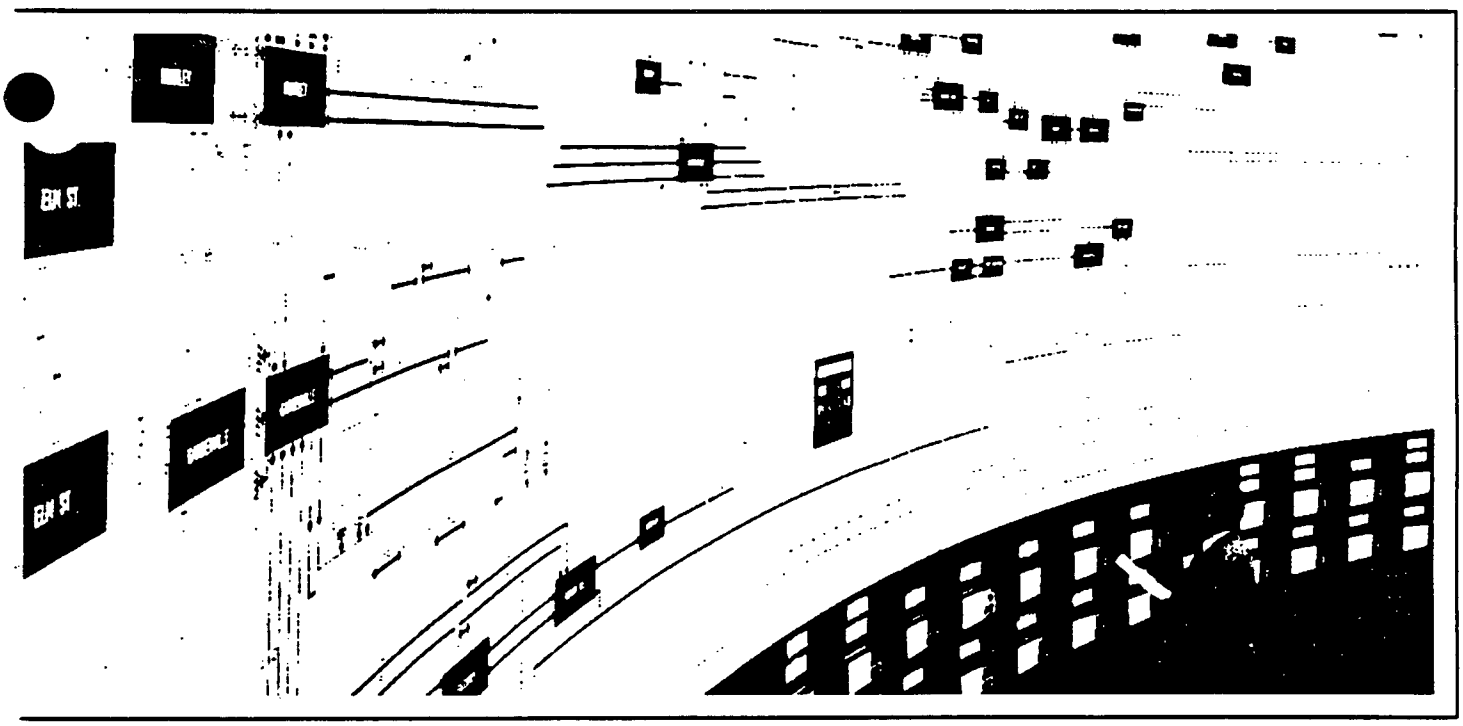
TECHNOLOGY EDUCATION
ENERGY/POWER

GRADES 9-12
FOUNDATION COURSE



Reprinted 1997

The University of the State of New York
The State Education Department
Bureau of Home Economics
and Technology Education Programs
Division of Occupational Education
Albany, New York 12234

THE UNIVERSITY OF THE STATE OF NEW YORK
Regents of The University

CARL T. HAYDEN, *Chancellor,* A.B., J.D. ..... Elmira
LOUISE P. MATTEONI, *Vice Chancellor,* B.A., M.A., Ph.D. ..... Bayside
JORGE L. BATISTA, B.A., J.D. ..... Bronx
J. EDWARD MEYER, B.A., LL.B. ..... Chappaqua
R. CARLOS CARBALLADA, *Chancellor Emeritus,* B.S. ..... Rochester
ADELAIDE L. SANFORD, B.A., M.A., P.D. ..... Hollis
DIANE O'NEILL MCGIVERN, B.S.N., M.A., Ph.D. ..... Staten Island
SAUL B. COHEN, B.A., M.A., Ph.D. ..... New Rochelle
JAMES C. DAWSON, A.A., B.A., M.S., Ph.D. ..... Peru
ROBERT M. BENNETT, B.A., M.S. ..... Tonawanda
ROBERT M. JOHNSON, B.S., J.D. ..... Lloyd Harbor
PETER M. PRYOR, B.A., LL.B., J.D., LL.D. ..... Albany
ANTHONY S. BOTTAR, B.A., J.D. ..... Syracuse
MERRYL H. TISCH, B.A., M.A. ..... New York
HAROLD O. LEVY, B.S., M.A. (Oxon.), J.D. ..... New York
ENA L. FARLEY, B.A., M.A., Ph.D. ..... Brockport

President of The University and Commissioner of Education
RICHARD P. MILLS

Chief Operating Officer
RICHARD H. CATE

Deputy Commissioner for Elementary, Middle, Secondary, and Continuing Education
JAMES A. KADAMUS

Assistant Commissioner for Curriculum, Instruction, and Assessment
EDWARD T. LALOR

Coordinator of Curriculum and Instruction
ROSEANNE DEFABIO

The State Education Department does not discriminate on the basis of age, color, religion, creed, disability, marital status, veteran status, national origin, race, genetic predisposition or carrier status, or sexual orientation in its educational programs, services and activities. Portions of this publication can be made available in a variety of formats, including braille, large print or audio tape, upon request. Inquiries concerning this policy of nondiscrimination should be directed to the Department's Office for Diversity, Ethics, and Access, Room 152, Education Building, Albany, NY 12234.

