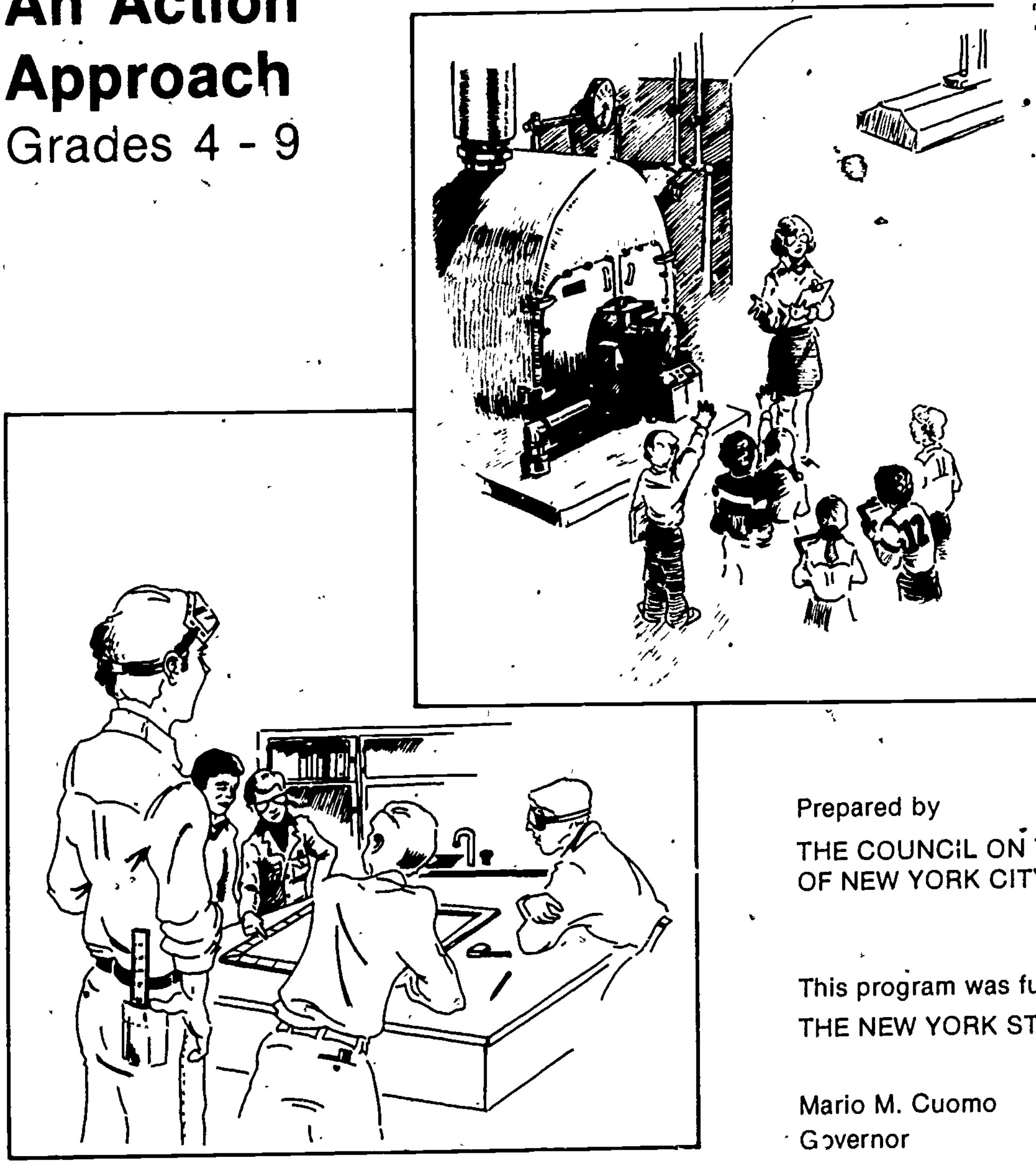
ABSTRACT

Seventeen lessons are provided in this curriculum designed to involve students (grades 4-9) in energy conservation. The lessons are presented in four parts. The three lessons in part I are intended to give students a preliminary conceptual framework for energy conservation and to motivate them to participate in the conservation-action projects which follow. Part II consists of one lesson, an electricity conservation project for the classroom. Students sharpen mathematical skills while learning how much electricity daily classroom lighting consumes and how much could be saved by reducing lighting. The three lessons in part III take the student's lessons in the classroom electricity project and enrich them with experiences in the school building, neighborhood, and home. The remaining 10 lessons and activities in part IV are meant to directly or indirectly reinforce the attitudes, actions, and concepts developed in the first three parts of the curriculum, but which can stand alone as meaningful educational activities. Topics include electricity, energy forms/conservation, alternative energy models, energy careers, and the history of energy. Although the curriculum is basically geared for grades 4-9, teachers of early childhood and high school grade levels will also find specific lessons or experiences adaptable to their classes. (JN)

ENERGY CONSERVATION EDUCATION

An Action Approach

Grades 4 - 9



Prepared by
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OF NEW YORK CITY

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ENERGY CONSERVATION EDUCATION

An Action Approach

Prepared By

The Council on the Environment of New York City

Michael Zamm
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TABLE OF CONTENTS

INTRODUCTION

The need for energy conservation is urgent. We are using up our petroleum and natural gas resources, and the price of oil is rising. It is essential that our educational systems help develop energy conservation conscious citizens.

The U.S., with only 6% of the world's population is using annually approximately one-third of the energy consumed in the entire world. By 1990, it is estimated that the average American family will spend 20% of its income -- one dollar in every five -- for energy.

This curriculum is designed to involve students in energy conservation. Teachers who use the curriculum will give their students the opportunity to study and conserve energy in the classroom, school building, school neighborhood, and home. The students will develop basic mathematics, writing, and other skills while engaging in projects which actually result in lowered energy use and costs. Parents, too, can participate in these energy and money saving efforts.

The curriculum is flexible; teachers can use any approach appropriate in implementing those parts of the curriculum applicable to their classes.

INSTRUCTIONS

1. The introductory lessons in Part I present an initial set of experiences for classes beginning the study of energy and energy conservation.

2. Part II is an electricity conservation unit comprised of lesson #4, an energy conservation log, a kilowatt hours savings graph, and six energy conservation worksheets. You can make copies of the log, graph, and worksheets for each student by photocopying the pages or by using them to make stencils or spirit masters.

3. While the curriculum is basically geared for grades 4-9, teachers of early childhood and high school grade levels will also find specific lessons or experiences adaptable to their classes.

There is no specific time or conceptual sequence for carrying out the lessons. Teachers should proceed in a manner they feel is appropriate for their students and do whatever lessons they wish in whatever order they see fit.

4. The Glossary Contains useful definitions of many terms used in the curriculum. The list of Energy Information Sources has names and addresses of agencies and groups which provide general energy information and educational materials.

5. IN ORDER TO EVALUATE THE EFFECTIVENESS OF THIS CURRICULUM, EACH TEACHER WHO USES IT IS ASKED TO PLEASE RETURN THE FEEDBACK SHEET ON THE FOLLOWING PAGE TO:

NEW YORK STATE ENERGY OFFICE
Office of Communications
Two Rockefeller Plaza
Albany, NY 12223

FEEDBACK SHEET

Please return this sheet to the New York State Energy Office after you've filled it out.

NAME ________________________________

SCHOOL ________________________________

ADDRESS ________________________________

____

GRADE __________ NUMBER OF CLASSES __________

DISTRICT ________________________________

Place a check in the appropriate column. Answer only those questions which relate to activities your class participated in.

Part I: Program Introduction	POOR	FAIR	SATIS.	GOOD	EXCELLENT
1. Was the instruction sheet adequate?	____	____	____	____	____
2. Were the introductory lessons adequate as preparation for both the electricity conservation project and the rest of the curriculum?	____	____	____	____	____

Comments for Part I: ________________________________

____

____

____

____

Part II: Electricity Conservation Project

1. Did the class participate?
____ Yes ____ No

Part II: Electricity Conservation Project	POOR	FAIR	SATIS.	GOOD	EXCELLENT
2. Were the activities suitable for your students?	____	____	____	____	____
3. Did the children develop positive energy conservation attitudes as a result of the project?	____	____	____	____	____
4. Did students improve math skills?	____	____	____	____	____
5. If you carried out the lighting conservation project and kept records, how many kilowatt hours did you save?	____	____	____	____	____

Comments for Part II: ________________________________

____

____

____

____

Part III	POOR	FAIR	SATIS.	GOOD	EXCELLENT
A. Energy Walks in School and Neighborhood					
1. Were these walks logical follow-ups to the classroom electricity conservation project?	___	___	___	___	___
2. Were you able to map the neighborhood?	___	___	___	___	___
3. Did the children gain a greater understanding of natural energy systems?	___	___	___	___	___
B. Parent-Child Home Checklists					
1. Were you able to motivate parents to fill out checklist?	___	___	___	___	___
2. Were you able to make copies of the checklists or did the children write the information in their notebooks?	___	___	___	___	___

Comments for Part III: ____________________

____

____

____

____

Part IV - Enrichment Lessons

	POOR	FAIR	SATIS.	GOOD	EXCELLENT
1. Were these lessons applicable to your class level?	___	___	___	___	___
2. Were they helpful in providing more in-depth experiences concerning certain basic concepts?	___	___	___	___	___

3. How many of these lessons did you complete? Number ____________

Comments for Part IV: ____________________

____

____

____

____

Final Evaluation

1. How many lessons from the entire curriculum did you complete with your class? ____________

	POOR	FAIR	SATIS.	GOOD	EXCELLENT
2. Did your class enjoy the program?	___	___	___	___	___
3. Did you feel this program was a valuable educational experience?	___	___	___	___	___
4. How would you rate this environmental education program?	___	___	___	___	___

Comments: ____________________

____

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PART I

An Introduction to Energy Conservation

Note to Teachers: The introductory lessons on energy are intended to give the students a preliminary conceptual framework for energy conservation and to motivate them to participate in the conservation-action projects which follow. More in-depth lessons on energy can be found in Part IV. Advanced or older students may want to skip Part I and proceed directly to Part II. Some teachers may feel it is necessary to involve their students in the lab lessons in Part IV in preparation for the electricity conservation project in Part II.

Lesson #1: WHAT IS ENERGY

AIM: To define energy.

MOTIVATION: "Who can pull the window shades shut?": Choose a few children to pull down all the shades at once. Ask the children to open and pull down the shades a few times.

MATERIALS: The classroom environment.

DEVELOPMENT:

1) Ask the class, "What changes occur in the room?" (Changes occur in the amount of light and heat that enters the classroom.)

2) Ask the children who performed the task if they feel tired from pulling the shades up and down.

3) Ask one of the students to walk over to the light switch and turn one or more switches off; then have the switches turned on.

4) "What do we call the strength we need to be able to pull the window shades up and down?" (Energy)

5) "What made the light bulbs work when the switch was turned on?"

6) "Can you think of other things that we need energy for?" (Home heating, hot water, stoves, televisions, cars, etc.)

7) "What is energy?" (Energy is the ability or capacity to work. Energy is the power by which anything moves itself or something else, or acts upon other things.)

8) Use examples to explain the definition of energy:

a) Hold up a rubberband and ask a student to pull it taut. Ask the children the difference between the loose and taut rubberband -- the taut rubberband was pulled, i.e., work was done. Work can be defined here as a push or pull over a distance. Which rubberband has more energy? (Taut rubberband)

b) Wind up a toy that has a coiled spring and ask the children how the energy got into the toy. (I tightened the coil and now the toy can work/move.)

SUMMARY: "What is energy?"

HOMEWORK:

a) Have the students list in their notebooks some of the things they use every day that require energy.

b) Ask them to draw energy users or to cut pictures of them out of newspapers or magazines.

Lesson #2: SOME COMMON SOURCES AND TYPES OF ENERGY

AIM: To learn about some sources and types of energy. (Lesson 9 in Part IV is more in-depth experimental treatment of the various types of energy.)

MOTIVATION: Ask the students to rub their hands together very hard. "What do we call this type of energy?" (Heat energy).

MATERIALS: Notebook and pencil.

DEVELOPMENT:

1) "What type of energy makes light bulbs produce light?" (Electricity or electrical energy) Start a list on the blackboard like the one on page 4.

2) "Do any of you know what we usually use to make electrical energy or as a source of electrical energy?" (Oil, coal, natural gas, water, uranium)

3) "What structures use these natural substances to produce electricity?" (Power plants)

4) "Oil, coal, natural gas also are often used as fuel to produce heat energy to heat our homes or schools in the winter. The sun, too, is used for this purpose."

5) "What man-made device uses these fuels to provide us with heat energy in school or at home?" (The boiler)

6) "What type of energy lighted our room when we raised the shades?" (Light energy from the sun)

7) "What type of energy did it take to open and close the shades?" (Mechanical energy)

8) "Where did we get this energy from?" (Our own bodies) Ask the students to name some simple machines that use mechanical energy. (Pencil sharpeners, lever)

9) "Everyone clap your hands together at once. Again. Our hands produce sound energy. What else produces sound energy?

10) "Has anyone read about the energy that we get from the splitting of atoms?" (Atomic energy)

11) Have the students complete and copy in their notebooks the listing of the types of energy and their natural and man-made sources.

SOURCES OF ENERGY

Types of Energy	Natural	Man-Made
Electrical	Oil, coal, natural gas, water, sun, etc.	Power plants (oil-fired, coal-fired hydroelectric, etc.)
Heat	Sun, human body, oil, coal, natural gas	Boiler...
Light	Sun, oil, coal, natural gas	Power plants (oil-fired, etc.)
Mechanical	Wind, water, human body	Lever, pulley, pencil-sharpener ...
Sound	Human voice ...	Saw, pencil-sharpener, musical instruments...
Atomic	Uranium	Nuclear power plant

HOMEWORK: Study your energy chart. "Are there any other types or sources that you can add?"

NOTES:

1) The division of energy sources into natural and man-made brings us to the principle of energy conservation and the idea of energy conversions. (See Follow-up to Lesson 6 and Lesson 9)

2) Have the students save their list for use in future lessons.

Lesson #3: THE IMPORTANCE OF ENERGY AND ENERGY CONSERVATION

AIM: To understand the importance of energy and energy conservation.

MOTIVATION: Ask a few of the students to turn off all lights and pull down the shades. Then ask the class to sit quietly in their seats. If possible, lower the thermostat.

DEVELOPMENT:

1) "Would we be able to do our work without any light at all?"

2) "What would happen if there was no oil or coal to give us the energy to keep our buildings and ourselves warm in the winter?"

3) "What about the trains, boats, planes and cars - could they then transport us without the energy from oil?"

4) "Suppose our bodies didn't have mechancial energy or heat energy to keep us warm?"

5) "Could people, animals, and plants survive without light and other types of energy from the sun?"

6) "Why is energy so important to us?"

7) "What are some of the natural sources of energy man uses?" (Oil, coal, natural gas, sun, water, wind, uranium, etc.)

8) "Do any of you know which of these sources we use the most?" (Oil, natural gas, coal)

9) Tell the class that the world is using up its supplies of oil and natural gas.

10) "What do we have to do to make sure we have enough energy for the future? It's the same thing you do when you save some money you've earned or been given so that you'll have enough for the future." (Save energy. Saving energy is called energy conservation.)

11) "We also have to develop and use other sources of energy: the sun for instance." (See lessons related to solar in Part IV)

SUMMARY: Why is energy conservation important?

HOMEWORK: Have the students add to the list of energy conservation possibilities in their home and classroom.

PART II

Electricity Conservation in the Classroom

An electricity conservation project is an excellent way for students to conserve energy. Lighting by electricity is one of the main types of energy used in the classroom and the type most under immediate, direct student control. For example, lighting represents 60% of all electricity used in New York City Schools[1] and nearly 40% of electric power usage in America. It is estimated that conservation could cut lighting use by 30% in New York City public schools alone without impairing vision or the educational process; total electricity use in the city schools could thereby be reduced 15-20%.[2] Schools in most sections of New York State and the entire U.S. can reap equivalent savings.

Using the graph, the log, and the worksheets, students can use and sharpen mathematics skills while they learn how much electricity daily classroom lighting consumes and how much money could be saved by reducing lighting. The exercises can be introduced through the lesson sequence in this curriculum booklet or can be applied in several other ways, depending on the ability level of the class, their experience with conservation concepts, and the teacher's own style of classroom management. Students can participate in the conservation activities without doing the computations if the math is too difficult. The teacher may want to involve advanced students in Lessons 8. 9, and 10 (Part IV) before, during, or after the lighting project. A study of significant terms, e.g., watt, kilowatt, etc., can also be undertaken if the teacher feels it is appropriate (see Note 1 and Glossary). Other teacher-prepared lessons, audio-visual presentations on electricity, and workshops on lighting conservation can be integrated into the study.

Lesson #4: A CLASSROOM ELECTRICITY CONSERVATION PROJECT

AIM: To develop and implement a classroom electricity conservation project. (please read all Notes after the lesson carefully.)

MOTIVATION: "What do we call the type of energy that makes a light bulb produce light?" (Electricity)

MATERIALS: Notebook, the 8½ by 11" energy conservation log and graph and the worksheets which can be duplicated by using stencils, copying machine, etc.

DEVELOPMENT:

1) "Do you remember what it was like when we turned all the light off?"

2) "What other things use electricity?" (Radio, clocks, refrigerator, television, etc.)

3) "What did we say were the main sources of energy man uses to generate electricity?" (Oil, coal, natural gas, etc.)

4) Explain or elicit from the students that much of the electricity used in classrooms is produced by burning oil. (See Note 2)

5) "What will happen if we use too much electricity?" (We'll waste oil and other energy sources, and maybe run out of them altogether.)

6) "What was one of the energy sources which we said we were using up and which is costing us more and more money?" (Oil)

7) "What is one very good way of using less oil, natural gas, coal, etc." (Conserve electricity)

8) "What is one of the best ways of conserving electricity in our classroom?" (Turning off the lights when we don't need them)

9) Ask students for lighting conservation suggestions. Elicit the strategy of turning off the lights closest to the windows on sunny days and using the light energy of the sun.

10) Begin using the log and worksheets. (See Notes)

TEACHER INFORMATION NOTES

1) KILOWATT HOURS ARE DERIVED BY USING THE FORMULA:

$$KWH = \frac{WATTS \times HOURS^*}{1{,}000}$$

This formula is necessary to derive the weekly total of kilowatt hours conserved on the energy conservaton log. The addition of these weekly totals provides the numbers for the kilowatt hours graph. This is all the math necessary to figure out actual electricity conserved.

Energy conservation worksheets A and B provide the math that is the basis of the kilowatt hour savings for a year long project. Sheets C to F cover savings in money, oil, and coal. If necessary you can conserve lighting without doing these calculations. Students can simple fill in "the dates" and "the hours the lights were turned off" sections of the log. The kilowatt hours graph can then be used as a visual representation of electricity savings, with specific KWH totals ignored.

Classes that use the worksheets should do so in sequence (e.g. worksheet A, B, C ...) since one sheet often depends on answers to previous questions on the same or preceding sheets. See Note 1 at the end of Sheet A.

To fill in the worksheets and charts it may be helpful to understand the relationship between watts and kilowatts versus watt hours and kilowatt hours. Watts and kilowatts are units of power, describe the rate of energy flow. Watt hours and kilowatt hours are units of energy. A 100 watt bulb does not have any specific quantity of energy associated with it: If it is burned for half an hour, it will consume 50 watt hours; if it is burned for one hour, it will burn 100 watt hours; and if it is burned for 10 hours, it will burn 1,000 watt hours or 1 kilowatt hour. There is no such thing as burning a watt or kilowatt of electricity.

2) Much of the electricity used in New York City classrooms is produced by the burning of oil by Con Edison. The 10¢ kilowatt hour figure used in the sheets is an approximate total cost of electricity as provided by Con Edison to NYC and Westchester residents. The figure is somewhat lower for Con Edison's commercial and public customers like schools but the 10¢ figure is used for the purposes of simplicity and consistency and is higher for residential customers, especially during the summer. In other parts of New York State and the U.S. the rate is lower. Teachers should find out the rate for their area.

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* Top half of this formula corresponds to the total watt/hrs. saved calculation on Energy Conservation log.

3) Again using NYC as an example, approximately 75% of the city public schools use fluorescent lighting. There are several fixture patterns. Most public school fixtures have 4 ft. bulbs (40 watts - 2 or 4 bulbs per fixture) or 8 ft. bulbs (80 watts - 2 per fixture) usually arranged in three rows, sometimes two. The teacher and class can simply count the number of fixtures and the bulbs per fixture and, if in doubt, ask the custodian or school administration what the length and wattage of the bulbs are. The fixture ballast also uses a certain amount of wattage but that is not included in the sheet calculations for the sake of simplicity. In the average school the ballast usually accounts for an additional 30 watts over the normal 160 watt fixture. Teachers who wish to include the wattage from the fixture ballast in their calculations should use the average or ask the custodian for the exact amount of watt hours used by the ballast. The class should turn off, whenever possible, the row of lights near the window, which will most often represent 1/3 of the lights in the room. If a room has only two rows, then the computation on the sheets will be done on the basis of conserving 1/2 of the lights when possible. There are several other wattages and fixture patterns and adaptations will have to be made for them. The same is true for classrooms with incandescent lighting.