COURSE: ENERGY AND POWER TECHNOLOGY

COURSE OVERVIEW

Course Description

Every technological endeavor makes use of one or more energy forms. The Energy and Power Technology course, designed as a half-unit, 18 week course, is intended to acquaint students with the sources and forms of energy available now and what may be available in the future. Students will learn that there are often choices to be made about the most appropriate energy form to use. The energy conversion systems which change energy forms to meet human needs also will be studied. The course stresses the importance of identifying the issues and problems associated with the use of each energy form and conversion system. Identifying the consequences of choices is also an important aspect of the course.

The first module identifies the forms of energy, the conversion techniques used to make energy more usable, the availability of each type of energy, and the uses made of each type in each major sector (residential, commercial, industrial, and transportation). Historical conversion systems and power use, measurement, and theory are included. The second module deals with the major sources of energy and the problems and issues surrounding their use. Module III explores internal combustion, external combustion, and fluid power theory and systems. Module IV emphasizes the conversion processes that make energy available in more usable forms. The last module provides opportunities for students to make decisions about the most effective use of energy in each sector of society.

Instructional Methodology

The course is intended to be 25 percent instruction and 75 percent hands-on experiences. Individual, small group, and large group instruction may be used. The Suggested Instructional Strategies are intended to provide maximum flexibility for the instructor regardless of the enrollment or resources available. Instructional strategies should be adapted to provide the most relevant learning experiences for the community. The minimum performance level is left to the discretion of the instructor.

Whenever possible, instruction should be reinforced with the use of actual devices, working models, data-gathering procedures, and other manipulative activities. The energy portion of the course can be taught in any laboratory which is equipped with the usual hand and machine tools used to fabricate wood, metal, plastic, and other commonly used materials. The power portion requires a facility which interfaces transportation with the above general laboratory.

USE IN SEQUENCE: Foundation course

This course is one of the New York State approved Foundation courses in Technology Education. It is one of seven courses designed to give students a firm but broad exploration of the technical world in which they live. Students completing a sequence in Technology Education must have successfully completed any two of these seven Foundation courses.

This course may also be taken by any student as an elective. If the instructor uses this syllabus as a guide for instruction, students may be granted Regents credit for the experience.

Several courses within Technology Education offerings can be offered on a 1/2-unit or 1-unit basis. Course work earning 1/2-unit must comprise a minimum of 54 hours of instruction and course work earning 1-unit must comprise a minimum of 108 hours of instructional time.

Students with Disabilities

The Board of Regents, through the part 100 Regulations of the Commissioner, the Action Plan, and The Compact for Learning, has made a strong commitment to integrating the education of students with disabilities into the total school program. According to Section 100.2(s) of the Regulations of the Commissioner of Education, "Each student with a handicapping condition as such term is defined in Section 200.1(ii) of this Chapter, shall have access to the full range of programs and services set forth in this Part to the extent that such programs and services are appropriate to such student's special educational needs." Districts must have policies and procedures in place to make sure that students with disabilities have equal opportunities to access diploma credits, courses, and requirements.

The majority of students with disabilities have the intellectual potential to master the curricula content requirements for a high school diploma. Most students who require special education attend regular education classes in conjunction with specialized instruction and/or related services. These students must attain the same academic standards as their nondisabled peers to meet graduation requirements, and, therefore, must receive instruction in the same content areas, at all grade levels. This will ensure that they have the same informational base necessary to pass statewide testing programs and meet diploma requirements.

Teachers certified in the subject area should become aware of the needs of students with disabilities who are participating in their classes. Instructional techniques and materials must be modified to the extent appropriate to provide students with disabilities the opportunity to meet diploma requirements. Information or assistance is available through special education teachers, administrators, the Committee on Special Education (CSE) or student's Individualized Education Program (IEP).

Strategies for Modifying Instructional Techniques and Materials

1. Students with disabilities may use alternative testing techniques. The needed testing modification must be identified in the student's Individualized Education Program (IEP). Both special and regular education teachers need to work in close cooperation so that the testing modifications can be used consistently throughout the student's program.

2. Identify, define and pre-teach key vocabulary. Many terms in this syllabus are specific and some students with disabilities will need continuous reinforcement to learn them. It would be helpful to provide a list of these key words to the special education teacher in order to provide additional reinforcement in the special educational setting.

3. Assign a partner for the duration of a unit to a student as an additional resource to facilitate clarification of daily assignments, timelines for assignments, and access to daily class notes.

4. When assigning long-term projects or reports, provide a timeline with benchmarks as indicators for completion of major sections. Students who have difficulty with organizational skills and time sequence may need to see completion of sections to maintain the organization of a lengthy project or report.

Infusing Awareness of Persons with Disabilities Through Curriculum

In keeping with the concept of integration, the following subgoal of the Action plan was established.

In all subject areas, revisions in the syllabi will include materials and activities related to generic subgoals such as problem solving, reasoning skills, speaking, capacity to search for information, the use of libraries and increasing student awareness of and information about the disabled.

The purpose of this subgoal is to ensure that appropriate activities and materials are available to increase student awareness of disabilities.

This curriculum, by design, includes information, activities, and materials regarding persons with disabilities. Teachers are encouraged to include other examples as may be appropriate to their classroom or the situation at hand.

STUDENT LEADERSHIP SKILLS

Development of leadership skills is an integral Part of occupational education in New York State. The New York State Education Department states that, "Each education agency should provide to every student the opportunity to participate in student leadership development activities. All occupational education students should be provided the opportunity to participate in the educational activities of the student organization(s) which most directly relate(s) to their chosen educational program."

Leadership skills should be incorporated in the New York State occupational education curricula to assist students to become better citizens with positive qualities and attitudes. Each individual should develop skills in communications, decision making/problem solving, human relations, management, and motivational techniques.

Leadership skills may be incorporated into the curricula as competencies (Performance Objectives) to be developed by every student or included within the Suggested Instructional Strategies. Teachers providing instruction through occupational educational curricula should familiarize themselves with the competencies. Assistance may be requested from the State advisor of the occupational student organization related to the program area.

Students who elect to become active members of one of the student leadership organizations chartered by the New York State Education Department have the advantage of the practical forum to practice leadership skills in an action oriented format and have the potential for recognition of their achievements at the local, State, and national level.

COURSE: ENERGY AND POWER TECHNOLOGY **54 hours**

CONTENT OUTLINE

MODULE I: INTRODUCTION TO ENERGY AND POWER

Submodule A: Energy Sources, Supplies, and Use — 3 hours

Topics:

1. Forms of Energy
2. Energy Conversion
3. Types and Availability of Resources
4. Energy Crises
5. How Energy is Used
6. Where Energy is Used

Submodule B: Concepts in Power — 3 hours

Topics:

1. Early Power
2. Power Measurement and Theory

MODULE II: EXPLORING ENERGY TECHNOLOGIES

Submodule A: Solar Energy — 6 hours

Topics:

1. The Characteristics of Solar Energy
2. Solar Heating and Cooling
3. Photovoltaics
4. Social Issues, Economic and Environmental Impacts, and Projections
5. Career Information

Submodule B: Other Renewable Energy Forms — 6 hours

Topics:

1. Wind Energy
2. Water Power
3. Bioconversion Energy
4. Ocean Energy Resources
5. Geothermal Energy
6. Social Issues, Economic and Environmental Impacts, and Projections
7. Career Information

Submodule C: Fossil Fuels — 6 hours

Topics:

1. Petroleum and Natural Gas
2. Coal
3. Storage and Distribution of Fossil Fuels
4. Social Issues, Economic and Environmental Impacts, and Projections
5. Career Information

Submodule D: Nuclear Fission and Fusion — 3 hours

Topics:

1. Atomic Theory
2. Development of Nuclear Fission and Fusion
3. Uranium Mining, Fuel Processing, and Fabrication
4. Reactor Types and Containment Designs
5. Safety
6. Waste Disposal, Spent Fuel Storage, and Reprocessing
7. Social Issues, Economic and Environmental Impacts, and Projections
8. Career Information

MODULE III: EXPLORING POWER TECHNOLOGY

Submodule A: Internal Combustion Engines — 10.5 hours

Topics:

1. Reciprocating Engine Design
2. 2- and 4-Stroke Cycle Engines
3. Compression Ignition (Diesel)
4. Gas Turbines
5. Airstream, Reaction (Jet) Engines
6. Rocket Engines
7. Innovative Engine Designs

Submodule B: External Combustion Engines — 1.5 hours

Topics:

1. Steam Engines
2. Steam Turbines
3. Stirling Engine

Submodule C: Fluid Power — 3 hours

Topics:

1. Hydraulics
2. Pneumatics

MODULE IV: TYPES OF ENERGY AND POWER CONVERSION SYSTEMS — 6 hours

Topics:

1. Laws of Thermodynamics
2. Fuel Conversion Systems
3. Commercial Electricity Generation
4. Other Methods of Producing Electricity

MODULE V: ENERGY CONSERVATION PRINCIPLES — 6 hours

Topics:

1. Definition, Terms, and Importance
2. Energy Conscious Design
3. Residential, Commercial, Industrial, and Transportation Sectors
4. Personal Commitment

COURSE: ENERGY AND POWER TECHNOLOGY
MODULE I: INTRODUCTION TO ENERGY AND POWER

OVERVIEW OF MODULE

Goal

The student will be able to identify energy sources, supplies, uses, and concepts in power.

Description

There are many forms of energy in use in society today. No physical activity can occur without an energy input. Because of specific characteristics, each form of energy is suited to one or more uses. The processes of converting energy forms to energy input requires energy to complete the conversion process. Some energy sources can be acquired easily, while others require that much energy be expended to make them usable.

This module covers each major energy resource, where it is found, and what steps must be taken to put it to use. The availability of major energy resources and the potential impact of possible shortages in each of the energy use sectors are addressed.

Skills, Knowledge, and Behaviors to be Developed

The student will be able to:

1. Define energy
2. Analyze forms of energy
3. List major energy resources
4. Analyze energy conversion systems
5. Describe the causes and impacts of the energy crises of the 1970s
6. Describe the uses of energy in the four energy sectors
7. Analyze the major historical milestones in the development of power devices
8. Describe power theory and measurement

MODULE I: INTRODUCTION TO ENERGY AND POWER
SUBMODULE A: ENERGY SOURCES, SUPPLIES, AND USE
TOPIC 1: Forms of Energy

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

1. Following class discussion, the student will define and analyze the forms of energy, differentiate between potential and kinetic energy, and give examples of uses of each energy form, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Define energy as it is used in our society today
   b. List forms of energy
   c. Describe characteristics of each form of energy
   d. Define potential and kinetic energy, and explain their differences
   e. State how each energy form can be used

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. la) Conduct a class brainstorming session to establish a common definition for energy that all students will be able to define and explain.

2. (P.O. la) Assign students to find a definition for energy. Have students be creative and find the definition using whatever resources they think are most appropriate.

3. (P.O. la) Use a film that gives an overview of energy in our society. After viewing the film have the class develop the most appropriate definition of energy.