4) Although a basic answer sheet could not be provided due to the variety of lighting patterns, most of the questions on the sheets contain a reference in parenthesis to answers in previous questions that are needed to answer the present questions.(See Notes on sheet A)

These notations are included in the curriculum for teacher use. Teachers can decide whether to put notations on any duplicating mechanism used for student copies. Good math students and upper-grade students may want to tackle not only the computations but also the challenging mental exercises involved in finding out which previous answers are a basis for the current question.

DAILY ENERGY CONSERVATION LOG

School ____________ **Class** ____________

DATE	HOURS LIGHTS TURNED OFF	WATTS PER HOUR SAVED	TOTAL WATT /HRS. SAVED

Weekly Total in Watt /Hrs. Saved = ________ **Weekly Total in Kilowatt/Hrs. Saved =** ________

School ____________ **Class** ____________

DATE	HOURS LIGHTS TURNED OFF	WATTS PER HOUR SAVED	TOTAL WATT /HRS. SAVED

Weekly Total in Watt /Hrs. Saved = ________ **Weekly Total in Kilowatt/Hrs. Saved =** ________

School ____________ **Class** ____________

DATE	HOURS LIGHTS TURNED OFF	WATTS PER HOUR SAVED	TOTAL WATT /HRS. SAVED

Weekly Total in Watt /Hrs. Saved = ________ **Weekly Total in Kilowatt/Hrs. Saved =** ________

School ____________ **Class** ____________

DATE	HOURS LIGHTS TURNED OFF	WATTS PER HOUR SAVED	TOTAL WATT /HRS. SAVED

Weekly Total in Watt /Hrs. Saved = ________ **Weekly Total in Kilowatt/Hrs. Saved =** ________

School ____________ **Class** ____________

DATE	HOURS LIGHTS TURNED OFF	WATTS PER HOUR SAVED	TOTAL WATT /HRS. SAVED

Weekly Total in Watt /Hrs. Saved = ________ **Weekly Total in Kilowatt/Hrs. Saved =** ________

School ____________ **Class** ____________

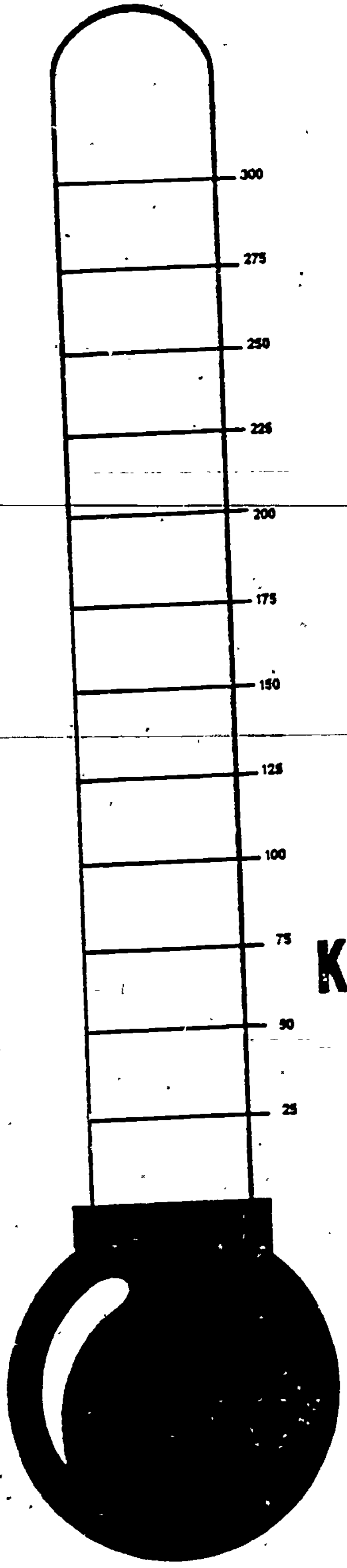
DATE	HOURS LIGHTS TURNED OFF	WATTS PER HOUR SAVED	TOTAL WATT /HRS. SAVED

Weekly Total in Watt /Hrs. Saved = ________ **Weekly Total in Kilowatt/Hrs. Saved =** ________

Graphics courtesy of CON EDISON

KILOWATT HOURS WE HAVE SAVED SINCE

(DATE)



KILOWATT HRS.

Graphics courtesy of CON EDISON

SCHOOL ____________________ NAME ____________________

CLASS ____________________ DATE ____________________

COUNTING WATT HOURS AND KILOWATT HOURS IN THE CLASSROOM FOR A DAY, WEEK, AND YEAR

Worksheet A

1. How many rows of lights are in your classroom? ________
2. How many light fixtures in each row? ________
3. How many light fixtures are in your classroom? (A.1 x A.2) ________
4. How many light bulbs are in each fixture? ________
5. How many light bulbs are in your classroom? (A.3 x A.4) ________
6. If each fluorescent bulb is either 40 watts (4ft.) or 80 watt (8ft.), how many watts are there per fixture? (A.4 x number of watts per bulb)* ________
7. How many watts** are there in all the fixtures in your classroom? (A.3 x A.6) ________
8. If each 40 watt (4ft.) or 80 watt (8ft.) bulb burns 40 or 80 watt hours each hour, how many watt hours does each bulb burn in a school day of 6 hrs? (6 x number of watts per fixture) ________
9. How many watt hours does each fixture burn in a school day? (6 x number of watts per fixture) ________
10. How many watt hours are burned during a 6 hour school day by all the fixtures in the classroom? (6 x A.7) ________
11. If the number of kilowatt hours is arrived at by multiplying the number of watts by the number of hours used, and dividing by 1000, how many kilowatt hours are used by your classroom during a school day? $\left(\frac{A.10}{1000}\right)$ ________
12. During a school week, when the lights are on 6 hours a day for 5 days, how many kilowatt hours are used? (5 x A.11) ________
13. If there are 180 school days*** in a school year, how many weeks in a school year? $\left(\frac{180}{5} = 36\right)$ ________
14. How many kilowatt hours does one classroom use in a school year? (A.12 x A.13) ________

WORKSHEET NOTES

A.1 means the answer to question 1 on energy conservation worksheet A; C.5 would signify the answer to question 5 on energy conservation worksheet C. (A.1 x B.2), for example, means that it is possible to derive the answer to the present question by multiplying the answer to question 1, sheet A by the answer to question 2, sheet B.

* For incandescent lit classrooms in NYC the bulbs are usually 200 or 300 watts. Teachers outside the city will have to determine the wattages for their particular types of bulbs.

** See Note 1 in the lesson for an explanation of the differences between watts, watt hours, kilowatts, and kilowatt hours. See the Glossary for specific definitions.

*** Most school districts in New York State operate for approximately 100 school days a year.

SCHOOL ____________________ NAME ____________________
CLASS ____________________ DATE ____________________

SAVING ELECTRICITY IN THE CLASSROOM AND SCHOOL FOR A DAY, WEEK, AND YEAR

Worksheet B

1. How many classes are there in your school? ____________
2. In one day, how many kilowatt hours are used by all the classes in your school? (A.11 x B.1) ____________
3. In one 5 day week how many kilowatt hours are used by all the classes in your school? (5 days x B.2) ____________
4. How many kilowatt hours do all the classrooms in your school use in a year? (180 days x B.2) ____________
5. If your class turned off 1/3 of the lights in your classroom for a day, how many kilowatt hours would be saved? (1/3 x A.11) ____________
6. If your class turned off 1/3 of the lights in your classroom for a week, how many kilowatt hours would be saved? (1/3 x A.12) ____________
7. If your class turned off 1/3 of the lights in your classroom for the entire year, how many kilowatt hours would be saved? (1/3 x A.14) ____________
8. If every class in your school turned off 1/3 of its lights for a day, how many kilowatt hours would your school save? (1/3 x B.2) ____________
9. If every class in your school turned off 1/3 of its lights for a week, how many kilowatt hours would your school save? (1/3 x B.3) ____________
10. If every class in your school turned off 1/3 of its lights for a year, how many kilowatt hours would your school save? (1/3 x B.4) ____________

SCHOOL ______________________ NAME ______________________

CLASS ______________________ DATE ______________________

SAVING MONEY IN THE CLASSROOM AND SCHOOL FOR A DAY, WEEK, AND YEAR

Worksheet C

1. If a kilowatt hour costs approximately 10 cents, how much does it cost to use the lights in your classroom for one day? (.10 x A.11) ____________
2. How much does it cost to use the lights in your classroom for a week? (5 days x C.1) ____________
3. How much does it cost to use the lights in your classroom for a year? (36 weeks x C.2) ____________
4. How much does it cost to use the lights in all the classrooms in your school for one day? (.10 x B.2) ____________
5. How much does it cost to use all the lights in all the classrooms for a week? (5 days x C.4) ____________
6. How much does it cost to use all the lights in all the classrooms for a year? (36 weeks x C.5) ____________
7. If every class in your school turned off 1/3 of its lights for a day, how much money would the school save? (1/3 x C.4) ____________
8. If every class in your school turned off 1/3 of its lights for a week, how much money would the school save? (5 days x C.7) ____________
9. If every class in your school turned off 1/3 of its lights for a year, how much money would the school save? (36 weeks x C.8) ____________

SCHOOL ______________________ NAME ______________________

CLASS ______________________ DATE ______________________

SAVING ELECTRICITY AND MONEY IN THE SCHOOL DISTRICT AND CITY OR TOWN FOR A DAY, WEEK, AND YEAR

Worksheet D

1. If every school in your school district (approximately 25* for NYC public schools) turned off 1/3 of its lights for a day, how many kilowatt hours would be saved? 1/3 (25 x B.2) ________

2. If every school in your school district turned off 1/3 of its classroom lights for a week, how many kilowatt hours would be saved? (5 days x D.1) ________

3. If every school in your school district turned off 1/3 of its classroom lights for a year, how many kilowatt hours would be saved? (.10 x D.1) ________

4. If every school in your school district turned off 1/3 of its classroom lights for a day, how much money would be saved? (36 weeks x D.2) ________

5. If every school in your school district turned off 1/3 of its classroom lights for a week, how much money would be saved? (5 days x D.4) ________

6. If every school in your school district turned off 1/3 of its classroom lights for a year, how much money would be saved? (36 x D.5) ________

7. If every school in your city (approximately 1000 public schools in NYC, for example) turned off 1/3 of its classroom lights for a day, how many kilowatt hours would be saved? (5 days x D.7) ________

8. If every school in your city turned off 1/3 of its classroom lights for a week, how many kilowatt hours would be saved? (5 days x D.7) ________

9. If every school in your city turned off 1/3 of its classroom lights for a year, how many kilowatt hours would be saved? 36 weeks x D.8) ________

10. If every school in your city turned off 1/3 of its classroom lights for a day, how many kilowatt hours would be saved? (.10 x D.7) ________

11. If every school in your city turned off 1/3 of its classroom lights for a week, how much money would be saved? (5 days x D.10) ________

12. If every school in your city turned off 1/3 of its classroom lights for a year, how much money would be saved? (36 weeks x D.11) ________

*Teachers should use whatever geographical or educational divisions and numbers are appropriate to their situation.

SCHOOL ____________________ NAME ____________________

CLASS ____________________ DATE ____________________

CONSERVING OIL IN THE CLASSROOM, SCHOOL DISTRICT AND CITY OR TOWN FOR A DAY, WEEK AND YEAR

Worksheet E

1. Do you remember how many kilowatt hours are used by your classroom during a day? (see A.11) ____________

2. If one gallon of oil burning in a power plant produces about 11 kilowatt hours of electricity, how many gallons of oil are used by your classroom in one day? (E.1 ÷ 11) ____________

3. How many gallons of oil are used by your classroom in a week? (5 days x E.2) ____________

4. How many gallons of oil are used by your classroom in a year? (36 weeks x E.3) ____________

5. Do you remember how many kilowatt hours would be saved if every classroom in your school turned off 1/3 of its lights for a day? (see B.8) ____________

6. If every classroom in your school turned off 1/3 of its lights for a day, how many gallons of oil would be saved? (E.5 ÷ 11) ____________

7. If every classroom in your school turned off 1/3 of its lights for a week, how many gallons of oil would be saved? (5 days x E.6) ____________

8. If every classroom in your school turned off 1/3 of its lights for a year, how many gallons of oil would be saved? (36 weeks x E.7) ____________

9. If every school in your school district turned off 1/3 of its classroom lights for a day, how many gallons of oil would be saved? (In New York City, 25 public schools x E.6) ____________

10. If every school in your school district turned off 1/3 of its classroom lights for a week, how many gallons of oil would be saved? (5 days x E.9) ____________

11. If every school in your school district turned off 1/3 of its classroom lights for a year, how many gallons of oil would be saved? (36 weeks x E.10) ____________

12. If every school in your city turned off 1/3 of its classroom lights for a day, how many gallons of oil would be saved? (In New York City 1000 public schools x E.6) ____________

13. If every school in your city turned off 1/3 of its classroom lights for a week, how many gallons of oil would be saved? (5 days x E.12) ____________

14. If every school in your city turned off 1/3 of its classroom lights for a year, how many gallons of oil would be saved? (36 weeks x E.13) ____________

SCHOOL ______________________ NAME ______________________

CLASS ______________________ DATE ______________________

CONSERVING COAL IN CLASSROOM, SCHOOL DISTRICT, AND CITY OR TOWN FOR A DAY, WEEK, AND YEAR

Worksheet F

1. How many kilowatt hours are used by your classroom during a day? (A.11) ________

2. If one pound of coal burning in a furnace produces about 1.3 kilowatt hours of electricity, how many pounds of coal are used by your classroom in a day? (F.1 ÷ 1.3) ________

3. How many pounds of coal are used by your classroom in a week? (5 days x F.2) ________

4. How many pounds of coal are used by your classroom in a year? (36 weeks x F.3) ________

5. How many kilowatt hours of electricity would be saved if every class in your school turned off 1/3 of its lights for a day? (see B.8) ________

6. If every class in your school turned off 1/3 of its lights for a day, how many pounds of coal would be saved? (F.5 ÷ 1.3) ________

7. If every class in your school turned off 1/3 of its lights for a week, how many pounds of coal would be saved? (5 days x F.6) ________

8. If every class in your school turned off 1/3 of its lights for a year, how many pounds of coal would be saved? (36 weeks x F.7) ________

9. If every school in your school district turned off 1/3 of its classroom lights for a day, how many pounds of coal would be saved? (In NYC, 25 public schools x F.6) ________

10. If every school in your school district turned off 1/3 of its classroom lights for a week, how many pounds of coal would be saved? (5 days x F.9) ________

11. If every school in your school district turned off 1/3 of its classroom lights for a year, how many pounds of coal would be saved? (36 weeks x F.10) ________

12. If every school in your city turned off 1/3 of its classroom lights for a day, how many pounds of coal would be saved? (In NYC, 1000 public schools x F.6) ________

13. If every school in your city turned off 1/3 of its classroom lights for a week, how many pounds of coal would be saved? (5 days x F.12) ________

14. If every school in your city turned off 1/3 of its classroom lights for a year, how many pounds of coal would be saved? (36 weeks x F.13) ________

PART III

Expanding the Energy Education Circle

The concentric circle approach to learning -- developing students' awareness of their immediate classroom environment and then providing them experiences in the ever-widening spheres of the school building, school neighborhood, and the city at large -- has become an increasingly popular educational procedure, particularly in environmental education. The lessons in Section III will take the student's learnings in the classroom electricity project and enrich them with experiences in the school building, neighborhood, and home. The activities can be carried out before, during, or after the electricity conservation project.

Lesson #5: ENERGY IN THE SCHOOL BUILDING

AIM: "To learn about the sources, types, and users of energy in the school building.

MOTIVATION: Ask the question, "Besides our classroom, where else can we conserve energy right in our immediate environment?" (the school building)

MATERIALS: Notebook and pencil.

DEVELOPMENT:

1) We are going to take a walk to study the man-made energy users/sources in the school and the types and natural sources of the energy they use.

2) Use a chart written in student notebooks (keep chart for possible use in next lesson) to record details and facts.

THE SCHOOL ENERGY ENVIRONMENT

Man-made Energy User/Source	Type of Energy		Natural Energy Source
	Used	Provided	
Kitchen Oven	Chemical	Heat	Oil, Coal, Natural Gas...
Mimeograph Machine	Electrical	Mechanical	Oil. Coal, Uranium...
Boiler	Chemical	Heat	Oil. Coal. Natural Gas; the sun...
______	______		______
______	______		______

3) Take a walk with the class to the various rooms and places where man-made energy sources are being used. Obvious discussion points will include: the school office and other offices where the class can examine office equipment (typewriters, copying machines, lighting, etc.); the lighting patterns in the school halls; facilities like the gym and library (machines, lighting, etc.); the school cafeteria and kitchen (oven, lighting, hot water use); the boiler room; school custodial service rooms (hot water use); and school ventilation and air conditioning systems (if applicable).

SUGGESTED ACTIVITIES:

1) Have the class map a building energy walk. Teachers can prepare a map and spirit master of the school building or of various school spaces by making a diagram of a particular floor or room. Each student can receive a copy of the map and the class can take one or more walks and place the various energy sites, users, etc., on the map using keys, tables, etc.

2) Develop an energy conservation plan for the school or for some of the school spaces. Have the class try to involve school officials and other classes in implementing the plan. The involvement of the school custodian in such a project is recommended. A few relatively simple examples of school energy conservation possibilities include:

LIGHTING

a) Reduce the number of bulbs in halls and offices. Use sunlight wherever possible.

b) Use bulbs of less wattage in as many school spaces as possible, particularly in storage areas, closets, etc.

c) Make sure all hallway and classroom bulbs are cleaned regularly.

d) Change incandescent bulbs to fluorescent.

HEATING AND COOLING

a) Lower thermostats as much as possible during the winter and wear sweaters when necessary. Do not open windows when radiators overheat. Call the custodian to reset thermostat.

b) During cold weather keep window shades down at night, up during sunlight hours.

c) Improve window framing and building insulation.

d) Reduce heat in gymnasiums and auditoriums.

e) Improve ventilation procedures, e.g., proper use of windows, shades, and doors to reduce air conditioning and fan use in hot weather.

f) Check water fountains and sinks in all classrooms, lunch rooms, storage areas, etc., for hot water drips, and have the custodian fix these immediately. Install flow restrictors where possible. They are available at no charge from the New York State Energy Office.

APPLIANCES AND EQUIPMENT

a) Discuss with the office staff and school aid staff ways to use office copying machines, coffee pots, audio-visual equipment, etc., in as efficient a manner as possible. Remember, equipment left on when not in use wastes energy.

b) Suggest that the administration and custodial staff make sure all new equipment is as energy efficient as possible.

c) Discuss with the custodial and kitchen staff the possibility of more energy efficient food preparation. Sample suggestions include: turning off all equipment when not in use; serving more cold lunches; not preheating the oven for a longer time than necessary; making sure new equipment is as energy efficient as possible, and using cold water when possible for washing.

Lesson #6: A NEIGHBORHOOD ENERGY WALK

AIM: To observe energy sources and uses in the school neighborhood.

MOTIVATION: "Now that we've studied energy in our classroom and school building, where else can we go to study energy conservation?" (School neighborhood and students' own homes). "Let's go right outside our school first."

MATERIALS: Notebook, writing materials, and teacher-made maps of school neighborhood, if desired. (See Note 1 on mapping)

DEVELOPMENT:

1) "What method can we use to observe the energy environment outside our school?" (Walking)

2) "Who can remember one source of energy that comes from the outdoors right into our room?" (The sun)

3) "Energy which is not made by man is natural energy. Can you think of any other kinds of natural energy in the outdoors?" (Plant and animals have natural energy. They move; they change; they provide food for people and other plants and animals. Plants and animals also use energy from each other and the sun.)

4) "Can you think of any animals or insects that get their energy from plants or flowers?"