4. (P.O. 1a) Conduct a pretest to determine student energy attitudes. At the end of the course, test again to see if attitudes have changed.

5. (P.O. 1b) Have students complete a textbook or teacher-created worksheet and assigned readings on forms of energy.

6. (P.O. 1b) Arrange for a guest speaker from your local utility company to present information and provide instructional materials.

7. (P.O. 1b) Plan a field trip to a local science or technology center.

8. (P.O. 1b) Have students construct a display that represents each form of energy using computer graphics, free hand drawings, or a collage of graphic materials.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

9. (P.O. 1b) Lead a class discussion to generate a list of the forms of energy.

10. (P.O. 1c) Develop a Jeopardy™ game dealing with the major energy forms of light, heat, mechanical, chemical, electrical, and nuclear energy.

11. (P.O. 1c) Provide a laboratory activity where students perform various types of testing and voltage data gathering (boiling water, testing and measuring batteries, and mechanical experiments).

12. (P.O. 1c) Print the forms of energy on separate index cards, and attach the cards to students' backs with masking tape. Have students pair up and try to guess what form of energy is on their backs by exchanging questions until they have determined the form of energy. Questions should be answered with either "yes" or "no."

13. (P.O. 1c) Have students design posters representing the forms of energy.

14. (P.O. 1c) For homework have students make a list of examples of various forms of energy.

15. (P.O. 1d) Have students construct a project that will clearly show the principles of potential and kinetic energy. The energy source for the project could be a spring, rubber band, balloon, or difference in height.

16. (P.O. 1d) Have each student list examples of potential and kinetic energy. Discuss and compare the lists and make a comprehensive list for students' records.

17. (P.O. 1d) Use laboratory activities that enable students to conduct experiments involving potential and kinetic energies. Students should be required to record all calculations, record observations, and gather information that will be helpful in the discovery/inquiry tasks (e.g., compress, bend and stretch different metals or plastics, measure wind velocities, and measure a volume of water and record the temperature in both Fahrenheit and Celsius).

18. (P.O. 1d) Invite the physics instructor as a guest speaker and in-house expert on potential and kinetic energy.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

19. (P.O. 1e) Brainstorm with the entire class and create a list of the uses of each form of energy.

20. (P.O. 1e) Have students list each energy application in their homes and identify the present and original energy form.

21. (P.O. 1e) Have student teams survey the school for energy uses. List and discuss all the forms of energy found.

MODULE I: INTRODUCTION TO ENERGY AND POWER
SUBMODULE A: ENERGY SOURCES, SUPPLIES, AND USE
TOPIC 2: Energy Conversion

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

2. Given instructions and laboratory activities, the student will analyze past and present energy conversion systems and conversion efficiencies, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Define energy conversion and related terms
   b. List and describe several energy conversion systems
   c. Trace the historical development of energy conversion systems
   d. List and explain energy conversion efficiencies

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 2a) Demonstrate energy form changes using a toy car, flashlight, solar powered calculator, or other items that show energy conversion.

2. (P.O. 2a) Develop a worksheet of energy conversion terms.

3. (P.O. 2a) Discuss how all animals convert food to energy.

4. (P.O. 2b) In a laboratory, have students work with as many energy converting devices as can be made available (e.g., small engine, fuel cell, solar cell, and batteries).

5. (P.O. 2b) Connect solar cells to a nickel cadmium rechargeable cell. This conversion system will show how the sun can be used to produce electricity which is "stored" in chemical form for use later.

6. (P.O. 2b) Have students construct a model wind turbine and connect a motor/generator to show energy conversion. Students are to turn the wind turbine and measure the voltage output then connect the motor/generator to a cell and observe the rotating turbine.

7. (P.O. 2c) Have students construct a scale model of an early energy conversion device (e.g., windmill, water wheel, and steam engine).

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

8. (P.O. 2c) Have students research and develop a timeline of energy conversion devices.

9. (P.O. 2c) Invite a guest speaker who has lived in the area for a long time to describe energy systems that were used locally in the past.

10. (P.O. 2d) Have students record and compute the fuel consumption of the family car or other vehicle. Compare and discuss results along with conversion efficiencies of other forms of transportation.

11. (P.O. 2d) Conduct experiments with energy conversion devices that are readily available in the classroom. Set up an experiment so students can compute the energy conversion efficiencies.

12. (P.O. 2d) Have each student research and report on a topic related to energy conversion efficiency (e.g., research the energy conversion efficiency of burning coal to product electricity for lighting an incandescent bulb).

MODULE I: INTRODUCTION TO ENERGY AND POWER
SUBMODULE A: ENERGY SOURCES, SUPPLIES, AND USE
TOPIC 3: Types and Availability of Resources

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

3. Following instruction, the student will list major energy resources, their past and present contributions, and projected supplies and discuss the potential impacts of their use on future living conditions, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. List major fossil energy resources and their geographic locations
   b. Graph energy reserves of the United States and the world
   c. Identify renewable energy resources and discuss the potential impacts of their use on future living conditions
   d. Discuss past, present, and projected future trends in energy use for the United States and the world

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 3a) Have students locate materials which deal with the exploration of energy sources and the movement of these from raw materials to usable energy forms. Report on these materials to the class.

2. (P.O. 3a) Invite a guest speaker from a local utility company to describe the energy resources it uses, how it receives its energy, and projected future directions.

3. (P.O. 3a) Have students do an energy crossword puzzle related to energy resources and their locations. Several commercial computer products are available.

4. (P.O. 3b) Display a chart showing the proportions of major resources that are available and used in the United States and the world.

5. (P.O. 3b) Have students use a computer to generate several different charts that show energy reserves of the United States and the world.

6. (P.O. 3b) Have students construct a three-dimensional display that represents the energy resources in the United States and the world.

7. (P.O. 3c) Guide students in a discussion about how to differentiate between renewable and nonrenewable energy sources.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

8. (P.O. 3c) Show a film about renewable resources and their projected impact on future living conditions.

9. (P.O. 3c) Role play debates on topics such as biomass energy, solar energy, and wind energy. Have students assume roles that represent different aspects of our society (e.g., environmentalist, scientist, business person, oil company person, student, parent, and teacher).

10. (P.O. 3d) If you have a local utility which has an Energy Education Center, contact them and borrow the Energy-Environmental Simulator. This device is a small group-participation analog computer which simulates energy resources versus energy demand for the United States and the world.

11. (P.O. 3d) Team teach creative writing techniques with the English Department. Have students write a story of their view of the future of energy in this country and the world in the next decade.

12. (P.O. 3d) Have students write a description of the potential effects of energy on their personal lives five years in the future.

13. (P.O. 3d) Construct a three-dimensional timeline that traces the historical development of energy.

14. (P.O. 3d) At the beginning of each class, discuss "energy in the news" since the last class meeting. Encourage students to clip newspaper articles, report on periodical articles, and note radio and TV reports. Make a bulletin board display of clipped articles.

15. (P.O. 3d) Have students report on a newspaper or magazine article about future energy trends. This also could make a nice display if you require the students to turn in a copy of their articles.

MODULE I: INTRODUCTION TO ENERGY AND POWER
SUBMODULE A: ENERGY SOURCES, SUPPLIES, AND USE
TOPIC 4: Energy Crises

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

4. Following instruction and research, the student will list the events leading up to the energy crises of the 1970s; describe their impact on society and implications for the future; and state what individuals, groups, and governments can do to plan for possible future energy crises, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Trace the historical events that led to the energy crises of 1973 and 1979
   b. Discuss the impacts that the energy crises had on our society.
   c. Formulate projections about future energy concerns, possible crises and their possible causes.
   d. Discuss what individuals, groups, and governments can do to plan for future energy crises.

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 4a) Have students construct a timeline of events that led to the energy crises of the 1970s.

2. (P.O. 4a) Have students role play a gasoline shortage. Set up several situations that will adequately represent how the energy shortage or crisis affected our society.

3. (P.O. 4a) Have students research newspaper articles on the energy crises (e.g. New York Times or other major papers on microfiche). If possible, have students use an on-line data base to conduct their research.

4. (P.O. 4b) Using an audio or video tape recorder, have students interview their parents and grandparents on impacts of the energy crises. Play tapes during class and have students write down and discuss the comments obtained.

5. (P.O. 4b) Having students research automobile design and performance over the past 20 years to assess the impact the energy crises of the 1970s had on its evolution.

6. (P.O. 4b) Have students eliminate an energy form they depend on for one day and record the impact it had upon their lifestyle.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

7. (P.O. 4c) Have students write a scenario of an energy crisis that takes place five years from now. The content should deal with societal, political, environmental, and financial issues.

8. (P.O. 4c) Invite a guest speaker from a local university or utility to speak on future energy projections.

9. (P.O. 4c) Have students collect current magazines and newspaper articles and bulletins that address projections of future energy needs and develop a bulletin board.

10. (P.O. 4c) Set up a simple activity that shows the students the results of supply and demand. The result could be compared to the current supply of fossil fuels and what could happen when the supply and demand situation changes.

11. (P.O. 4d) Lead a discussion on what might be done to eliminate future local, regional, national, and worldwide energy crises. Discuss the roles of individuals, groups and governments.

BACKGROUND REFERENCES AND RESOURCES

Energy: 2000. Manufacturers Hanover. (Available from your local utility company or contact Niagara Mohawk Power Corporation: The Energy Center, P.O. Box 81, Lycoming, NY 13093.)

MODULE I: INTRODUCTION TO ENERGY AND POWER
SUBMODULE A: ENERGY SOURCES, SUPPLIES, AND USE
TOPIC 5: How Energy is Used

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

5. Following instruction, the student will describe how energy is used in our society, differentiating between effective and ineffective uses, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. List different ways that energy is used in our society, and show the percentage of energy use by each sector
   b. Give examples of effective and ineffective use of energy resources

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 5a) Brainstorm with the class the major categories of energy uses in our society.

2. (P.O. 5a) Arrange a field trip to a local utility, industry, or other large user of energy. Observe how energy is produced, converted, and applied.

3. (P.O. 5a) Have students develop a survey to help determine the major energy users in our society. Results from the survey could be compared to research conducted by the Department of Energy.

4. (P.O. 5b) Through class discussion, develop lists that show effective and ineffective uses of energy in our society.

5. (P.O. 5b) Invite a guest speaker who deals with energy conservation (a person from a utility company, city planner, architect, or technical consultant concerned with appropriate and effective use of energy).

6. (P.O. 5b) Have students contact airlines, bus terminals, and railroad transportation systems and compute the cost effective way to travel to a certain location in the country. Students should take into account the number of people transported, the time involved, and other factors that may add to the cost. This also may be done for shipping a heavy object.

MODULE I: INTRODUCTION TO ENERGY AND POWER
SUBMODULE A: ENERGY SOURCES, SUPPLIES, AND USE
TOPIC 6: Where Energy is Used

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

6. Given instruction, the student will describe the energy forms, quantities, and end uses in the residential, commercial, industrial, and transportation sectors, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. List examples of energy use in the residential, commercial, industrial, and transportation sectors and give the percentage of total use for each
   b. Rank order the major uses of energy in the residential, commercial, industrial, and transportation sectors

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 6a) Have students identify user sectors and prepare graphs and data for each sector. Worksheets will be helpful to direct students to information sources.