5) "What about man-made things that we might see in our neighborhood that use energy? Let's make another list of man-made and natural energy users and sources, this time thinking about what we might see on our neighborhood energy walk." Refer to lists developed in Lesson 2 and Lesson 5, if necessary. Develop a table like the following:

THE NEIGHBORHOOD ENERGY ENVIRONMENT

MAN-MADE				NATURAL		
Energy Source	Energy User/ Source	Type of Energy Used/Provided		Energy Source	Energy User/ Source	Type of Energy Used/Provided
Gasoline station	Bus	Chemical/mech		Sun	Plants, animals	Light/chemical Light/mech/che
Gasoline station	Car	Chemical/mech		Wind	Flowers, birds	Mech/chemical Mech/kinetic
Power plant	Street Lamp	Electrical/ light		Plants	Insects, animals	Chemical/mech Chemical/mech

See Follow-up Activity #2. Also see follow-up to Lesson 9 for formal introduction of principle of energy conservation.

6) "Let's take a walk to learn about these and other natural and man-made energy sources and users in our neighborhood environment."

7) Take a walk with the class on the same day or soon after this lesson. Have the children take their notebooks and pencils, as well as the list of things they expect to see. Let them add to or subtract from that list as the walk continues. The walk route can be planned by you, and/or the students. Parent aides are helpful. If you feel that mapping the walk is appropriate for your class, see Note 1.

HOMEWORK: Have the children prepare a list in their notebook of the energy sources and users they see as they walk home from school.

FOLLOW-UP ACTIVITIES:

1) If you've chosen to participate in the mapping exercise, have the children do a second copy of their maps. Add a language arts component to the mapping by asking the children to write a composition explaining their walk.

2) Develop a more in-depth understanding of natural energy systems in the environment by having the class study one natural system intensively. For example, develop a gardening project (see Figures 1 and 2) with your class in an open space outside your school. Such a project can show students the close relationships between human and other natural energy systems and the connections between different forms of energy in the natural environment. A complete natural energy system studied by children right in their school neighborhood will help the comparative study of the natural and man-made energy systems.

3) Develop specific natural energy walks such as an energy walk in a park near your school.[3]

4) Discuss and develop specific strategies for saving energy in the environment outside the school, e.g., reducing street lighting, limiting nighttime store and building lighting, reducing auto use, using natural energy (man, sun) in place of man-made energy (power plants, machines), etc.

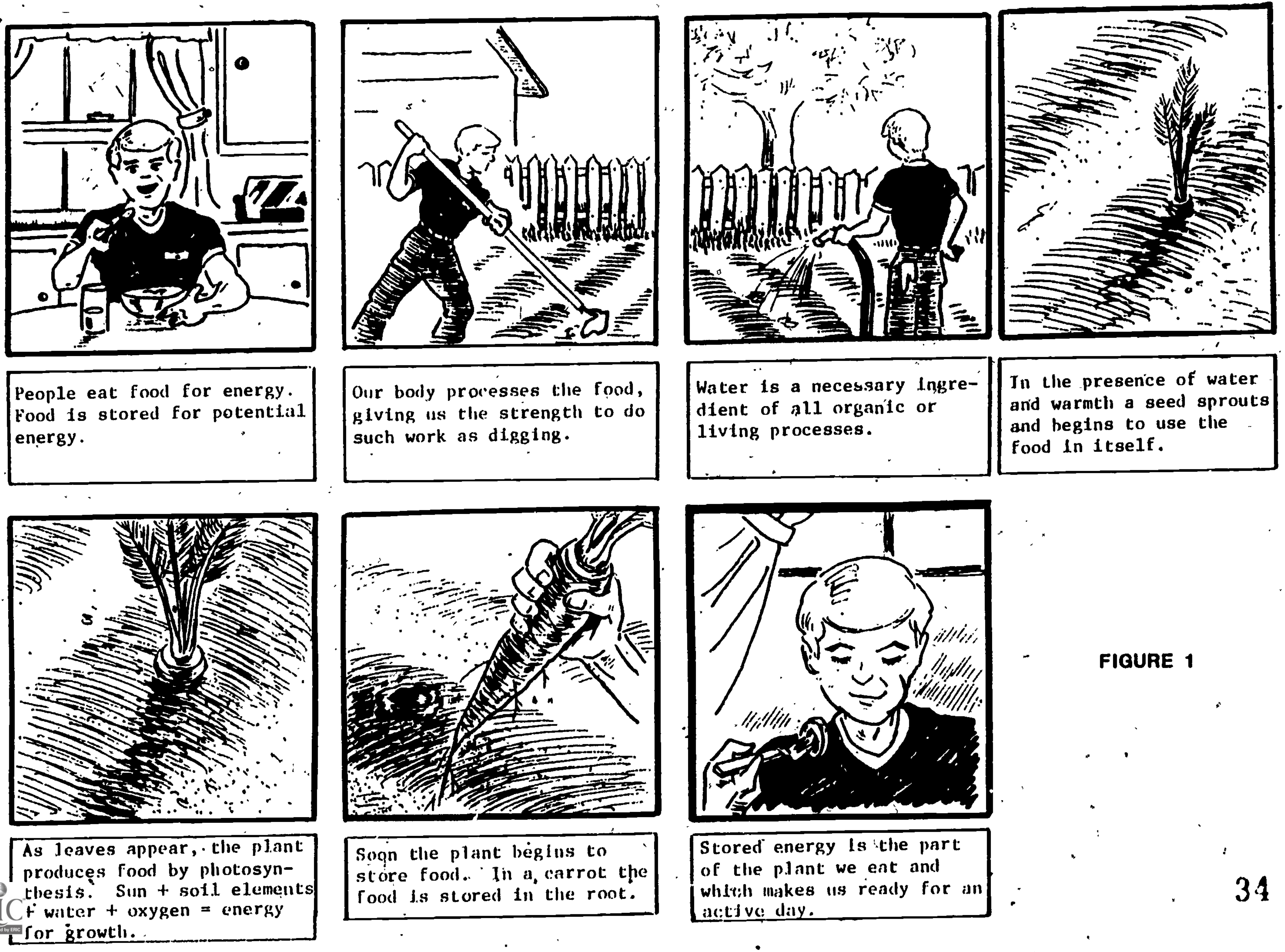
5) Take the class on trips to other energy sites -- power plants, refineries, etc. -- in the neighborhood or in other parts of your city or town. (See list of Energy Information Sources)

NOTE 1: PREPARING AND USING YOUR OWN NEIGHBORHOOD MAP FOR USE IN LESSON 6.

If maps of directly applicable scale cannot be obtained from local municipal planning or related offices, then get a street map of your general area from a local bookstore or library, and draw your own enlarged block or section map of the area around your school on a sheet of paper. Other sources of street maps are police maps, tax assessment maps, mortgage department or mortgage company maps, and land-use or zoning maps. In New York City, the Planning Department and its local borough offices have maps which can be obtained for a nominal fee. Another possibility is to have your students draw their own maps from an official map or from their own explorations in the neighborhood around the school.

If you want to make map copies inexpensively for several classes, photocopy an 8½ x 11, or 8½ x 14 inch section of the area around your school, place it through a thermofax machine (most masters or stencils are in one or both of these sizes). Then run the spirit-master off on a spirit duplicating machine, or the stencil on a mimeograph machine to get the desired number of copies. Maps can be labeled and various neighborhood energy sources can be shown through use of map keys which employ symbols, letters, numbers, etc. Arrows or other indicators should be used to show the path of the walk.[4]

A Garden As An Energy System



People eat food for energy. Food is stored for potential energy.

Our body processes the food, giving us the strength to do such work as digging.

Water is a necessary ingredient of all organic or living processes.

In the presence of water and warmth a seed sprouts and begins to use the food in itself.

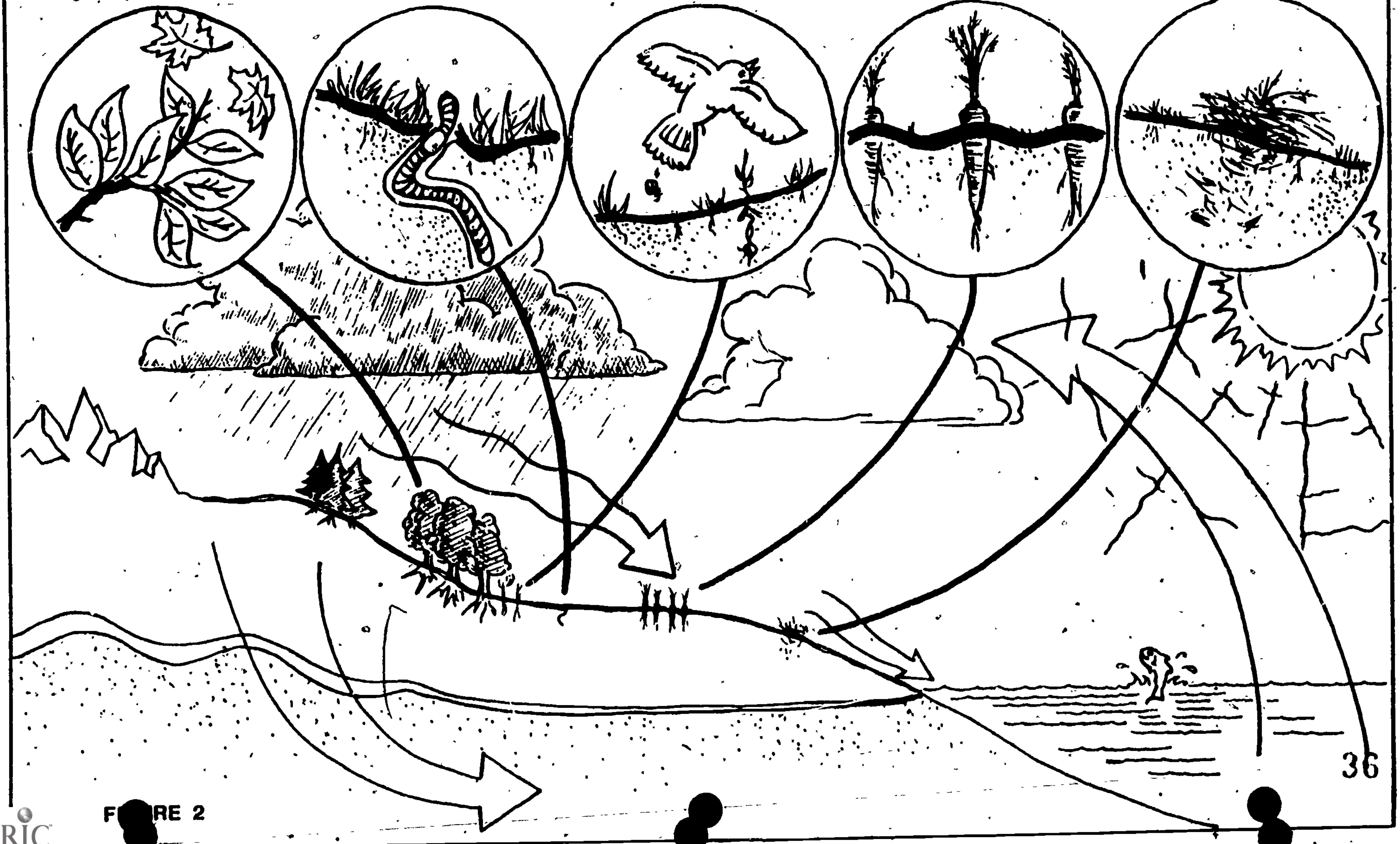
As leaves appear, the plant produces food by photosynthesis. Sun + soil elements + water + oxygen = energy for growth.

Soon the plant begins to store food. In a carrot the food is stored in the root.

Stored energy is the part of the plant we eat and which makes us ready for an active day.

FIGURE 1

- The leaves that plants produce fall to the earth at the end of the summer and decay. This decaying material replaces nutrients in the soil.
- Worms digest the decaying material and leave wastes that fertilize the soil. They also dig tunnels that create air spaces which are necessary for supplying plants with oxygen.
- Many fruits are eaten by birds. The seeds are left in the birds waste and sprout to become new plants.
- Energy from the sun + nutrients in the soil + water and oxygen = food (energy for growth).
- Some soil and decaying plant material is washed into the sea where it provides nutrients for marine plants which are eaten by small fish, which are eaten by bigger fish, etc.



F[illegible]RE 2

Lesson #7: HOME ENERGY CONSERVATION

AIM: To conserve energy in the home.

MOTIVATION: "Now that we've started our electricity conservation project in our classroom and seen some of the man-made energy users in our school, building and neighborhood, where else can we conserve energy? (Our homes)

MATERIALS: Notebook, pencil, parent/child home energy conservation strategy sheets on the following pages -- to be copied in notebooks or duplicated, if teacher so desires.

DEVELOPMENT:

1) "What are some of the ways we use energy in our apartments or homes?" (Lighting, appliances -- refrigerators, stove, air conditioning, etc. -- heat and hot water)

2) Choose an initial strategy with the class for home energy conservation from the strategy sheets following this lesson. Have the students copy the chosen strategy in their notebooks; make photocopies of the appropriate sheet(s) for students and their parents or develop and run off a stencil or spirit-master.

3) Once one action strategy sheet has been accomplished, the class can move into the others. It might be best to begin with the lighting conservation sheet since the students have been most recently familiar with this energy form.

Parent/Child Home Energy Conservation

Checklists

The following sheets are meant to stimulate joint parent/child energy conservation efforts in the home. Participating in the activities will help parents save energy and money and involve children in attitude and skill developing exercises.

A. LIGHTING

SAVING MONEY AND ENERGY BY CUTTING DOWN ELECTRIC LIGHT USAGE

Place a check next to each activity you've participated in

_____ 1. Wherever possible, replace in a fixture, two light bulbs of smaller wattage with one of higher wattage. (For example: two 74-watt bulbs with one 100-watt bulb.) Place a burned-out bulb in empty sockets to prevent accidental shocks.

_____ 2. When possible, replace single bulbs with lower wattage bulbs (150 watt with 100 watt, 75 watt with 60 watt, etc.).

_____ 3. Task lighting: Use lamps with adjustable arms (swivel, gooseneck) to concentrate light for specific tasks - cooking, reading, sewing.

_____ 4. Use fluorescent (long, tube-shaped) light bulbs instead of incandescent (pear-shaped) light bulbs whenever possible. Fluorescent bulbs use one-third to one-half the energy and last 10 times longer than incandescent bulbs. They also produce less heat. Contact the State Energy Hotline at 1-800-342-3722 to learn about conversion from incandescent to fluorescent.

_____ 5. Keep all shades and fixtures clean. Dirt blocks light.

_____ 6. Install dimmer switches for when you need less light (watching TV) or just background light.

_____ 7. When painting or decorating, use lighter colors for walls and ceilings. Light colors reflect light; dark colors absorb light.

_____ 8. TURN OFF LIGHTS when you leave a room. Always turn them off, even for a few minutes. It is a myth that turning lights on and off requires a great deal of energy.

B. APPLIANCES

SAVING MONEY AND ENERGY BY REDUCING ELECTRIC APPLIANCE USE

Place a check next to each activity you've participated in

I). In the Kitchen

A). Refrigerator and Freezer

____ 1. Defrost refrigerator when ice reaches 1/4 - 1/2 inch thickness.

____ 2. If buying a refrigerator remember frost-free refrigerators use more energy than standard ones.

____ 3. Keep the refrigerator clean. Unplug and vacuum the coils and compressor in back at least once a year.

____ 4. Make sure the sealing around the doors are air tight. Replace it if there are any gaps or air spaces.

____ 5. Smaller refrigerators (less than 15 cubic ft.) use less energy than larger ones.

____ 6. The refrigerator is located in a cool spot with good circulation of air around it and away from heat sources like direct sunlight, kitchen stove and heat vents.

____ 7. Avoid putting foods in the refrigerator when they are hot.

____ 8. Make sure the refrigerator and freezer are not too cold. Recommended temperatures are 38°F to 40°F for the food compartment and 5°F for the freezer. A separate freezer for long-term storage should be kept at 0°F.

B). Oven - Range

____ 1. Remember self-cleaning ovens use more energy than standard ones.

____ 2. Make the most use of the oven's heat by cooking a number of things in it at the same time.

____ 3. Preheat the oven for only 10 minutes. Generally that's all that's necessary.

____ 4. Don't peek. Opening the oven door wastes heat and energy.

____ 5. Buying a new kitchen range? Many new models have electronic ignition systems instead of energy wasting pilot lights. For safety reasons, do not shut off the pilot light on your current stove without the help of a technician.

____ 6. Does the flame on your gas stove burn with a clear, blue flame? If not, and the flame is yellow, improper combustion is occurring.

____ 7. Cover pots with lids while cooking. This prevents heat from escaping and helps the food cook faster.

____ 8. Use flat-bottomed pans and match the size of pots and pans to the size of burners.

____ 9. Eat light - feel right! Why cook in the heat of the summer? Fresh salads, yogurt, cheese, fresh fruit, ice cream are all nutritious, delicious and, of course, save energy.

____ 10. Pressure cookers save energy and time. Use them when cooking.

____ 11. Small cooking appliances (electric fry pans, toaster ovens, etc.) are energy efficient for small meals.

____ 12. If you cook with electricity, turn off the burners several minutes before the regular cooking time. There will be enough heat to finish. This also applies to ovencooking.

C). Dishwasher

______ 1. Dishwashers are energy efficient but only with full loads; be careful not to overload though.
______ 2. Don't use the "rinse hold" setting - it uses three to seven gallons of hot water each time you use it.
______ 3. Scrape dishes before you load them so you won't have to rinse them. If you do rinse them, use cold water.
______ 4. Let the dishes air dry when the wash cycle is over.

II. In The Laundry

______ 1. Full loads save hot water, electricity and money.
______ 2. Try using cold water whenever possible. Use warm water instead of hot water for the tough loads.
______ 3. Don't over-soap. Use 1/2 to 3/4 of the amount of detergent suggested on the box. You'll save money, energy and get your clothes just as clean.
______ 4. Try the old fashioned clothes line. That's using solar and wind power!
______ 5. Clean the lint screen of the dryer after each load.
______ 6. Check the clothes dryer exhaust to make sure it isn't blocked. A clogged exhaust lengthens the drying time and increases the amount of energy used.
______ 7. Turn off the iron a few minutes before finishing. There will still be enough heat for you to finish.

III. Television, radio, stereos, etc.

______ 1. Turn off - when nobody is watching or listening!
______ 2. Keep appliances in good working order so they will last longer, work more efficiently and use less energy.

COST OF RUNNING APPLIANCES

	Estimated Annual Expence	
	KWH	Dollars
Refrigerator		$
12 cu. ft.	728	80.08
12 cu. ft., frostless	1,217	133.87
Refrigerator/Freezer		
12.5 cu. ft.	1,500	165.00
17.5 cu. ft., frostless	2,250	247.50
Freezer		
16 cu. ft.	1,190	130.90
16.5 cu. ft., frostless	1,820	200.20
Coffee Maker	140	15.40
Toaster	39	4.29
Dishwasher	1,200	132.00
Radio	86	9.46
Television		
b&w - Tube Type	350	38.50
- Solid State	120	13.20
Color - Tube Type	660	72.60
- Solid State	440	48.40
Washing Machine		
Hot water wash & rinse	2,500	275.00
Cold water wash & rinse	103	11.33
Clothes Dryer	993	109.23
Iron	144	15.84
Electric Blanket	147	16.17
Window Fan	170	18.70
Portable Heater	176	19.36
Hair Dryer	14	1.54

*Estimated annual consumption figures in kilowatt hours are from the New York State Energy Office, Information Services Unit. Dollar values are based on the 1982 residential statewide average cost of 11c (10.67c) per kilowatt hour. This cost will vary according to your utility company. Check with them for your actual cost.

C. HOUSEHOLD HEATING AND HOT WATER

Household space heating uses around 70% of all the energy your home needs. Hot water uses around 15%. If you are a homeowner or part of a tenant cooperative, your can save between $50-$100 on your water bills each year by simple conservation strategies. You can save much more by investing in insulation and weatherization measures. Below are some basic ideas for conserving heat and saving energy.

Place a check next to each activity you've participated in

I. Conservation

_____ 1. If you have a thermostat, keep it set in the winter to 65°F-68°F during the day and 55°F-60°F during the night.

_____ 2. Keep your radiator, baseboard, or heat register free of dust and dirt.

_____ 3. Don't block them with furniture and allow the heat produced to flow through the room.

_____ 4. Don't open windows to counter oven heating. Close the radiator valve or turn down the thermostat as needed (part or all of the way) to reduce heat flow.

_____ 5. Are the heat registers in unused rooms closed off?

_____ 6. Close your shades and draperies to keep heat inside on cloudy days and open them to let in the sun's warm rays on sunny days.

_____ 7. Conserve your own heat. A good sweater, quilt, comforter or socks can keep you warm at night.

_____ 8. Keep your radiators, hot water heaters, furnaces and heating systems in good working order. Regular inspections and maintenance is a must for a comfortable winter and lower heating bills.

_____ 9. If you have a fireplace, is the damper closed when not in use? Warm air from your home escapes up the chimney.

II. Insulation

_____ 1. Storm windows and doors provide a sandwich of 2 layers of glass with a layer of insulating air in between. They're a big plus in saving heat and energy.