2. (P.O. 6a) Have students conduct a small production line and record all energy consuming activities.

3. (P.O. 6a) Visit a local construction project. Have students list and identify specific materials and attempt to find out where they came from. Students can then calculate manufacturing and transportation costs.

4. (P.O. 6a) Have students list all the electrical appliances used in their home in one day and calculate the cost of operation.

5. (P.O. 6a) Have students compute the cost of home and water heating over a one-year period.

6. (P.O. 6a) Have students conduct a home energy audit. Compare results.

7. (P.O. 6a) Have students conduct a school energy use audit. Address appropriate and efficient or inefficient use. Communicate your analysis to the appropriate administrators.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

8. (P.O. 6a) Discuss the availability and success or failure of local mass transit systems. Address the attitudes of people concerning the systems.

9. (P.O. 6b) Divide the class into small groups and assign each an energy sector. Have the groups complete the following questions and give oral reports to the class.

   - What is your sector and how would you define it?
   - How is energy used in each sector?
   - What is the growth or regression of energy use over the past 10 years in your sector? This should be reported in actual units of energy used as well as a percent of the total sector use.

10. (P.O. 6b) Invite a parent to explain the reality of paying bills related to energy costs. Address the impacts on other financial obligations, investments, and lifestyle.

11. (P.O. 6b) Invite a guest speaker from one of the major sectors to discuss the cost of and uses for energy in his/her area.

MODULE I: INTRODUCTION TO ENERGY AND POWER
SUBMODULE B: CONCEPTS IN POWER
TOPIC 1: Early Power

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

1. Following instruction, the student will be able to relate a general history of human use of power, demonstrate making and using simple machines, and show how they are still used in the present, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Identify the period of time when human and animal muscle power were of primary use
   b. Illustrate significant periods in human history by making simple machines and mechanical advantage devices relevant to given periods, and identify current uses of these machines.
   c. Describe how water and wind power were put to significant human use throughout history
   d. List the sources of power developed over the last 250 years, e.g., steam generators, internal combustion, electricity generation, and fluid power.

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 1a) Have the class develop a time line on a bulletin board or on a line across the laboratory with pictures and dates signifying human and animal muscle power.

2. (P.O. 1a) Connect a bicycle to an automobile electrical generator. Have the students pedal to light a bulb, establish meter readings, or power some other useful visual device to demonstrate how much muscle power is required by simple power and energy needs.

3. (P.O. 1a) Have the students conduct a race, using a small cart and one, two, three, four, and six "horse" teams. The students will be the horses. Vary the cart load. Record the finishing times for each race.

4. (P.O. 1b) Have groups of students construct a working model of different lever types and examples of each of the other simple machines.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

5. (P.O. 1b) Instruct the students to bring in mechanical devices from home that demonstrate as many simple machines as possible, for instance, a wood screw to demonstrate the screw as a simple machine, and an axe handle wedge to demonstrate an inclined plane. Let them be creative and disassemble old, broken appliances and similar objects. Give a prize for the most creative device.

6. (P.O. 1c) Have the students construct several examples of the different types of water wheels. Test them in a tank with a hose supplying a constant force. Use a counter to register the number of revolutions, or a stroboscopic measuring device to count the revolutions. Vary the load to compare the effectiveness of designs.

7. (P.O. 1c) Have the students build several examples of wind devices and conduct a test similar to the one described above, using air as the medium, and a fan rather than a hose.

8. (P.O. 1d) Have the students develop a chart showing the land speed record over the centuries, and the devices that were used.

9. (P.O. 1d) Contribute additional materials to the laboratory time line, showing the developments in power, starting with animal muscle power.

10. (P.O. 1d) Lead a discussion about the advantages and disadvantages of each modern source of power. Address size, weight, location, and other requirements.

MODULE I: INTRODUCTION TO ENERGY AND POWER
SUBMODULE B: CONCEPTS IN POWER
TOPIC 2: Power Measurement and Theory

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

2. Following instruction, the student will be able to use mathematical concepts to measure power, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Define work as the mathematical concept of FORCE x DISTANCE
   b. Analyze and calculate horsepower as a unit of power measurement
   c. Utilize torque as a measurement of rotating power devices
   d. Describe efficiency as it relates to power devices
   e. Apply basic heat theory to the operation of combustion engines

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 2a) Complete a worksheet that develops mathematical problems using the formula: W = FxD.

2. (P.O. 2a) Have the students push a weighted skid across the floor with a bathroom scale attached at the point of applied force. Register the force necessary (average) to move the skid. Add varying amounts of weight and try several tests. Calculate the work accomplished for each test.

3. (P.O. 2b) Working with James Watt's definition that one horsepower is the ability to do 33,000 ft./lbs. of work per minute (or 550 ft./lbs. per second), have the students run a small engine on a dynamometer and use a worksheet to record the results of this laboratory experiment. Compare results with theory. Explain any differences.

4. (P.O. 2b) Using James Watt's definition of one horsepower necessary to raise one ton 16 1/2 feet in one minute (assuming no friction), develop an activity where several students pull a fractional equivalent weight up 16 1/2 feet or a fractional equivalent. Calculate the horsepower used. Use a flag pole or exterior of the school building.

5. (P.O. 2c) Have the students use a torque wrench to properly apply the correct specifications or tightness to various engine bolts.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

6. (P.O. 2c) Using a dynamometer experiment and a small engine, have the students calculate the torque as they work on the horsepower experiment.

7. (P.O. 2c) Build a torque arm attached to a hefty analog or digital scale calibrated in pounds. Have one or more students push on the arm at various distances and record the highest torque attained at each distance. Make a competition out of it. Compare these simple results to several popular, modern engines used in race and drag cars, airplanes, and so forth.

8. (P.O. 2d) Using the formula EFFICIENCY = OUTPUT WORK/INPUT WORK, develop a worksheet that demonstrates the efficiency of several engines and other energy conversion devices.

9. (P.O. 2d) Lead a brainstorming session about loss of efficiency, and discuss how this pervades the natural world. List as many examples as possible, including the human body, electrical transmission, residential heating, repeated copying on a copy machine, and wear on an automobile. Describe how efficiency is lost and where the energy goes.

10. (P.O. 2e) Have the students analyze compression ratio changes in automobile engines over the last four decades (use motor manuals). Have them discuss the relationship between increased gas compression and the increase in heat, thus power.

11. (P.O. 2e) Have the students conduct an experiment demonstrating that heat always flows from the warm body to the cooler one. Steel blocks warmed in an oven and cooled in a refrigerator can be placed in contact. Temperature readings can be taken at specific time intervals. Ask how this relates to the cooling system of engines. Why must we remove heat if more heat produces more power?

COURSE: ENERGY AND POWER TECHNOLOGY
MODULE II: EXPLORING ENERGY TECHNOLOGIES

OVERVIEW OF MODULE

Goal

The student will be able to identify the sources of energy available today and describe technologies used to convert each energy form to usable energy.

Description

In this module, the future outlook for each of the energy resources is considered in relation to potential shifts in energy resource use. All of these factors have an impact on potential careers within the field of energy as well as on other occupations.

Students will have experiences in the construction and operation of energy conversion devices. They also will compare and contract renewable and non-renewable energy resources.

Skills, Knowledge, and Behaviors to be Developed

The student will be able to:

1. Describe the basic principles of solar energy
2. Identify passive, active, and hybrid solar systems
3. Describe how wind energy can be used
4. Identify sources and uses of water power
5. Describe bioconversion, ocean energy resources, and other sources of renewable energy
6. Describe the technical processes associated with finding, extracting and processing fossil fuels
7. Identify means of transporting fossil fuels
8. Trace the development of nuclear fission energy
9. Relate basic atomic theory
10. Identify the characteristics of radioactivity
11. Differentiate between fission and fusion nuclear energy
12. Trace the development of geothermal energy
13. Describe the types of geothermal reservoirs and extraction techniques
14. Relate career requirements and opportunities with each energy form.

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE A: SOLAR ENERGY
TOPIC 1: The Characteristics of Solar Energy

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

1. Following instruction, the student will describe the basic principles of solar energy, describe their means of measurement, and evaluate the benefits and potential harmful effects of using solar energy, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. State the principles of solar energy caused by thermonuclear reactions in the sun
   b. State the characteristics of radiant energy from the sun
   c. Make measurements of solar radiation
   d. State the benefits and potential harmful effects of the use of solar energy

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 1a) Describe how the sun produces energy, what type of energy is produced, and how it reaches the Earth's surface.

2. (P.O. 1a) Develop a chart which shows the wavelengths of sunlight as compared to the total light spectrum.

3. (P.O. 1b) Have students use a prism or other device to break sunlight into a spectrum.

4. (P.O. 1b) Using a Fresnel lens (or other lens type) to focus the sun's rays, have students measure the temperature of this concentration of energy. Allow the students to start a fire in a carefully controlled situation.

5. (P.O. 1b) Have students define "greenhouse effect" and give examples of how the effect is accomplished.

6. (P.O. lb) Using library resources, have students identify the Sun-Earth distances for different seasons and the angle of incidence for the northern hemisphere. Students should describe the consequences of these data.

7. (P.O. 1b) Have students identify the effects of latitude on sun angle and the implications for solar installations.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

8. (P.O. 1c) Have students determine the solar altitude and azimuth readings of your geographic location for today and other selected dates.

9. (P.O. 1c) Have the class construct a device to check and monitor the sun angle at school during the year. Record and plot angle changes.

10. (P.O. 1c) Have students build or use a solarimeter to measure solar radiation.

11. (P.O. 1d) Have students describe both the beneficial and harmful effects of solar radiation on humans.

12. (P.O. 1d) Invite the school nurse or an area doctor to describe the hazards and benefits of the sun to humans.

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE A: SOLAR ENERGY
TOPIC 2: Solar Heating and Cooling

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

2. Following instruction, the student will identify, describe, construct, and evaluate passive, active, and hybrid solar energy heating and cooling systems, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Analyze a given site for potential solar energy use
   b. Design and build devices which convert solar energy to heat
   c. Design and build devices which use solar energy for cooling
   d. List the components needed for a domestic water heating system and describe their functions
   e. Measure temperature changes in both heating and cooling systems

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 2a) Have the class survey the community for evidence of solar energy installations for passive, active, and hybrid systems of solar heating.

2. (P.O. 2a) Have students conduct a site analysis by identifying potential solar collector locations by use of a "solar site analyzer" or other device.

3. (P.O. 2a) Have students draw to scale a selected site, including trees, topography, roads, fences, and other "solar obstructions." Determine the best location(s) for solar collectors.

4. (P.O. 2a) From the Climatic Atlas of the United States, have students determine the average daily solar radiation for your geographic location. Take readings with an insolation meter and make comparisons with published data. Identify any differences and the causes for those differences.

5. (P.O. 2b) Have students design and build a flat-plate solar collector.

6. (P.O. 2b) Have students research, design, build, and use a solar food dryer.

7. (P.O. 2b) Have students research, design, build, and use a solar desalinization unit.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

8. (P.O. 2b) Conduct a water heating contest. Have teams of two or more students design and construct devices which will heat a given volume of water to the highest temperature in the shortest time.

9. (P.O. 2b) Given parameters of internal volume and materials which may be used, have students design and construct a model house with passive solar features and appropriate insulation. Compete with other students or teams to determine greatest "solar gain" and greatest heat retention. (Use a shoebox or small ice chest as the house.)