_____ 2. Weatherstripping windows and doors prevents heat from escaping through those small cracks. Filling other cracks with a caulking compound, newspapers or rags will help too.

_____ 3. Insulation is a worthwhile investment. Blanket, batt. or loose fill insulation installed in attics, walls, floors, and ceilings is the best way to save heat and money.

_____ 4. Wrapping insulation around water heaters, heating ducts and hot water pipes prevents heat loss in those areas.

III. Hot Water

_____ 1. Showers generally use much less hot water than baths.

_____ 2. Is the water heater well insulated? If it feels warm to the touch, there probably isn't enough insulation.

PART IV

Enrichment Lessons and Activities

Introduction

In the following section teachers will find lessons and activities which are meant to directly or indirectly reinforce the attitudes, actions, and concepts developed in the first three parts of the curriculum but which can stand alone as meaningful educational activities. Students can expand their knowledge of electricity, energy forms and energy conservation, as well as learn about alternative energy models, energy careers, and the history of energy. Reading and language arts skills can also be developed by involvement in these lessons. Follow-up suggestions point the way to the study of other energy concepts and experiments.

Lesson #8: ELECTRICITY AND HOW IT IS MADE

AIM: To learn about electricity and how it is made?

MOTIVATION: "Who would like to learn more about how electricity is made?"

MATERIALS: Notebook, pencil, chalkboard (or spirit master/stencil of reading passage and questions).

DEVELOPMENT:

1) Present and copy on the chalkboard the following reading passage and questions or make a master or stencil of the paragraph and accompanying questions. If possible, reproduce on the chalkboard (or give students a spirit master copy of) the electricity creation and flow diagram.

2) Reading passage and diagram (see next page).

D. HOUSEHOLD COOLING

SAVING ENERGY AND MONEY WHILE KEEPING COOL IN THE SUMMER

Place a check next to each activity you've participated in

I. Use Windows and Doors Wisely

_____ 1. Close drapes, shades or blinds on sunny days to block the sun's heat.

_____ 2. Open windows top and bottom for good circulation.

_____ 3. Open pairs of windows opposite one another for cross ventilation.

II. Air Conditioners and Fans

_____ 1. Buy energy efficient air conditioners. Check the manufacturer's label for high energy efficient ratings (EER).

EER's for room air conditioners range from a low of 5.4 to a high of 11.5. The 11.5-rated air conditioner is more than twice as efficient than the 5.4 variety and uses less than half the electricity.

_____ 2. Use air conditioners sparingly. Running an air conditioner costs close to 15¢ an hour in New York City, for example -- over $1 per night.

_____ 3. Close all windows, doors and unused rooms when the air conditioner is running. Use it in only one room at a time.

_____ 4. Turn off the air conditioner when no one is home. You can purchase a timer that can automatically turn on and off your air conditioner at pre-set times.

_____ 5. If you have a thermostat, try to keep your summer temperature at a cool 78°F.

_____ 6. Keep your air conditioner clean and in good repair. Vacuum the coils in the rear once a month in the summer. Make sure you unplug it before vacuuming. Clean the filter regularly.

_____ 7. The air conditioner condenser is shaded from the sun.

III. Other Appliances

_____ 1. Use appliances and cook during cooler hours of summer days. Peak demands for energy in summer in urban areas are during the warmest hours because of air conditioner use. Two kilowatts of electric equipment in operation will add as much heat to a room as a 7000 BTU air conditioner can remove.

What Is Electricity and How Is It Made In A Power Plant?[5]

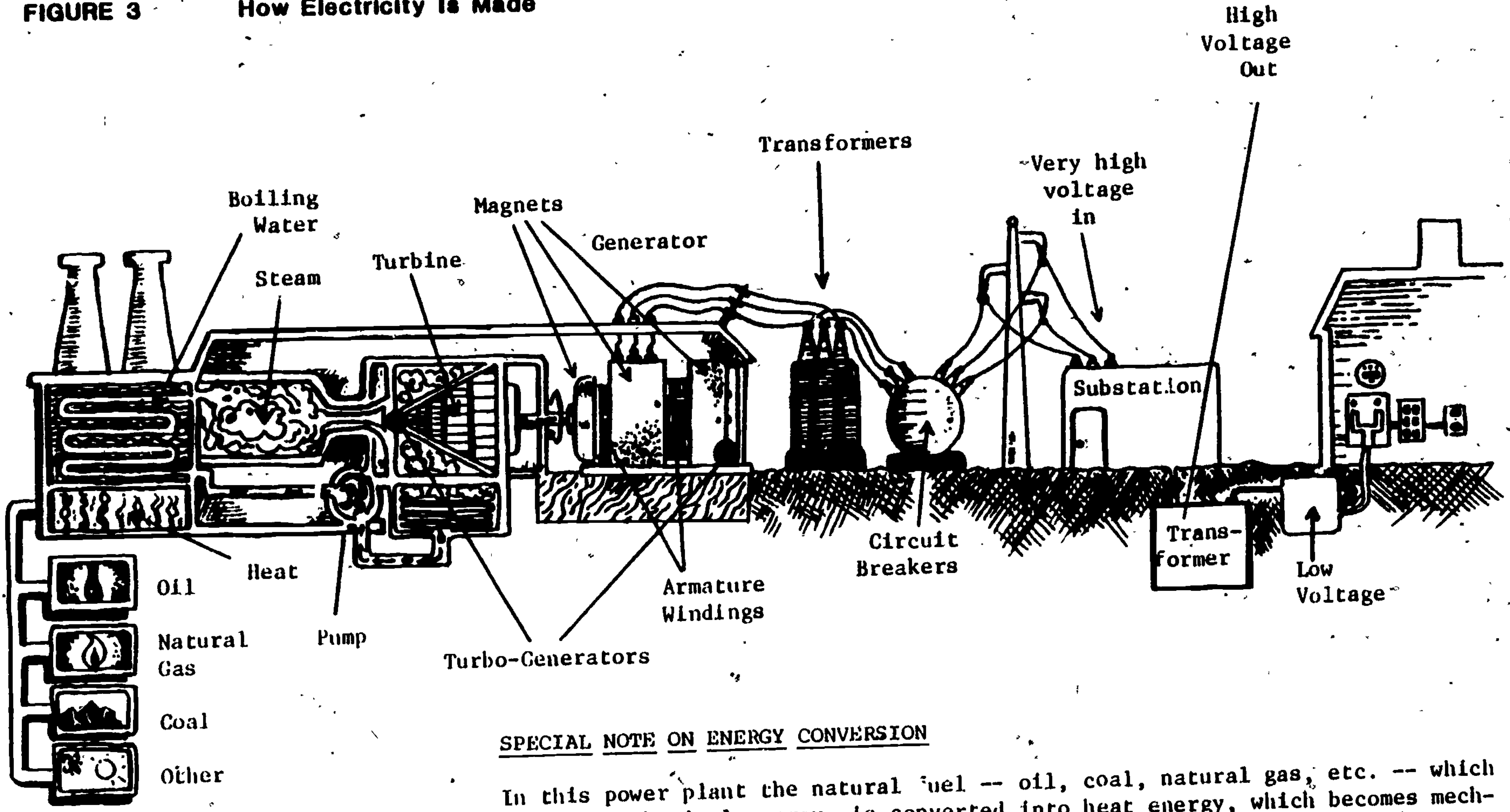
Electricity is a form of energy. It is the movement of charged particles, called electrons, through space. It exists in nature and sometimes you can see it or hear it in the form of lightning; or you can feel it in the form of static electricity, a harmless spark that comes when you touch something after walking on a thick carpet. But usually electricity is invisible. In spite of that, man has learned how to make and deliver it in a split second.

The energy in natural fuels, such as oil, coal, and natural gas, can be converted into electricity. Oil, gas, and coal are the most commonly used fuels in power plants. Electricity can also be made from the energy in falling water, from sunlight, winds and tides, from the earth's heat, and from uranium.

In a power plant the basic fuels -- oil, coal, etc. -- boil water to make steam to turn turbogenerators. (If the energy source is falling water, the water turns the turbogenerators.) Inside the generators, magnets rotate and create a moving magnetic field, which generates a flow of current in the armature windings of the generator. This flow of current is caused by the relative motion between a magnet and a closed coil of wire.[6]

The current flows from the generator coils through cables and is transmitted at high voltages from generating plants to substations. From here the high voltage current flows through the transformers which reduce the voltage so that electricity can flow into wires in homes, buildings, schools, etc. In the manner, electricity is produced and delivered to you at home and in school. (See Figure 3)

FIGURE 3 **How Electricity Is Made**



SPECIAL NOTE ON ENERGY CONVERSION

In this power plant the natural fuel -- oil, coal, natural gas, etc. -- which possesses chemical energy, is converted into heat energy, which becomes mechanical energy, which becomes electrical energy, as steam turns the turbo-generators, creating the moving magnetic field that generates electricity. Thus, there are four energy conversions in the plant itself. See follow-up to lesson 9.

DEVELOPMENT:

3) Questions - Place on chalkboard or reproduce for students. Answers are underlined or filled in for teachers.

Multiple Choice (underline the correct answer)

1. What is electricity?
   a) lightning b) a spark c) a form of energy consisting of a flow of charged particles
   d) static electricity

2. What substance is not used as a natural source of electricity?
   a) oil b) natural gas c) coal d) thick carpets and materials

3. What is the first step in a power plant?
   a) creating a magnetic field b) using fuel to boil water
   c) transmitting current d) putting a plug in a socket

4. The boiling water creates
   a) steam b) oil c) electricity d) magnetic fields

5. What function does the steam serve in the man-made generation of electricity?
   a) creates moving magnetic fields b) creates a flow of currents
   c) provides electricity d) turns turbogenerators

Fill-ins

1. In making electricity what does man use to generate the flow of currents? (Rotating magnets - rotating magnetic fields).

2. Current flows from the generator coils through (cables).

3. The current is transmitted from generating plants to (substations).

4. What changes and transmits high voltage current into low voltage current that is usable in homes? (Transformer)

4) Vocabulary - Have the children alphabetize, define, write sentences with and generally study the following words mentioned in the passage.

lightning
invisible
magnet
armature

utility
generator
rotate
voltage

system
transformer
stationary
static

FOLLOW-UP:

1) See Lesson 9.

2) See list of organizations after Lesson 6 for possible sources of audio-visual materials on this subject.

Lesson #9: SOME DIFFERENT KINDS OF ENERGY

AIM: To learn more about some different kinds of energy. (See Glossary for definitions of different forms of energy.)

MOTIVATION: If the class has already discussed Part I, Lesson #2, then the teacher can ask the class to think back to the discussion of the different kinds and sources of energy and ask them if they would like to embark on some experiments to learn more about this topic. If the class was too advanced for the first lesson and is proceeding directly to these exercises for an exploration of this area, each demonstration should serve as its own inherent motivation.

MATERIALS: (If necessary see Lesson 10, Figure 5, Note "d" for names of science supply houses)

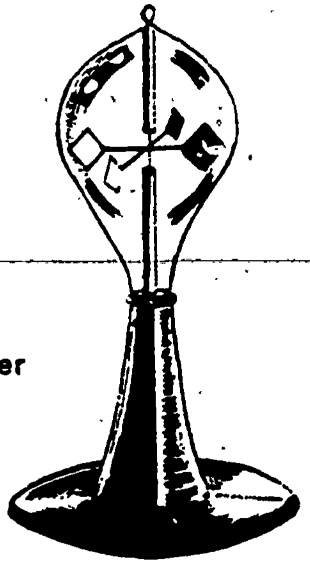
- Diluted hydrochloric acid
- Marble chips
- 250 ml beaker
- Radiometer
- Shoe box
- Piece of plastic
- Thermometer
- Piece of Cloth
- Pinwheel
- Dowel
- Thumbtack
- Beaker (boil water)
- Water
- Narrow glass tubing
- Burner
- Tuning fork
- Copper wire
- Small iron cylinder
- Galvanometer
- Two 24 in. bar magnets

DEVELOPMENT EXERCISES:

1) Demonstrate chemical energy by adding a small amount of diluted hydrochloric acid to a few marble chips in a 250 ml beaker. The resultant release of gas caused by chemical reaction between the acid and the marble will cause a bubbling which pupils can learn to identify as a release of chemical energy.7/

2) A radiometer held in sunlight will demonstrate the effect of light energy from the sun or an artificial light source (e.g., a light bulb) on the vanes.8/

3) Heat energy from the sun can be shown by taking a shoe box and wrapping a smooth piece of plastic across the open top. Punch a small hole in one end of the box and slip a fish-tank thermometer in place. Put the box on your sunniest windowsill with the plastic front facing the sun. Observe the thermometer climb as the sun's rays heat the air inside the box.9/



Radiometer

4) Mechanical energy can be demonstarted using the following apparatus.[10/] (see Figure 4)

a. Develop a pinwheel by cutting off the raised portion of an aluminum pie pan or some other such circular object. Cut out and fold sections, as in Figure 4, so that the folded section is perpendicular to the disc. Assembly as in Figure 4.

b. Use a beaker with water, narrow tapered glass tubing, and a burner.

c. Show mechanical energy by having a pupil blow on the turbine (pin-wheel) and ask the class to observe that moving air causes the turbine to move. Have another student pour water on the turbine. The subsequent movement also demonstrates mechanical energy. By heating the water and causing steam to flow through the tubing, have the students again observe mechanical energy as the steam moves the pinwheel.

5) Sound energy can be produced and demonstrated by striking a tuning fork.

6) To show electrical energy, blow up and tie two balloons, then rub them on a shirt or sweater. This process builds up a charge of static electricity. Watch how the attracting and repelling forces of static electricity make the balloons stick to a wall but repel each other.

SUMMARY:

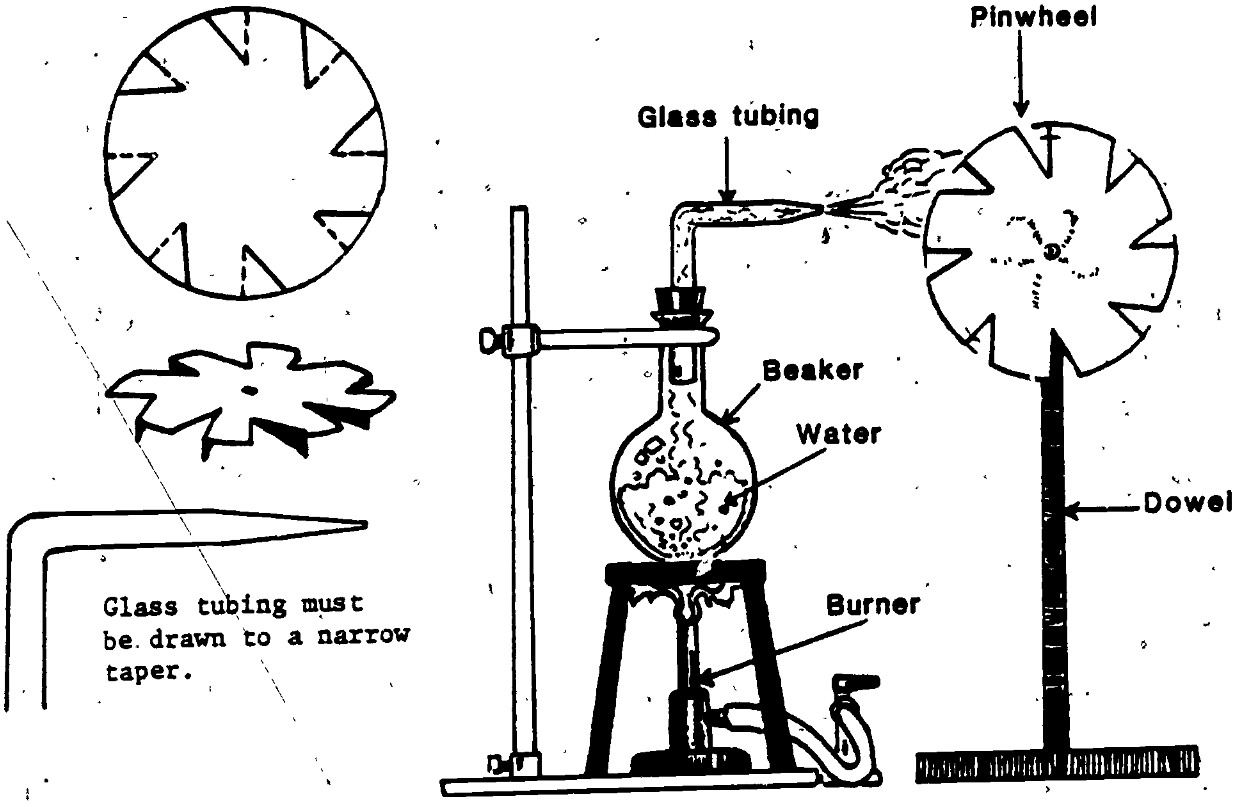
What are some of the different forms of energy?

HOMEWORK:

Have each student, from their experiences in Lessons 2, 5, 6, and this lesson, write about one way to produce each of five different types of energy.

FIGURE 4

Mechanical (And Heat) Energy



Glass tubing must be drawn to a narrow taper.

FOLLOW-UP: The Principle of Conservation of Energy

Through their specific experiences in Lessons 2, 5, 6, and 9 and through the numerous examples given in the curriculum, many students should now be able to synthesize the various themes into an understanding of the conservation of energy principle: that energy cannot be created or destroyed, only changed from one form to another -- the first law of thermodynamics.

The conversion of energy from the natural sources of energy (oil, natural gas, coal, the sun, etc.) to the man-made sources in Lesson 2, e.g., the conversion of the chemical energy in oil to electrical energy in power plants, are specific instances of conservation of energy principle. In Lesson 5, the man-made energy users in the school are all energy sources too: e.g., when the kitchen oven or broiler converts the chemical energy in natural gas to heat energy.

The natural and man-made urban energy environment of the school neighborhood (Lesson 6) is replete with energy cycles: the conversion of the light energy of the sun into chemical energy in plants (photosynthesis), the chemical energy of plants into the heat and mechanical energy in animals (through food), etc. Then there are the man-made users and sources of energy which perform various energy conversions: the power plant, the bus, etc.

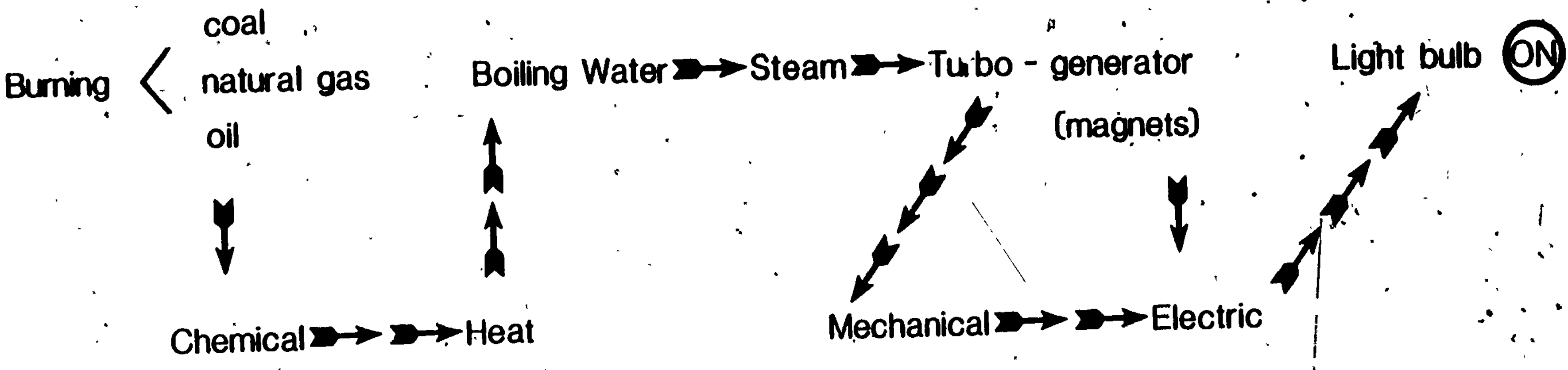
The teacher can tie these examples together by having the students look back over the charts in Lesson 2, 5, and 6 and the experiences they've gone through. Students should be motivated into giving other examples of energy conversions, e.g., the striking (mechanical energy) of a match to produce heat energy or, for more advanced students, the energy conversions that occur in a flashlight, beginning with the dry-cell and ending with the light bulb.

The power plant diagram in Lesson 8 on the making of electricity may be combined with the earlier classroom experiences in Lessons 1-6 to show diagrammatically the energy conversion that is involved in lighting.

The teacher may proceed, if he or she so desires, to examine the concept of energy waste: when energy is converted from one form to another, not all the energy is changed to the new form. Some energy is wasted in the conversion. However, in accordance with the energy conservation principle, this wasted energy is not destroyed but is converted into other forms. Thus it is important to design as efficient energy users as possible. For example, a fluorescent bulb produces -- and therefore, wastes -- much less heat energy in producing light than does the incandescent bulb. This process can be shown by simply touching both bulbs after they have been on for a few minutes.

POWER PLANT

(Energy Conversion)



Lesson #10: FLUORESCENT AND INCANDESCENT LIGHTING

AIM: To compare fluorescent and incandescent lighting and evaluate which is more energy conserving.

MOTIVATION: Show the demonstration apparatus. Ask the students if they know the names of the two different types of light bulbs. (fluorescent and incandescent)

MATERIALS: Foot-candle meter, appropriate desk-size wood or cardboard surface, 40 W fluorescent light, 200 W incandescent bulb. (W = Watt)

DEVELOPMENT:

1) What type of bulb is being used for lighting our classroom?

2) Tell the class that you are going to demonstrate the amounts of light produced by fluorescent and incandescent bulbs on a surface.

3) Using the materials shown in the diagram (Figure 5), the students will see that a 40W fluorescent bulb projects slightly more light on a surface at a distance of 8 ft. to 9 ft. (about 15 footcandles) than a 200 W incandescent bulb (about 12 footcandles).

4) Ask the student which type of bulb uses electricity more efficiently and thus conserves electricity better. (The incandescent bulb uses 5 times as many watts as the fluorescent while projecting less light on a surface).

5. "Are we using the most energy-conserving bulbs in our room?" If not, consider motivating the class to discuss replacement of incandescent by fluorescent bulbs with the school principal and custodian. (See Follow-up Project.)

6. "How could we calculate the savings in kilowatt hours that occur by using fluorescent bulbs?" Students can compute the kilowatt hour savings produced by one fluorescent vs. one incandescent bulb over time by using the formula mentioned in Part II:

$$\text{Kilowatt hours} = \frac{\text{watts} \times \text{hours}}{1000}$$

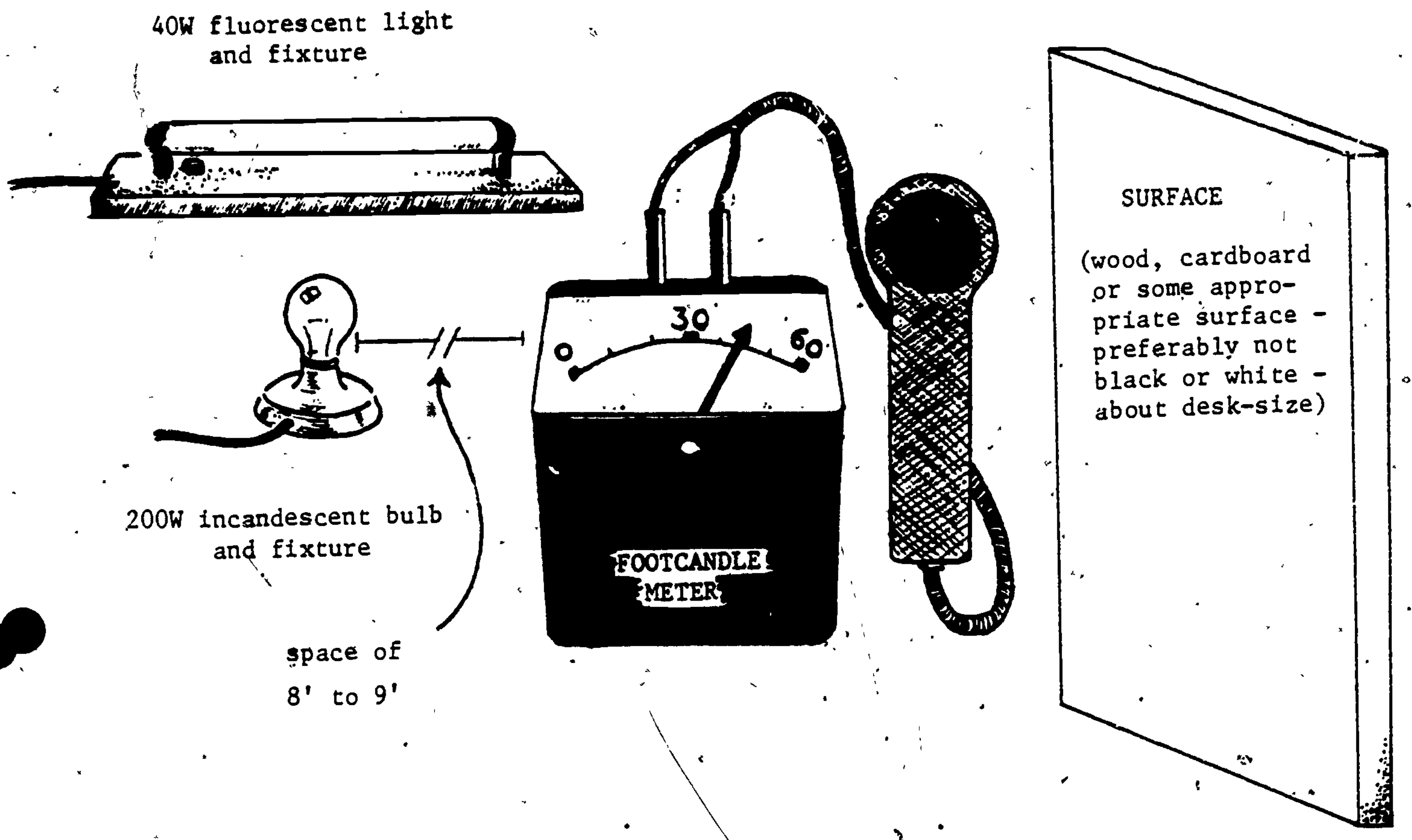
Subtract the figure for the fluorescent bulb from the figure for the incandescent bulb to obtain the kilowatt hour savings. This can be done for a classroom by assuming that the usual classroom with incandescent light has five 200 W bulbs (1000 W). By replacing each 200 W incandescent bulb with a 40 W fluorescent, we are using 200 W of fluorescent lighting to provide the same amount of surface light. Using the kilowatt-watt formula, the savings can then be tabulated. In addition, fluorescent bulbs last 7 to 10 times longer than incandescent bulbs.

FOLLOW-UP PROJECTS

1) Ask your class to count the number of incandescent bulbs in the school hallways and offices and calculate the savings in kilowatt-hours if the bulbs were replaced by fluorescent bulbs. Of course, savings in terms of oil, coal, and money can also be calculated using the methods developed in Part II. If necessary, and possible in your school, motivate the class to consult the custodian and administration and start a project to change from incandescent to fluorescent lighting. Foot-candle levels for different rooms and surfaces can be determined and lighting reduced within standards.

2) Suggest that students conduct a similar project in the buildings in which they live and that they involve their parents, other tenants, and the landlord in the project. This type of incandescent/fluorescent interchange project can supplement lighting conservation activities already motivated by the parent/child checklists in Lesson 7.

FIGURE 5 **Fluorescent vs. Incandescent Lighting**



a) Window shades should be pulled down

b) The light source should be directly in front of (at as little angle as possible) the surface. The distance and angle between the light source and surface should be consistent for both types of lighting.

c) Foot-candle measurements can also be taken from overhead lights that are already in place.

d) Contact a science supply house to obtain a foot-candle meter if you do not have one in your school or laboratory. Some good supply houses are Edmund Scientific, Markson, Nafco, Turtox-Cambosco and World's Natural Science Establishment. These and others are often listed in your area's Yellow Pages under "Science."

e) <u>Metric equivalencies for foot-candles</u>:

1 foot-candle = 1 lumen per square foot
1 lux = 1 lumen per square meter
1 lux = 1 meter-candle
number of luxes = foot-candles x 0.76

Lesson #11: HOW INSULATION WORKS

AIM: To learn how insulation works.[12]

MOTIVATION: Demonstration.

MATERIALS: Small water glass or cup, fish tank thermometer, modeling clay, cotton balls, crushed newspaper, cardboard box (see Figure 6).

DEVELOPMENT:

1) Explain to the class that you are going to demonstrate another way of conserving energy - that better building insulation prevents heat loss in homes.

2) Fill the glass with water that is at room temperature (about 70°F); use the thermometer to measure the exact temperature.

3) Put the thermometer in the glass using modeling clay to keep the thermometer in place. Then place the glass inside a refrigerator (if available) or outside on the windowsill on a cold day. The water temperature will drop quickly. Have students keep a record of the temperature drop in their notebooks.

Time in Minutes	Temperature without Insulation		Temperature with Insulation	
	Fahrenheit	Centigrade	Farenheit	Centigrade
5 minutes				
10 minutes				
15 minutes				
20 minutes				
25 minutes				
30 minutes				
35 minutes				
40 minutes				

The temperature will probably drop 3°-4° Fahrenheit, 1°-2° Centigade every 5 minu.

4) Add insulation by refilling the glass with water at room temperature and placing a layer of cotton balls inside the bottom of a cardboard box and put the glass on top of the layer of cotton. Pack the empty space between the glass and the sides of the box with cotton balls. Put the box and its contents in the refrigerator or outside on the windowsill.

5) Have students observe and record the drop in temperature using the chart. The temperature will drop much less quickly - approximately 1 degree Fahrenheit or so every five minutes.

6) Lead the class to observe that the cotton insulation slowed down the loss of heat from the water in the glass.

7) Perform the same operations using crushed newspaper as an insulator and have the students observe the different temperature drop (heat loss) using the different types of insulation.

SUMMARY: What is insulation and how does it work?

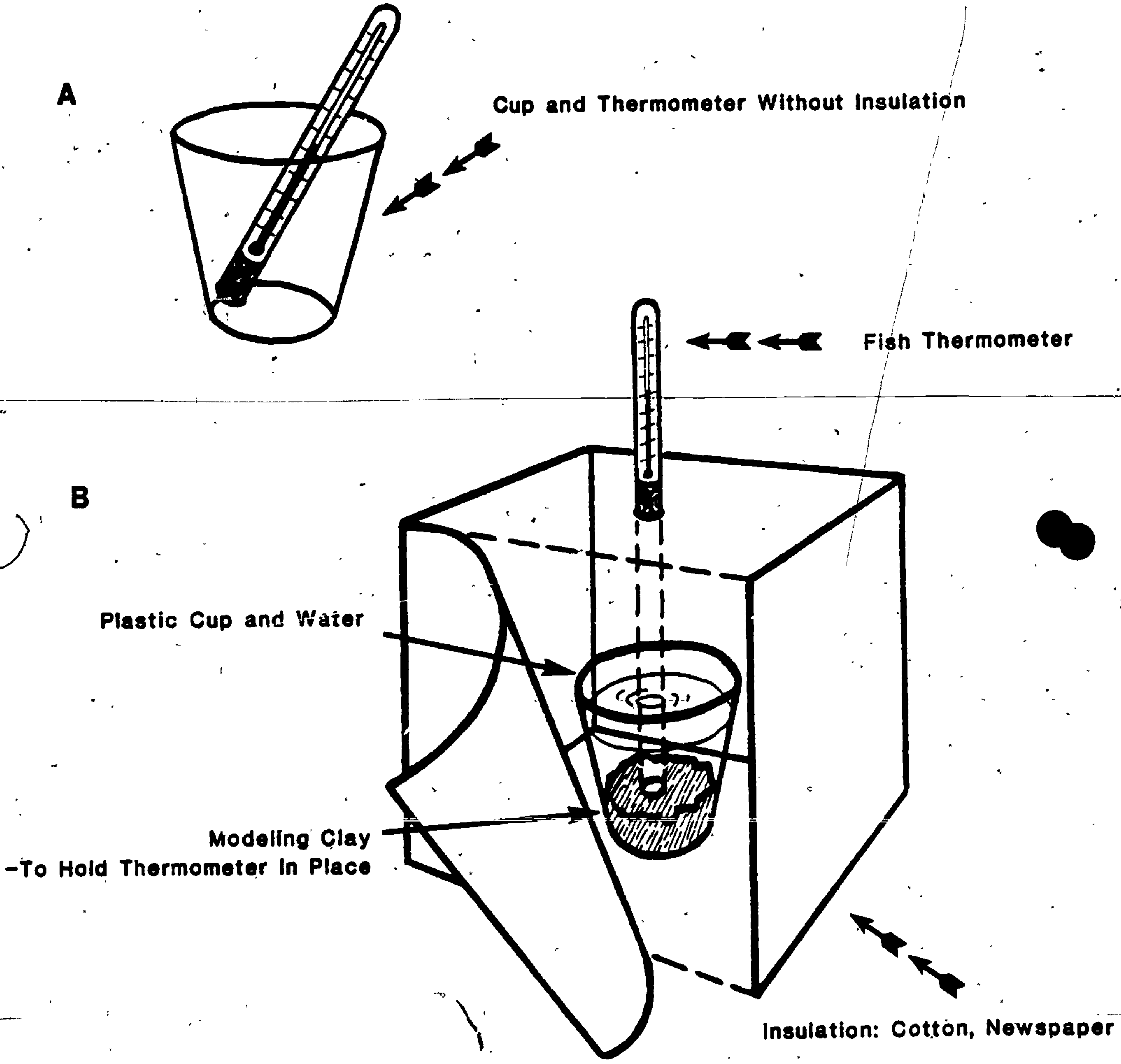
FOLLOW-UP:

1) Explain and discuss with students that while the walls in their houses are not made of cotton or newspaper, insulation material works in approximately the same way as did the cotton or newspaper in the experiment. Explain that many private houses and apartment buildings are not well insulated. Instead of retaining heat inside, they lose heat, thus requiring the burning of more fuel to replace the heat they have lost. Better insulated houses require less oil or natural gas be burned to provide heat.

   Motivate students to investigate and find out what type of insulation is used in their buildings. Such investigations can be integrated with actions taken as a result of the suggestions in the parent/child home checklists (p. 31). Teachers and parents who want special information on this subject should contact the New York State Energy Office.

2. The booklets, Energy Conservation -- Experiments You Can Do, Simple Experiments in Magnetism (Gr. 4-6) and Useful Science Projects (Gr. 7-12), available from the Charles Edison Fund, 101 So. Harrison Street, East Orange, New Jersey, 07018, are easily understandable compilations of other energy-related experiments that can be performed in the classroom. Single copies can be requested by mail.

FIGURE 6 Insulation Experiment



Lesson #12: HOW TO MAKE A SIMPLE SOLAR COLLECTOR

AIM: To make a simple solar collector.[13]

MOTIVATION: From their readings, experience, and the activities described in this curriculum (lighting conservation, gardening, etc.) the students will be aware of the sun as a major source of the earth's energy. Improved solar energy technology and increased use of solar energy could substantially reduce our dependence on fossil fuels. The making of a solar collector should stimulate great interest.

MATERIALS: A can, plastic bag, some black paint (or paper), a thermometer.

DEVELOPMENT:

1) "What kinds of things get very hot when the sun shines on them for a while?" (pavement, car seats, metals, water)

2) "Do some things seem to get hotter than others when they're left in the sun?" (Yes)

3) "These things have a greater ability to convert light energy from the sun into heat energy."

4) "This ability to absorb light energy and convert it into heat is very important - a good solar collector should absorb as much light as possible and lose as little heat as possible."

5) Ask the students if different colors absorb different amounts of light energy from the sun. "Which colors absorb more light and get hotter?" (Black, darker colors)

6) "How can we use this idea to make our own solar collector?" Discuss with the students what materials act as effective absorbers of light energy, how to find them, how they turn light energy into heat, and how to cover such items with a dark color. This is the basis of making a simple solar collector.

7) Put together a collector as shown in Figure 7.

8) Place the collector on a window ledge that has a southern exposure. Explain that the plastic bag helps to cut down on the amount of heat given off by the collector. Insulation in the form of cotton or wool can be placed around the part of the can not facing the sun.

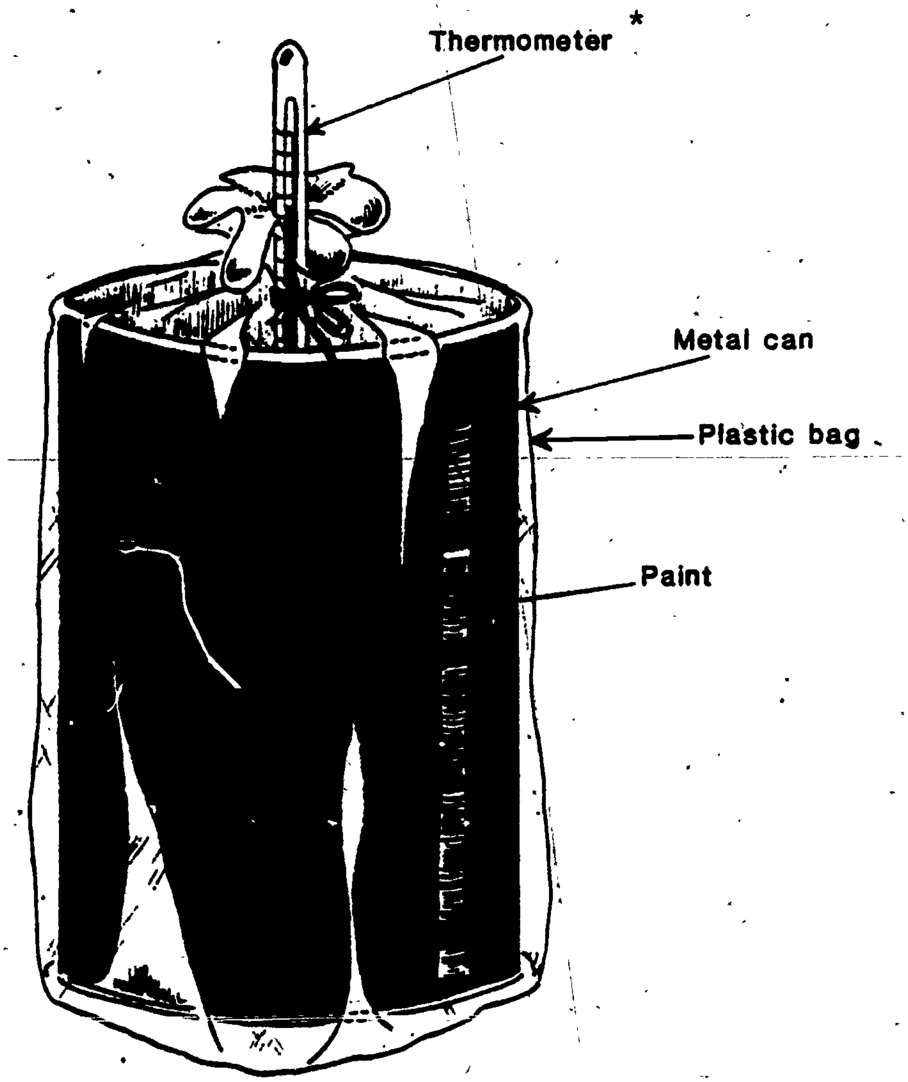
9) Explain that large solar collectors can be used to heat hot water as well as rooms in a building.

FOLLOW-UP:

Measure the temperature of the collector every 15 minutes. Make two or more collectors and paint each a different color. Compare the temperature of the different colored collectors. Also compare temperatures when water and anti-freeze are in the can as insulators, as when air alone is in the can.

FIGURE 7

Making A Solar Collector



* Thermometer can be held up with some clay placed around its base at the bottom of the can.

Lesson #13: HOW A SOLAR WATER HEATER WORKS

AIM: To learn how a solar water heater works.

MOTIVATION: What was the main idea behind the operation of the homemade solar collector in Lesson 12? (Absorption of light energy and its transference into heat energy)

MATERIALS: Photocopies of solar collector diagram (see Figure 8A).

DEVELOPMENT:

1) Explain to students (a) that large solar collectors can be used to heat hot water as well as rooms in a building, and (b) that such large collectors are generally placed on the roof or a nearby sunny location closer to the ground.
2) "What would be the best color for the collector surface of a solar water heater?" (Black or other dark color)
3) "What material should the surface be made of?" (Metals, concrete, etc.)
4) Hand out diagrams and discuss with students how the surface section of the collector works based on the preceding lesson and Figure 7.
5) Explain to the students that once water is heated in the solar collector it has to be stored until it is needed.
6) One type of system used in places where the temperature drops below freezing during the winter is shown in Figure 8B.
7) "How does the hot water get from the city pipes to the collector, to the storage tank, to the building pipes?"
8) Explain to the students that most of the time, water in the city buildings using solar water heating systems must be forced from the storage tank through the collector and then through the rest of the system by mechanical pumps powered by electricity. Temperature sensors in the collector and storage tank signal the pumps to switch on when the sun is shining and off when it is not.
9) When the storage tank is placed above the collector, the cold water entering the bottom of the collector will rise into the storage tank and then flow by gravity into the building pipes. This works best in small buildings.

FOLLOW-UP:
Have the class gather the necessary materials and then construct a model solar water heater similar to the one in Figures 8A and 8B.

FIGURE 8A **Solar Water Heater Collector**

There are several basic kinds of collectors made by a number of manufacturers.

This flat-plate collector consists of a black absorber plate which is heated by the sun's radiation. The heat is transferred through tubing to water running through the tubes.

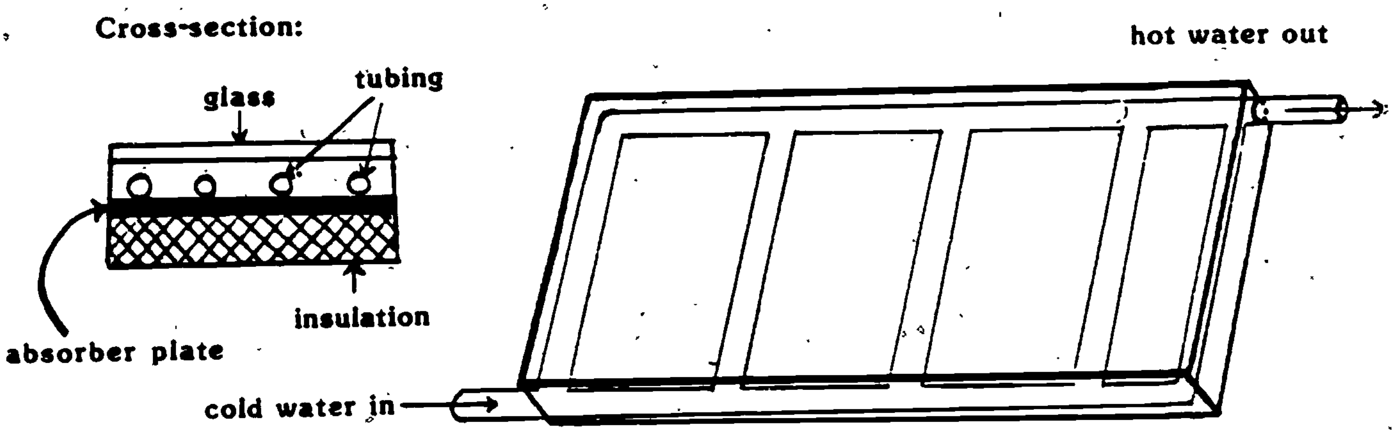
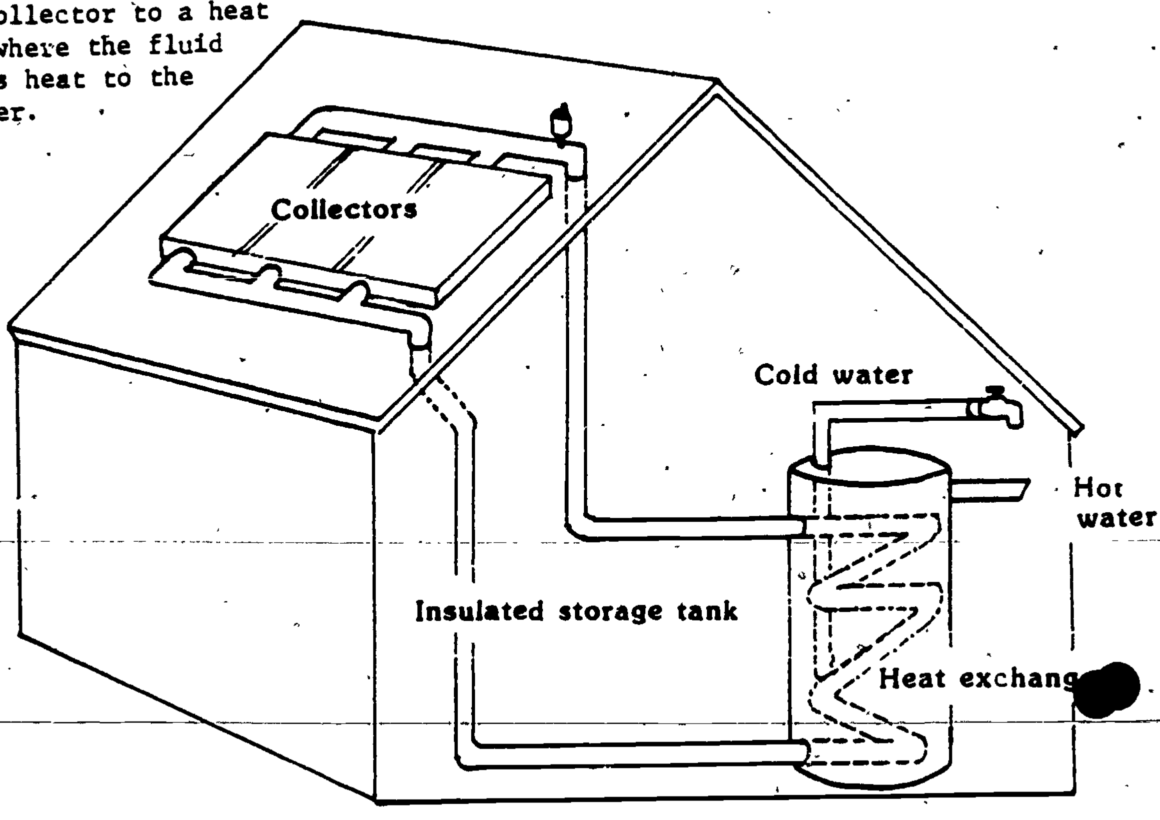


FIGURE 8B **Closed Loop System**

A closed loop system circulates a pressurized, nonfreezing heat transfer fluid through a collector to a heat exchanger, where the fluid gives up its heat to the potable water.



Lesson #14: HOW A WINDMILL GENERATES ELECTRITY

AIM: To learn how a windmill generates electricity.

MOTIVATION: Take a simple pinwheel and blow on it.

MATERIALS: Pinwheel, photocopies diagram of windmill.

DEVELOPMENT:

1) "From our previous discussions, do you remember what we called the type of energy that moved the pinwheel?" (Mechanical)

2) "This is the energy that turns a windmill."

3) "Do you remember how electricity is generated from our previous discussion?" (See Lesson 8)

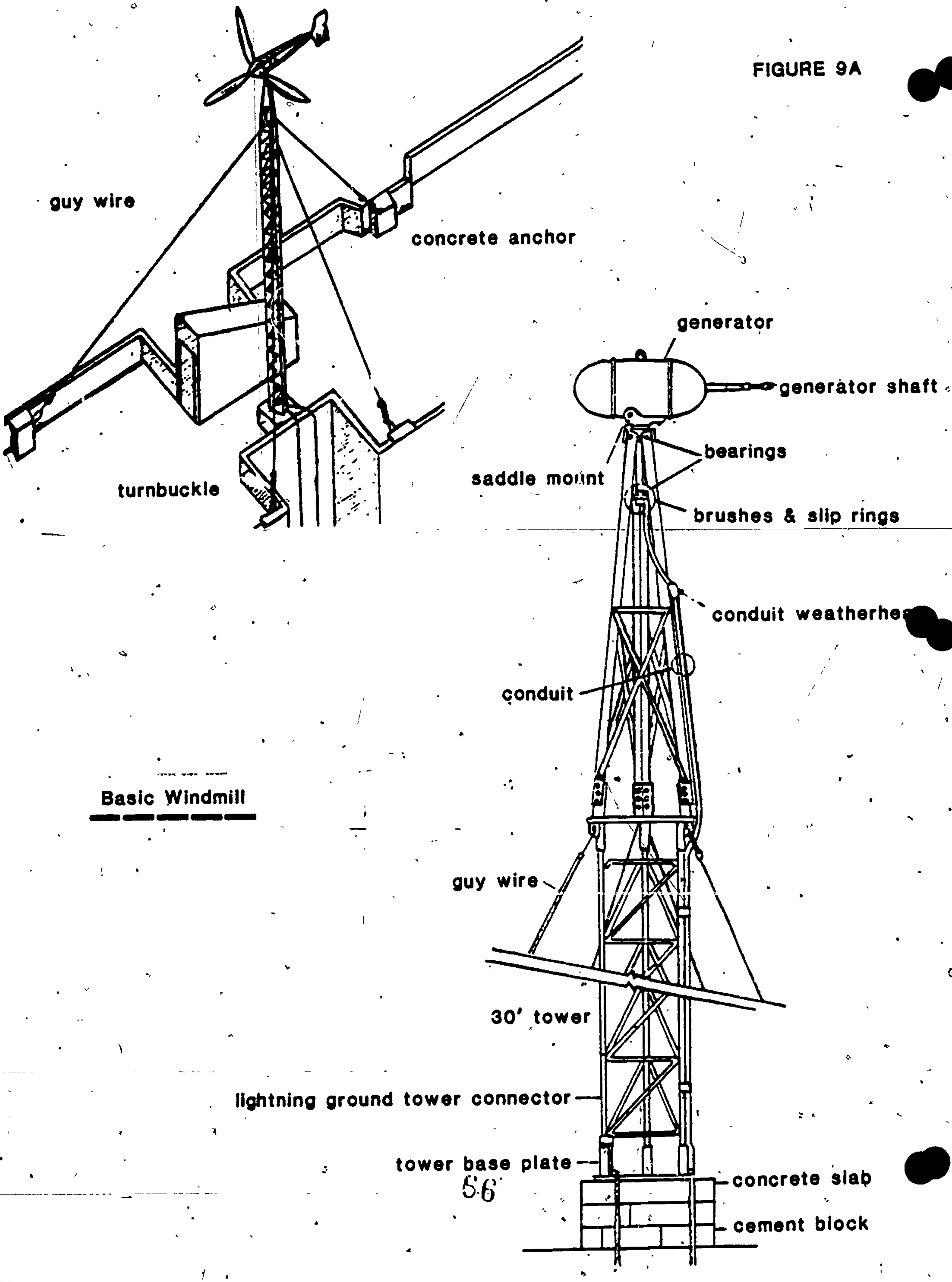
4) Review with the students the operation of a power plant as covered in Lesson 8.

5) The wind causes the blades of a windmill to revolve and turn a shaft connected to a generator which causes the generator to revolve. (In a power plant, oil, coal, or another energy source is used to boil water which produces steam, the mechanical energy which causes turbogenerators to turn.)

6) The revolving generator in a windmill creates an electric current in an armature. (See Figures 9A and 9B)

7) This power is transferred from the armature through a commutator to stationary brushes where it is transferred through slip rings down the electric wires of the windmill tower and eventually into the building or house the windmill services.

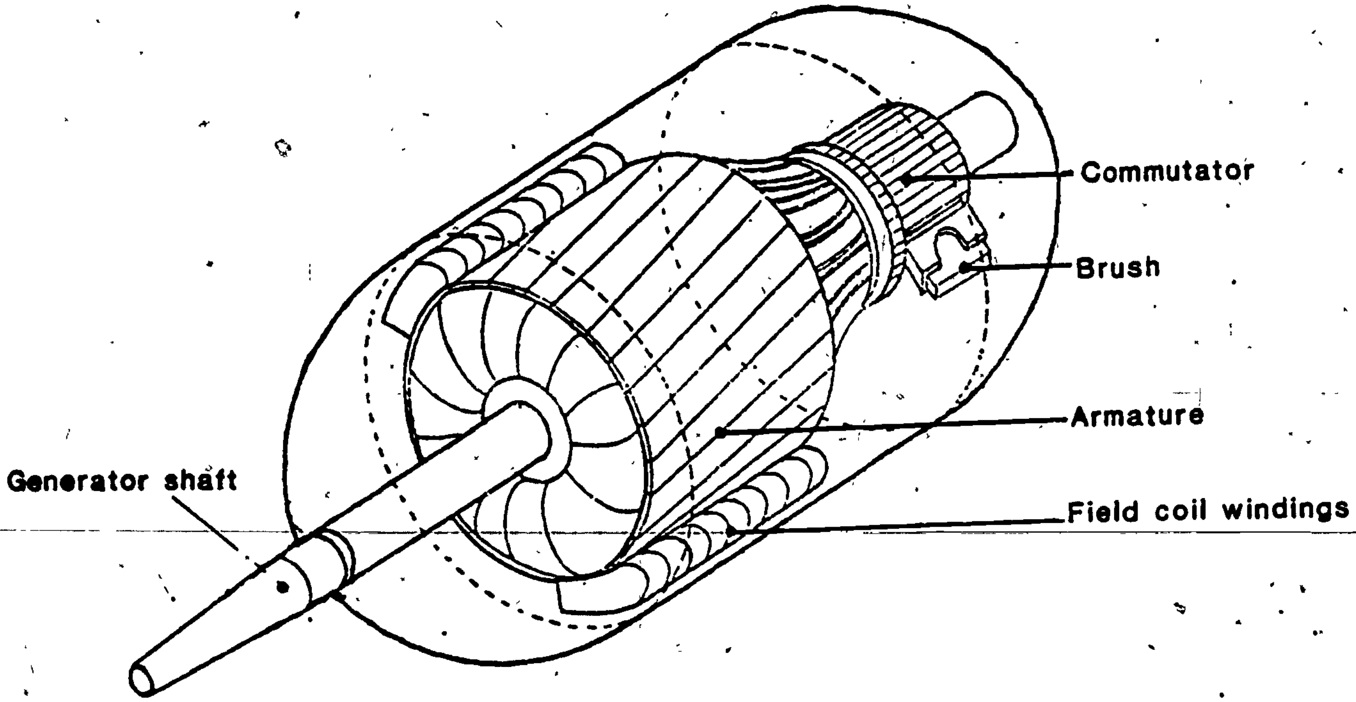
FIGURE 9A



Basic Windmill

FIGURE 9B

Basic Generator



An electric current can be created through the rotation of a magnet or of an electro-magnetic field which basically consists of a wire around a metal core. The relative motion of such a magnetic field creates a flow of electricity through the windings of the armature. While this diagram represents the classic direct current (DC) generator, many windmills employ an alternator to send out alternating current (AC).

FOLLOW-UP

Have the student research the final steps through which the electric current generated in the windmill flows from the electric wiring of the windmill towers to the various appliances, machines, etc. which depend on the current for their operation.

Lesson #15: SMALL HYDROELECTRIC PLANTS

AIM: To learn how a small hydroelectric plant works.

MOTIVATION: Now that we've studied about how a solar collector, solar hot water heater, and windmill work, let's study one more way we could fill our energy needs besides using oil, coal, or natural gas.

MATERIAL: Photocopied diagrams of small hydroelectric plant.

DEVELOPMENT:

1) "What was one of the main sources of energy we discussed in previous lessons in addition to oil, coal, natural gas, the sun, etc.?" (Water or hydroelectric power)

2) "What do we call the energy of moving bodies, e.g. - the energy of drops of water in a waterfall?" (Kinetic)

3) "What kind of energy causes the blades of the windmill and the generator to turn?" (Mechanical energy)

4) "We said the drops of falling water possess kinetic energy. What about the whole waterfall?" (Mechanical energy)

5) "When water is used as a source of energy, it is usually stored in a reservoir."

6) "It flows from the reservoir through a gate or penstock where the mechanical energy of the falling water causes a turbine to revolve which then causes a generator to turn." (See Figure 10)

7) "How is electricity produced when this happens?" (Refer to lessons 8 and 14).

8) Explain to the students that many years ago hydroelectric plants were small. They were used to power a single factory or home or a cluster of factories or homes built beside the river. They were not intended or able to provide power to vast areas. In recent years power companies have built large hydroelectric plants which service large numbers of people. Large dams had to be constructed to increase and regulate the flow of water to these plants. Such dams have often substantially changed the surrounding landscape, for instance, by creating large lakes where before there was only a river (See Figure 10). Some proponents of conservation who want to save oil, coal and gas are now saying that more small hydroplants should be built. Such plants can provide energy and are less destructive to the land than large hydroplants. Such small plants can be hooked into existing transmission systems (See Lesson 8) or can be attached directly to a small electric user, e.g., a factory, a house, etc.

FOLLOW-UP:

Have the students research and diagram the various types of small hydroplants now in operation.

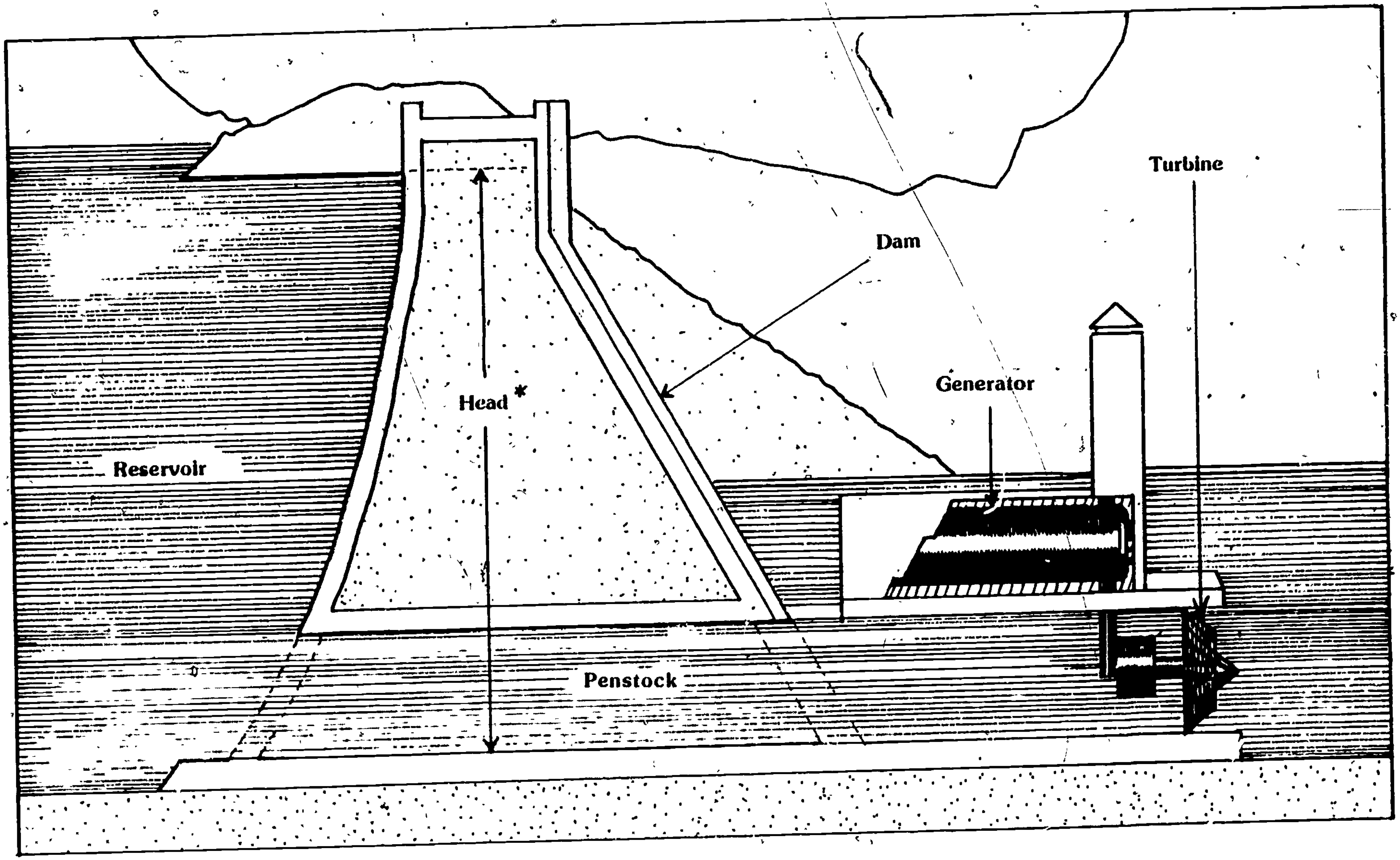


FIGURE [illegible] Hydroelectric Plant

*Head – the distance or height between the level of the water surface and the turbine

Lesson #16: ENERGY CAREERS

AIM: To explore different energy research and development careers.

MOTIVATION:

1) "Would any of you be interested in having jobs that involve the research and development of energy?"

2) "Let's find out what jobs might be available."

MATERIALS: Notebook and pencil.

DEVELOPMENT:

1) a) "What are some of the natural sources of energy?" (Oil, coal, natural gas, sun, wind, water, uranium, etc.)

b) "Is it always easy to find and use the more conventional natural sources of energy?"

2) "Where do we find oil, coal, and natural gas?" (Under the ground, under the sea, etc.)

3) "What kinds of workers help in finding these sources of energy?" (Geologist, oceanographer, mining engineer, etc.) Discuss possible functions of each briefly.

4) Start a list in students' notebooks of energy careers by function:

Finding Natural Energy Sources
Geologist
Oceanographer
Mining Engineer
____
____
____

5) "Who helps to tap the natural sources of energy and deliver them to us?" (All kinds of engineers (mechanical, electrical, civil), construction workers, miners, technicians (electrical, mechanical, etc.) truck drivers, etc.) Add to the list developed in question 4:

Locating Energy Sources	Energy Source Development and Delivery
Geologist	Engineer (mechanical, civil, electrical)
Oceanographer	Construction worker
Mining engineer	Mechanic
____________	Miner
____________	Electrical technician
____________	Truck driver
____________	Geologist

6) a) "What are some of the jobs that involve research and development of some of the alternative sources of energy like solar, geothermal, etc.?"

b) "For example, who helps us install solar collectors on a house?" (Architects, engineers, mechanics, plumbers, construction workers, etc.)

c) "Who would do research into such developments?" (Chemists, physicists, engineers, etc.)

7) "Who would help in conserving energy, for example, building houses that have proper insulation, heating systems, design?" (Architects, construction workers, electricians, appliance mechanics - TV, air conditioning, etc.)

8) "Let's expand our list"

Energy Careers

Finding Energy Sources	Conventional (e.g. oil, gas) Energy Development, and Delivery	Alternative Source Development and Conservation Technology	The Politics of Energy
Geologist	Engineers (mechanical, civil, electrical)	Chemist	Lobbyist
Oceanographer	Construction worker	Physicist	Organizer
Mining Engineer	Mechanic	Architect	Teacher
________	Miner	Engineer	________
________	Technicians (electrical, nuclear, etc.)	Mechanic	________
________	Truck driver	Construction worker	________
	Geologist	Electrician	
	________	Appliance mechanic	
	________	Truck driver	
	________	________	
		________	
		________	

SUMMARY: "Who thinks they might be interested in an energy related career?"

FOLLOW-UP:

Using the committee approach, divide the class into four or more committees for the four areas outlined in the Energy Careers list and any other categories you can think of. Give each student the opportunity to select a particular career that he or she is interested in and have the students prepare reports on the functions performed by the career specialty, the educational and occupational requirements for achieving a career in the specialty, future job possibilities in that area, etc. Feel free to expand or change the career categories in any manner you wish.

Lesson #17: FAMOUS PEOPLE IN ENERGY

AIM: To learn about famous people in the energy field.

DEVELOPMENT: As a motivational follow-up to the careers lesson, involve students in researching people who have contributed to energy research and development. Use the descriptive list of famous people in energy as a starting point for individual or committee research. Divide famous people by historical periods, by energy types, or in any other way conducive to class research.

SOME FAMOUS PEOPLE IN ENERGY[14, 15]

Isaac Newton (1643-1727) formulated the three basic laws of motion, defining mass, inertia and force and their relationship to velocity and acceleration. Newton also formulated the concept of universal gravity. To make his theoretical concepts and laws usable, he developed calculus.

Benjamin Franklin (1706-1790) discovered in 1752 that the discharge of electricity produced by the friction machine was the same as lightning in the heavens. He developed the lightning rod.

Andre-Marie Ampere (1775-1836), George Ohm (1787-1854), and Alessandro Volta (1745-1827) all lived at about the same time. People were aware that electricity and magnetism existed, but lacked knowledge of their relationship and ways of measuring them. In 1792, Volta found he could arrange some metals in series so as to produce a momentary flow of electricity; the volt was named for him. Ampere discovered the mathematical relationship between electricity and magnetism and was the first to develop a measuring technique for electricity; the amp (or ampere) was named for him. Ohm established the idea of resistance and formulated a law showing the relationship between current, voltage, and resistance.

Michael Faraday (1791-1867) discovered that relative motion between a magnet and a closed coil of wire induces a flow of current in the wire. In other words he showed that electricity could be produced from magnetism. Similar discoveries were also being made independently at the same time by Joseph Henry in America. Faraday's concept led to the invention of the dynamo, later called the generator, and the motor.

James P. Joule (1818-1889) was a physicist who established that various forms of energy -- mechanical, electrical and heat -- are basically the same in that they can be changed, one into another. In 1843, he published his measurement for the amount of work required to produce a unit of heat; the value of the mechanical equivalent of heat is generally represented by the letter J and that standard unit of heat is called the joule.

William Thompson (Lord Kelvin, 1824-1907) played a major role in the development of the conservation of energy principle. He formulated the absolute temperature scale (273°K = 0°C = 32°F). Absolute zero is the temperature at which there is no molecular motion. Kelvin also helped in the development of the dynamic theory of heat, the mathematical analyses of electricity and magnetism, and the basic ideas for the electromagnetic theory of light (as opposed to the wave theory).

Thomas A. Edison (1847-1931) was an inventor who, in 1879, created the first incandescent bulb. The same year he began to manufacture these bulbs and opened the first power plant in New York City.

Albert Einstein (1879-1955) formulated concepts which led to the development of atomic energy, the theory of relativity which relates mass to energy, and the photoelectric theory whereby electricity is obtained from light.

Other Important Contributors to Energy Development

- Robert Hooke (1635-1703)
- Daniel Bernoulli (1700-1782)
- Henry Cavendish (1731-1810)
- Joseph Priestley (1733-1804)
- James Watt (1736-1819)
- Charles Augustin de Coulomb (1736-1806)
- John Dalton (1766-1844)
- H.C. Oersted (1777-1851)
- Humphrey Davy (1778-1851)
- Joseph Louis Gay-Lussac (1778-1850)
- Sadi Carnot (1796-1832)
- Joseph Henry (1799-1878)
- Hermann Hemholtz (1821-1894)
- Jean Joseph Etienne Lenoir (1822-1900)
- James Maxwell (1831-1879)
- Willard Gibbs (1839-1903)
- Elijah McCoy (1844-1928)
- Karl Benz (1844-1929)
- Howard Lewis Latimer (1848-1928)
- Henrich Hertz (1857-1894)
- Rudolph Diesel (1858-1913)
- Pierre (1859-1906)
  Marie (1867-1934) Curie
- Ernest (Lord) Rutherford (1871-1937)
- Charles Parsons (1854-1931)
- George Westinghouse (1846-1914)
- Granville T. Woods (1856-1910)
- William Stanley (1858-1916)
- Charles Steinmetz (1865-1923)
- Guglielmo Marconi (1875-1937)
- Neils Bohr (1885-1962)
- Linus Pauling (1901 ----)

Students will discover other key figures in the development of energy as they do their research.

CURRICULUM ADDENDA

Coal

Our large supplies of coal were formed about 250 million years ago at a time when swamps and forests covered great areas of the earth. Dense vegetation trapped and stored energy from the sun and as plants and ferns died, layers of rich soft coal began to form. Later, the earth's surface sank, and ocean water water rolled in over these layers. The tremendous pressure and weight of the water caused the formation of coal.

In the U.S., during the late 1800's, coal replaced wood as the major source of fuel for home, industrial, and railroad uses. Coal remained "king" well into the 20th century until the "wonder fuel," oil, became the market favorite.

In recent years, coal has been used primarily for conversion into electric power at generation plants. A look at current U.S. energy resources indicates a very abundant supply of coal as compared to all other fossil fuels. With such a great amount, why aren't we using more of it? There are a few major drawbacks to the use of coal. The most easily accessible coal supplies have already been mined and workers must now dig deep into the earth. The additional equipment and manpower needed is quite expensive and the risk of physical danger to the workers is greatly increased.

There are also environmental problems associated with the use of coal. Most coal has a high sulfur content, when it is burned at industrial plants and factories sulfur waste pollutes the air. Another environmental problem is that in order to mine many available coal sites, large areas of land have to be destroyed.

Natural Gas and Oil

Since the turn of the 20th century, there has been a steady increase in the use of oil and natural gas to meet our nation's energy needs. Combined, natural gas and oil provide over 75% of the United States and 90% of New York's energy demands. These fossil fuels were formed thousands of years ago as tremendous heat and pressure worked on layers of decaying plant and animal life.

Today oil supplies the greatest portion of U.S. energy needs. The fact that two-thirds of the world's proven oil reserves lie under the deserts of the Middle East and Africa has a major effect on foreign relations and the balancing of trade. Thirteen foreign oil producing nations have formed an organization called OPEC (Organization of Petroleum Exporting Countries) and together they determine the price on a barrel of oil. Foreign oil is delivered to the U.S. via huge ships called super tankers.

Most United States domestic oil is produced in the southern and southwestern states including Texas, Louisiana, California, and Oklahoma. Oil is also shipped to the U.S. mainland from Alaska via the Alaskan pipeline. Domestic crude oil is sent from drilling sites to refineries where it is converted into such by-products as gasoline, heating oil, diesel fuel, and various other fuels. In most cases the product is received by a distributor, who stores the product in large tanks commonly referred to as "tank farms." The product is then transported by truck to a retailer who sells it, to consumers (i.e. home heating oil) or to places where it will be resold to many customers (i.e. gas station). A good description of this procedure is provided in a 16mm film entitled "Faces of Energy" distributed by Buchan Pictures, 254 Delaware Avenue, Buffalo, New York 14202 on a loan-free basis.

The discovery of oil is often accompanied by the presence of natural gas, another fossil fuel. Gas is supplied to homes, factories, etc., by gas companies through underground pipelines. Many consider natural gas to be the most desirable fossil fuel because it requires little maintenance and is relatively pollution-free when burned. The difficulty with natural gas is that known reserves are limited and the prospects of discovering new supplies are low.

Conversions

BTU

One very popular measure of energy is the British Thermal Unit (BTU), which is the amount of energy required to increase the temperature of one pound of water by one degree Fahrenheit. Note the following energy conversions:

To Convert	Into	Multiply By
Kilowatt hour (Kwh)	BTU's	3,413
1 Barrel (42 Gallons crude oil)	BTU	5,600,000*
1 Gallons, No. 2 oil (home heating & diesel)	BTU	138,000*
1 Gallon, No. 6 oil (Apartment bldgs., etc.)	BTU	150,000*
1 Gallon, Kerosene	BTU	135,000*
1 Gallon, Gasoline	BTU	125,000*
1 Horsepower	BTU/min	42.4176
1 Horsepower (boiler)	BTU/hr.	33,476
1 Short ton, anthracite coal	BTU	25,400,000*
1 Short ton, bituminous	BTU	26,000,000*
1 Cubic foot, Natural Gas	BTU	1,000*
1 Therm, Natural Gas	BTU	100,000*

*These are average values. Since exact "BTU" content varies with type and source, contact a supplier when extreme accuracy is essential.

Common Metric Measurements

Kilometer (km)	1,000 m.	0.62 mi
Meter (m)	1 m.	39.37 in.
Decimeter (dm)	0.1 m.	3.94 in.
Centimeter (cm)	0.01 m.	0.39 im.
Millimeter (mm)	0.001 m.	0.04 in.
Liter (l)	0.908 qt. (dry)	1.057 qt. (liquid)
Metric Ton (MT or t)	1,000,000 g.	1.1 U.S. tons
Kilogram (kg)	1,000 g.	2.2046 lbs.
Gram (g or gm)	1 g.	0.035 oz.

Temperature

A 9° rise or fall in the fahrenheit temperature scale corresponds to a 5° change in the centigrade scale.

To get: Celsius multiply by 9/5ths, then add 32 = Fahrenheit

Fahrenheit subtract 32 then multiply by 5/9ths = Celsius

Can Solar Collector[16]

Who Can Do It?

Fifth- through eighth-graders should be able to build this simple can solar collector at home or at school. The carpentry skills needed are minimal. Anyone who has used a saw and hammer should be able to construct this collector. Teachers who have had no carpentry experience should be able to obtain advice and aid from the vocational/technical departments of local secondary schools or any friend who has a basic wood workshop at home.

Material Costs

Costs can be little to nothing if scrap materials are used. In fact, it is highly recommended that scrap materials be used to emphasize the concept of recycling "waste" materials as well as to convey the principles of solar heating. If materials are purchased, the cost of the solar collector will be around $2.00/sq. ft..

Time to Completion

This solar collector can be built in about 4 hours if all the materials are available. However, it usually takes several days to organize all of the materials.

Advantages

Solar collectors similar to this prototype have been built by sixth- and seventh-graders and have held appeal to students in lower grade levels (one through five) as well. The youngsters' enthusiam for this kind of solar collector largely stems from the use of materials with which the students are familiar, such as juice cans.

Procedure

Students are asked to bring in coffee cans and large juice cans from home, a sheet of glass, an old storm window or transparent plastic and a piece of 3/4-inch exterior grade plywood will also be needed.

The bottoms of the cans are removed, converting the cans into metal tubes. The can-tubes are then taped together with fiberglass tape, forming longer tubes which are in turn painted flat black on their outer surface. Flat-black paint can be obtained from a hardware store; 1 pint should be enough. The length of the tubes is determined by the size of the solar collector box and storm window and will be unique for each collector built. For the best thermal performance, the collector should be 6 feet or longer.

A solar collector box can be built of 3/4-inch exterior grade plywood or shelfing boards. Its width and length are determined by the storm window to be used. However, if one chooses to use clear plastic sheeting (polyethylene) for the collector's glazing, the collector can be made longer than the size prescribed for a storm window. The depth of the collector can be about 1 foot. Air inlet and outlet holes should be cut at either end of the collector box. The storm window can be mounted onto the plywood box with screws and should be sealed with caulking compound, If plastic sheeting is used for glazing, it could be nailed down with wooden laths to the collector's box.

Fiberglass or styrofoam insulation can be placed in the back of the can solar collector. With the collector inclined toward the sun, sunlight passes through the storm window glazing or clear plastic and strikes the black metal tubes. A portion of the sunlight is converted to heat on the flat black surface. The air inside the tubes is heated and begins to rise through the tubes, finally passing out of the hold at the top end of the collector box. Cooler air flows in the hole at the bottom of the box and replaces the heated air that is escaping from the upper portions of the tubes and collector. Under natural, sunny conditions, a collector such as this one has heated air to above 150°F.

Students could be asked to take air temperature measurements of the air flowing into and out of the collector. By comparing the difference between these measurements, the students should be able to comprehend the effectiveness of the solar collector as an air heater. Air temperature measurements can be taken while the collector is positioned at various angles in relation to the sun. The temperature exiting the collector should be the highest when the collector is perpendicular to the sun's radiation. The class members could be questioned. For instance: "what is the best angle for the collector to gather heat in the winter or the summer?" For a detailed description of collector angles for optimum winter and summer solar collection, see the text entitled The Solar Home Book (included in the references).

The basic means of heat transfer (radiation, conduction, and convection) can be discussed in relation to the collector. For example, the solar radiant energy is absorbed by 'flat-black' metal cans and is converted in part to heat. The heat conducted through the cans can be measured by taping a thermometer to the cans. And the air currents created by heat convection can be demonstrated by holding a smoking match near the air exit of the collector.

References

Direct Use of the Sun's Energy by Farrington Daniels. Available from Ballantine Books, P. O. Box 505, Westminster, MD 21157, $2.20.

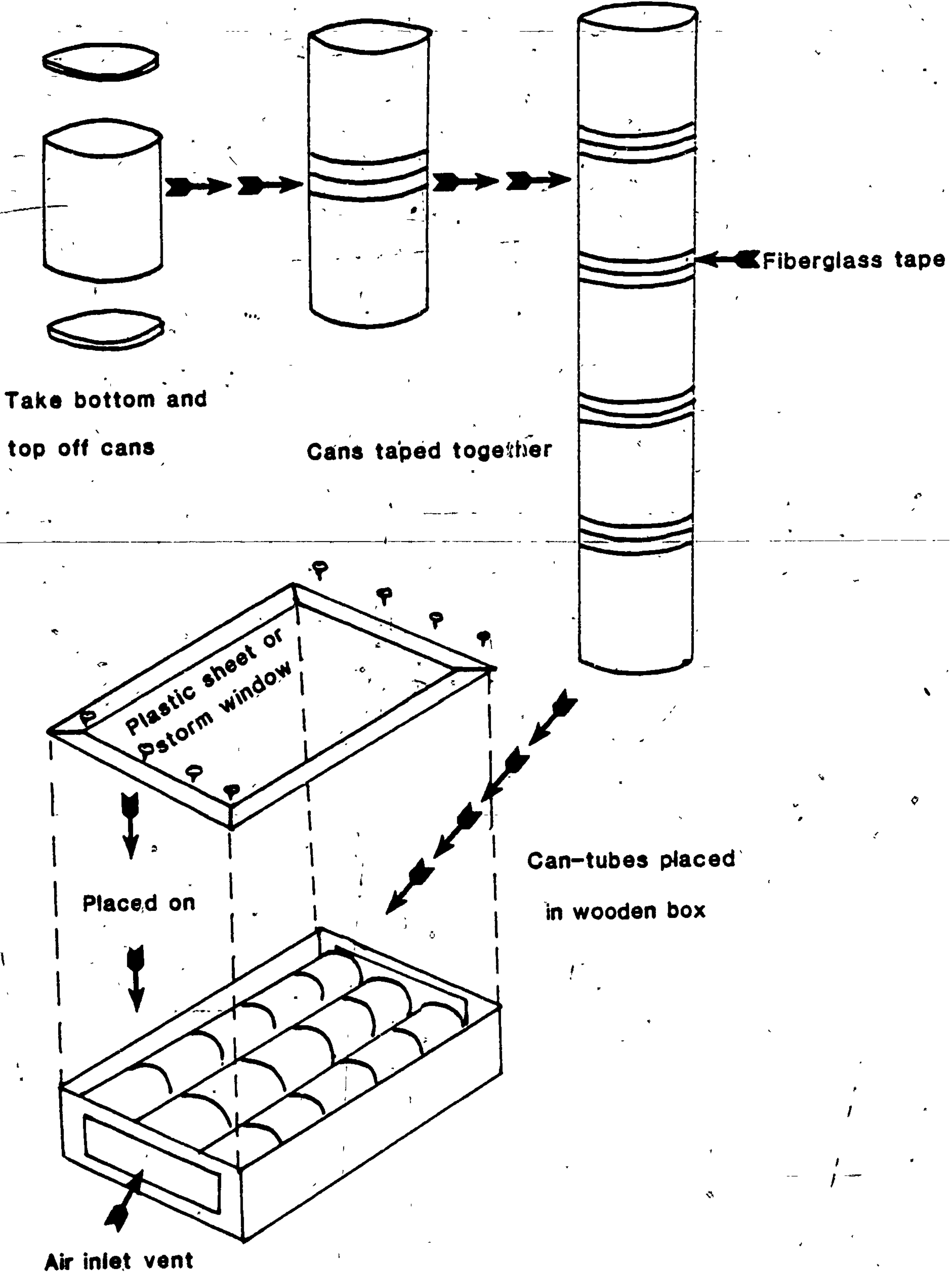
Solar Age (a monthly periodical). Available from Solarvision, 200 East Main Street, Port Jervis, NY 12771, $20.00 per year.

Solar Energy Digest (a monthly periodical). Available from S.E.D., Box 17776, San Diego, CA 92117, $28.50 per year.

Solar Engineering (a monthly periodical). Available from Solar Engineering, 8435 North Stemmons Freeway, Suite 880, Dallas, TX 75247, $10.00 per year.

The Solar Home Book by Bruce Anderson and Michael Riordan. 1976. Available from Cheshire Books, Church Hill, Harrisville, NH 03450 $7.50.

30 Energy Efficient Houses . . . You Can Build by Alex Wade, 1970. Available from Rodale Press, Emmaus, PA, 18049, $10.95.


Fiberglass tape
Take bottom and top off cans
Cans taped together
Plastic sheet or storm window
Placed on
Can-tubes placed in wooden box
Air inlet vent

A Small Wind Generator[17]

Who Can Do It?

Advanced science students in junior high school could build this wind generator. However, it could serve as a wind demonstration project even at the community college level.

Material Costs

Could be as high as $40.00 if all the parts are purchased. However, costs can be cut if recyclable parts are used.

Time to Completion

At least 16 hours should be allocated for the wind generator's construction. This does not include the time involved in locating the parts.

Advantages

A minimal amount of skill is needed for this wind generator's construction and it can provide a working demonstration of the conversion of kinetic wind energy to electricity.

Procedure

This wind generator prototype involves a propeller or blade connected to a bicycle generator. The bike generator is in turn connected to a pivoting arm with a tail. The electrical current generated is stored in a battery.

A bicycle generator (6 volts, 3 watts) is the major component of this sytem to convert the kinetic wind energy to electricity. Since the electrical current generated is alternating (A.C.) it needs to be converted to direct current (D.C.) if it is to be stored in a battery (6 volts). A semiconductor diode serves as a bridge rectifier to transform the 6 volt A.C. to a pulsating 6 volt direct current. A salesperson at a local electrical parts shop or someone versed in electronics should be able to help in locating the bridge rectifier (IR 18DBZA). To demonstrate the practical use of the electrical energy being generated, a small 6 volt D.C. radio or light can be connected to the battery. The 6 volt D.C. battery can be obtained from various surplus houses. Nickel cadmium batteries such as the rechargeable varieties used for portable tools should serve the purpose.

A discarded fan propeller can serve as the blades for the wind generator. Students could also experiment by constructing and designing their own blades. Certain references listed at the end of this activity discuss blade construction. See Alternative Sources of Energy, issues #14, 20, 24, 29, and Jack Park's book Simplified Wind Power Systems for Experimenters.

The friction wheel of the bike generator hopefully will fit into the hub of the discarded fan blades. If the hud is too large, metal contact cement such as aluminum glue (obtainable at a local hardware store) can be used. If the hub is too small, a rat-tail file may be needed to enlarge the hub hole to size.

A pivot arm made of wood about 1" x 1" and 3 feet long should be obtained. A tail is attached by screws to one end of the pivot arm. The tail, made of wood or metal sheeting, should be built with 2 square feet of surface area. The bike generator (with blades) is then mounted on the other end of the pivot arm. Airplane clamps or wire can be used to hold the generator to the pivot arm.

Once the tail, generator, and blades have been mounted one can experiment with balancing the pivot arm on one's finger. After a few trials, one will discover the position on the pivot arm where the weight of the tail is equally balanced against the weight of the generator. This "balance point" should be marked and a hole drilled at that spot. A bolt is then passed through the hold and attached to the pole where the wind generator is to be permanently placed. A washer should be placed between the pivot arm and the pole.

The wires that run from the generator and down the windmill pole (see illustration) should have enough slack in them so that the windmill can turn easily into the wind without binding. The wires can be periodically unravelled should they become tangled.

Variations on the Same Theme

The class can connect a small 6 volt light to the generator and watch it brighten as the wind speed increases.

Several concepts are important to mention. If the wind speed doubles, the power that the generator can put out increases by a factor of eight. If the diameter of the propeller is doubled, the power that the generator can put out is increased by a factor of four.

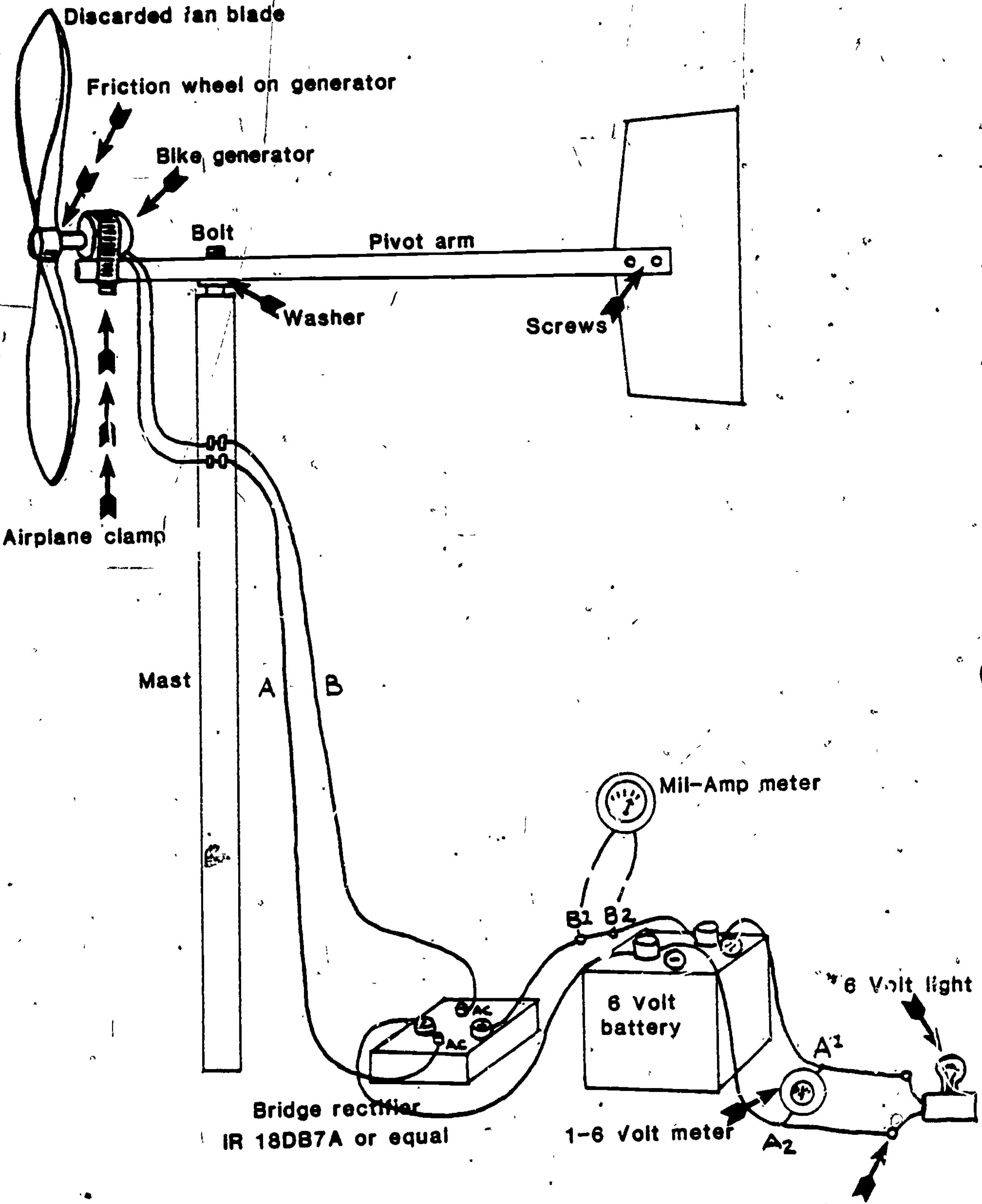
Students could analyze the power output at various wind speeds by using a hand-held wind speed indicator and checking the power output with multi-amp meters (connected at points A_1A_2 in circuit diagram) and with 1-10 volt voltmeter (connected at points B_1B_2 in circuit diagram).

References

Alternative Sources of Energy magazine has carried a number of articles on handbuilt wind generators. The activity given in this guidebook was adapted from "Low Power Windmill" by John McGeorge, February, 1978, issue. Other issues which have covered wind generators as well as blade construction are #14, 20, 24 and 29. Single issues are $2.00 and subscriptions $15.00 per year. Order from Rt. 2, Box 90A, Milaca, MN 56353.

Simplified Wind Power Systems for Experimenters by Jack Park (73 pages). Available from Jack Park, Box 445, Brownsville, CA 95919, $6.00. Provides basics on designing windmill blades.

Wind and Windspinners by Michael Hackleman, 1974 (139 pages). Available from Earthmind, 5246 Boyer Road, Mariposa, CA 95338, $7.50. A "how-to" book on building S-rotor wind generators.


Discarded fan blade
Friction wheel on generator
Bike generator
Bolt
Pivot arm
Washer
Screws
Airplane clamp
Mast
A
B
Mil-Amp meter
B1 B2
6 Volt battery
6 Volt light
A1
Bridge rectifier
IR 18DB7A or equal
1-6 Volt meter
A2
Terminals

FOOTNOTES

[1] Richard G. Stein and Carl Stein, Research, Design, Construction, and Evaluation of a Low Energy Utilization School. Prepared for the Board of Education, City of New York with the support of the National Science Foundation (New York, 1974). Phase 1; interim report, sections a-e, p. B, 7.

[2] Stein and Stein, p. B, 7.

[3] Energy - Ideas for Parks, Park Project on Energy Interpretation, National Recreation and Parks Association (Arlington, Virginia, November, 1976) Issue 4, p.4.

[4] Michael Zamm, Walking: A Realistic Approach to Environmental Education, Center on the Environment of New York City (New York, 1976), p. 14.

[5] Adapted from Using Electricity Safely In Your Home, Consumer Affairs Dept., Consolidated Edison Company of New York (New York, 1976), pp. 26-29.

[6] Robert F. Schultz, Electrical Experiments You Can Do . . . From the Diary of Michael Faraday, Thomas Alva Edison Foundation (Detroit, 1971), p. 4.

[7] Science - Grade 8, Curriculum Bulletin, 1967-68 Series, No. 20, Bureau of Curriculum Development, Board of Education, City of New York (New York, 1968), p. 101.

[8] Science - Grade 8, p. 101.

[9] Energy Conservation. . . Experiments You Can Do, Thomas Alva Edison Foundation (Southfield, Michigan, 1975), p. 17.

[10] Science - Grade 8, p. 101.

[11] Science - Grade 8, p. 101.

[12] Energy Conservation. . . Experiments You Can Do, p. 11.

[13] Handbook of Energy Lessons-Elementary Level, Solar Education Corporation (Litchfield, Connecticut, 1978).

[14] Encyclopedia Britannica, Encyclopedia Britannica Education Corporation (Chicago, 1976).

[15] Careers in Electrical Wiring and Electrical Contracting: Careers Research Monographs, The Institute for Research (Chicago; 1959), pp. 4-5.

[16] Energy Education Guidebook, Community Services Administration (Washington, D.C.), pp. 87-91.

[17] Energy Education Guidebook, pp. 121-124.

GLOSSARY

Ampere - A unit of electrical current produced by one volt in a conductor or resistance of one ohm.

BTU (British Thermal Unit) - The quantity of heat necessary to raise the temperature of one pound of water one degree Fahrenheit. One BTU equals 252 calories, 1055 joules and 0.293 watt-hours.

Circuit - The path of an electric current.

Energy - The power by which anything moves, changes other things, or accomplishes any results. Energy is capacity for work. Energy and work are measured in the same units, e.g. joule, calorie, kilowatt hour.

Chemical Energy - Many forms of matter contain large amounts of potential energy because of their chemical composition. Coal, natural gas, and oil are important examples of substances that have chemical energy; these substances are also known as primary fuels.

Electrical Energy - A form of energy created by the flow of electricity charged particles.

Heat Energy - The energy an object possesses as its molecules move faster and its temperature increases.

Kinetic Energy - The energy of an object in motion, e.g., the water droplets in a waterfall have kinetic energy.

Light Energy - Energy from luminous bodies like the sun. There are two theories used but not reconciled on the composition of light energy: one that it's composed of waves, the other that it's composed of particles.

Mechanical Energy - The energy that is caused by the movement of physical bodies, e.g., a pulley.

Nuclear Energy - Energy released by actions and reactions of atomic nuclei.

Sound Energy - Pressure waves, created by vibrating objects, that travel through the air, water and solid matter.

Fluorescent Lamp - A glass tube coated on the inside with a fluorescent substance that gives off light when activated.

Foot Candle - Unit of illumination quantity. It is the illumination on a surface one square foot in area on which there is a uniformly distributed luminous flux of one lumen.

Force - The push or pull exerted on a body which may alter its motion by causing its speed or direction to change.

Geothermal Energy - The internal heat of the earth.

Horsepower (Hp) - A standard unit of power equal to 746 watts in the United States. One horsepower equals 2545 Btu/hour or 550 foot-pounds/second.

Incandescent Lamp - A lamp in which the light is produced by a filament of conducting material contained in a vacuum or inert gas and heated to incandescence by an electric current.

Insulator - A material that does not conduct electricity. Rubber, plastic and glass are examples.

Joule (rhymes with "pool") - A unit of energy or work which is equivalent to one watt per second or 0.737 foot-pounds.

Kilowatt (KW) - A measure of power equal to one thousand (1000) watts, approximately 1-1/3 horsepower, usually applied to electricity.

Kilowatt-hour (KWH) - The amount of energy equivalent to 1 kilowatt of power being used for one hour. It is equivalent to 3,413 BTU's of heat energy.

Langley - A measure of solar radiation.

Lumen - Unit of luminous flux. Lumens represent the time rate of transferring luminous energy (quantity of light).

Ohm - A measurement unit of electrical resistance.

Photosynthesis - The process by which green plants utilize solar energy to convert carbon dioxide and water into carbohydrates.

Power - The rate at which work is done; power is measured in units of work per unit of time, e.g., watt, horsepower.

Pyranometer - An instrument for measuring solar radiation.

Retrofit - The improvement of existing dwellings with insulation, fitting storm windows and doors, and applying weather stripping and caulking.

Thermodynamics, Laws of - The first law of thermodynamics states that energy can neither be created nor destroyed. The second law of thermodynamics states that when a free exchange of heat takes place between two bodies, the heat is always transferred from the warmer to the cooler body.

Volt - The volt is defined as the difference in electric potential between the points of a conducting wire carrying a constant current of 1 ampere, where the power dissipated between these points is equal to 1 watt.

Watt - A unit of electrical power equal to the work done by a current of one ampere with a potential difference of one volt. (number of Watts = voltage x current).

Watt hour - The amount of energy needed to power a one-watt device for one hour.

Work - A push or pull (force) over a distance.

ENERGY INFORMATION SOURCES

1. Buffalo Energy Project, 70 Harvard Place, Buffalo, NY, 14209, (716) 881-5150 Ext. 260.
2. Chautauqua County Energy Office, Mayville, NY, 14757, (716) 753-4258. Teachers Handbook on Energy.
3. Chemung County Energy Information Center, 205 Lake Street, Elmira, NY, 14901, (607) 737-2986.
4. Citizen's Energy Project, 110 Sixth Street, N.W., Washington, D.C., 20001, (202) 387-8998.
5. Conservation and Renewable Energy Inquiry and Referral Services (CAREIRS), P. O. Box 1607, Rockville, MD, 20850, 1-800-523-2929.
6. Consumer Action Now, 110 West 34th Street, New York, NY, 10001, (212) 736-8170.
7. Cornell University Cooperative Extension, Mailing Room, 7 Research Park, Ithaca, NY 14853, Energy fact sheets for homeowners and apartment dwellers.
8. Edison Electric Institute, 1119 19th Street, Washington, D.C. 20036, (202) 828-7587. Conservation and nuclear energy; energy kits (gr. 4-6) on electricity.
9. Energy Task Force, 156 Fifth Avenue, New York, NY 10010, (212) 675-1920. Has helped develop solar projects on 11th Street in Manhattan and 167th Street in Bronx. Good source of information on alternative energy.
10. Environmental Action Coalition, 417 Lafayette Street, 2nd Floor, New York, NY, 10003, (212) 677-1601. Recycling information.
11. Erie County Energy Office, Rath Building, 95 Franklin Street, Buffalo, NY, 14202.
12. Fireboat House Solar Energy Demonstration and Education Center, Fireboat House Pier, Gracie Mansion, 89th Street and East End Avenue. New York, NY 10028.
13. Nassau County Division of Energy, 1 West Street, Mineola, NY 11501, (516) 535-3838.
14. National Alliance to Save Energy, 1925 K Street, Suite 507, N.W., Washington, D.C. 20006, (202) 857-0666. Publishes a newsletter, distributes energy publications, posters.
15. National Center for Appropriate Technology (NCAT), P. O. Box 3838, Butte, MT, 59701, (406) 494-4572. Curriculum materials for small charge.
16. National Energy Foundation, 521 Fifth Avenue, New York, NY, 10017, (212) 697-2920. Educational materials for teachers.
17. National Recreation and Parks Association, 3101 Park Center Drive, Alexandria, VA, 22303, (703) 820-4940. Developed materials on energy in parks.
18. National Science Teachers Association (NSTA), 1742 Connecticut Avenue, N.W., Washington, D.C., 20009, (202) 328-5840. Publishes "Energy & Education" newsletter and distributes materials to provide direct classroom assistance to science teachers.

19. New York City Energy Office, 49 Chambers Street, New York, NY, 10007, 212-349-2951.

20. New York State Energy Office, Two Rockefeller Plaza, Albany, NY, 12223. Films and curriculum materials on all aspects of energy are available free to teachers; operates toll-free New York State Energy Hotline 1-800-342-3722.

21. New York State Energy Research & Development Authority, Department of Communications, Two Rockefeller Plaza, Albany, NY, 12223, (518) 465-6251. Booklets, brochures and reports on ERDA-sponsored projects aimed at developing and advancing new energy alternatives and energy conservation methods in New York State.

22. Operation Open City, 103 East 125th Street, New York, NY, 10035, (212) 427-0300.

23. Solar-Ed Corporation, 1627 Litchfield Turnpike, P. O. Drawer X, Woodbridge, CT, 06525, (203) 624-5151. Developed solar energy education material for the classroom; teacher manuals, slides, and demonstration kits.

24. Solar Energy Research Institute (SERI), 1917 Cole Boulevard, Golden, CO, 80401, (800) 231-1825. Solar information and educational materials.

25. Thomas Alva Edison Foundation, Cambridge Office Plaza, Suite 143, 18280 W. Ten Mile Road, Southfield, MI, 48075, (313) 559-1780. Will send booklets with energy experiments to teachers on request (free single copies).

26. U.S. Department of Energy, Technical Information Service, Oak Ridge, TN, 37830 Curriculum materials and films for teachers on energy topics.

27. Utility Contacts - New York State's utilities offer free energy information and teacher materials, as well as tours and films.

    1) Central Hudson Gas & Electric Corporation, 284 South Avenue, Poughkeepsie, NY, 12602, (914) 452-2000.

    2) Consolidated Edison Company of New York, 4 Irving Place, Room 1625-S, New York, NY, 10003, (212) 460-6905. Con Ed has a Conservation Center in the Chrysler Building at 42nd Street and Lexington Avenue.

    3) Long Island Lighting Company, 250 Old Country Road, Mineola, NY, 11501, (516) 228-2228. Energy Awareness Inservice Institutes for teachers.

    4) New York State Electric and Gas Corporation, 4500 Vestal Parkway East, Binghamton, NY, 13902, (607) 729-2551.

    5) Niagara Mohawk Power Corporation, 300 Erie Boulevard West, Syracuse, NY, 13202, (315) 474-1511.

    6) Orange Rockland Utilities, Inc., 1 Blue Hill Plaza, Pearl River, NY, 10965, (914) 627-2469.

    7) Power Authority of the State of New York, Marcy Operation & Maintenance Center, P. O. Box 191, Marcy, NY, 13403, (315) 724-8100.

    8) Rochester Gas & Electric Corporation, 89 East Avenue, Rochester, NY, 14649, (716) 546-2700.

    9) New York Power Pool, 3890 Carman Road, Schenectady, NY, 12302, (518) 381-2243, "Energy Today and Tomorrow" program for school children.

    10) Brooklyn Union Gas, 195 Montague Street, Brooklyn, NY, 11201, (212) 643-2000.

    11) National Fuel Gas, Consumer Services, 10 Lafayette Square, Buffalo, NY, 14203.

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The Council on the Environment of New York City

is a privately funded citizens' organization affiliated with the Office of the Mayor. CENYC is charged with promoting environmental concern among New Yorkers and solutions to environmental problems through demonstration projects and research, publications and public conferences.

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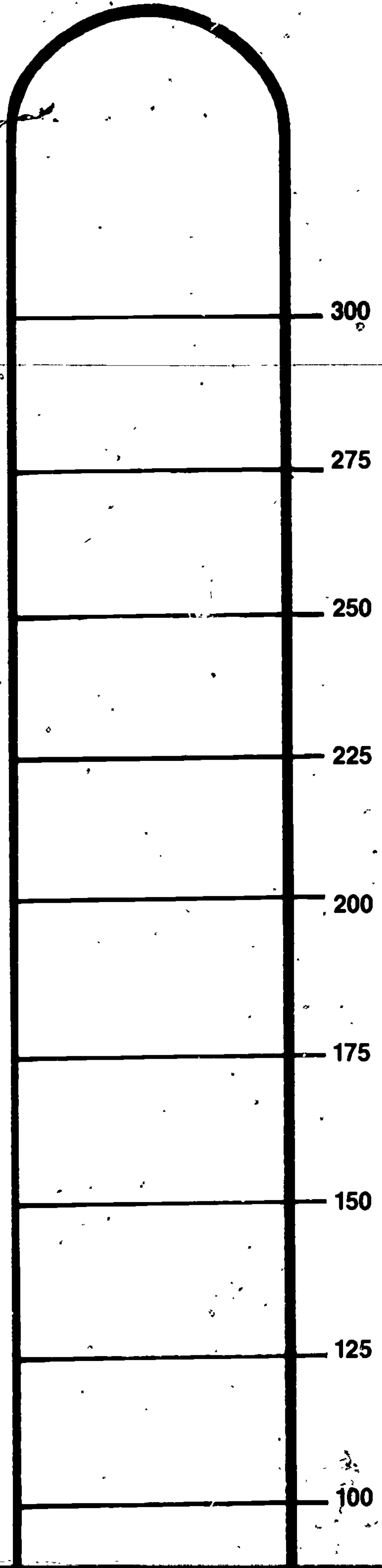

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