10. (P.O. 2b) Have students construct a solar cooker, oven, or other heating device using low-cost, easily available materials.

11. (P.O. 2b,2c) Have students calculate the energy needed to provide the heating and cooling needs of a home, office, or work site.

12. (P.O. 2c) Have students design and construct a model house which can be kept as cool as possible using solar shading and cooling concepts.

13. (P.O. 2d) Have students construct a model solar domestic water heating system. Test and measure the temperatures achieved.

14. (P.O. 2d) Have students experiment with alternative design modifications of commercial domestic water heating systems or a system they have designed.

15. (P.O. 2e) Have students calculate the efficiency of solar heating and cooling devices. Use the computer software package "The Science Tool Kit" to monitor the heating and cooling devices.

16. (P.O. 2e) Have students compare active and passive systems in terms of cost, efficiency, and appropriateness for a given geographic location.

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE A: SOLAR ENERGY
TOPIC 3: Photovoltaics

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

3. Following instruction, the student will describe how a photovoltaic cell converts light energy to electrical energy and create a device which illustrates the conversion, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Explain how a photovoltaic cell is constructed
   b. Describe the process by which light energy is converted into electrical energy
   c. Calculate the efficiency of solar energy conversion from light which strikes a photovoltaic cell
   d. Describe the differences among photovoltaic cells, panels, and arrays
   e. Construct devices which use photovoltaic cells to convert light energy to electrical energy

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 3a) Name the materials used in the construction of photovoltaic cells. Describe their characteristics and how they are manufactured.

2. (P.O. 3b) Describe the sequence of conversion from sunlight to useful electrical energy produced by a solar cell.

3. (P.O. 3c) Using a solarimeter and voltmeter to provide data, have students calculate the efficiency of a solar cell or panel.

4. (P.O. 3c) Using various meters, have students measure the electrical output (voltage and current) of photovoltaic cells connected in series, parallel, and series/parallel and calculate the energy conversion efficiency.

5. (P.O. 3d) Using identical conditions, have students compare the electrical characteristics of PV cells made of different materials and assembled in various panels and arrays.

6. (P.O. 3d, 3e) Have students develop a plan for the construction of a solar array to provide electrical energy for household appliances.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

7. (P.O. 3e) Have students use PV cells to demonstrate the effects of cells connected in series, parallel, and series/parallel.

8. (P.O. 3e) Have students design and build a PV array to charge a NiCad cell, operate a portable radio, or charge an automobile/boat battery.

9. (P.O. 3e) Have students design and build a PV powered toy or vehicle.

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE A: SOLAR ENERGY
TOPIC 4: Social Issues, Economic and Environmental Impacts, and Projections

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

4. Given instruction, the student will identify social issues, economic and environmental impacts, and projections related to solar energy, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Describe the conditions under which solar energy can be and is being used
   b. State the personal and legal barriers to the use of solar collectors
   c. Compare the costs of construction, operation, and maintenance of solar installations with comparable fossil fuel energy conversion systems
   d. Compare the environmental impacts of solar installations with other types of energy conversion systems
   e. List the potential future development of solar installations in the United States

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 4a) Have students survey the community to identify uses of solar energy systems. Describe and clarify each application, e.g., greenhouse, passive solar space heating, and active domestic water heating.

2. (P.O. 4a, e) On a map of New York State or the United States, identify the locations of major solar energy installations. Identify potential locations and list the factors which would make these locations suitable sites. Consider both active and passive systems.

3. (P.O. 4b) Have students survey community members to determine their attitudes about the use of solar collectors and their reasons for favorable or unfavorable views. Report the findings to the class.

4. (P.O. 4b) Identify legal barriers to the use of solar energy. Be sure to address solar acquisition rights, building codes or ordinances restricting home orientation, and aesthetic limitations established by neighborhood covenants.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

5. (P.O. 4c) List the costs associated with a specific type and size of collector. Identify the value of the output of the collector or array. Compare the installation costs, operating costs, and the resultant output with another type of energy converter which provides the same function.

6. (P.O. 4c) Have students research and compare the costs of two identical homes, one of which takes advantage of passive solar heating and cooling methods. Calculate the period of time required to pay for the solar-related expenses. Calculate the estimated financial and energy savings over the next 10 years. Be sure to include an estimate for inflation.

7. (P.O. 4d) Draw up a list of environmental factors which compare solar energy installations with other energy converters providing the same function.

8. (P.O. 4e) Based on projected estimates concerning the future availability and cost of fossil fuels, have students list possible energy scenarios for dates within their lifetimes (10 years, 25 years, and 50 years from now).

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE A: SOLAR ENERGY
TOPIC 5: Career Information

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

5. Given instruction, the student will describe jobs in the solar energy field, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. List the careers associated with solar energy technologies
   b. List the qualifications necessary to obtain a position in one of those careers

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 5a) Have students survey the Dictionary of Occupational Titles, publications by labor groups, and the New York State Energy Office, and other resources for lists of occupations related to the solar energy field. Identify those which are scientific, managerial, service and repair, office, and other categories.

2. (P.O. 5b) Have each student select one occupation related to solar energy and determine the entrance qualifications, working conditions, salary, opportunities for advancement, and other occupational information.

BACKGROUND REFERENCES AND RESOURCES

Printed Materials

Anderson, B. (1987). The New Solar Home Book. Harrisville: Cheshire.

Daniels, F. (1964). Direct Use of the Sun's Energy. New York: Ballantine Books. (classic)

Garrison, J.A. (1981). Solar Projects. Philadelphia: Running Press.

Holstroemn, I.R. (1981) Energy From the Sun: 33 Easy Solar Projects. Blue Ridge Summit, PA: TAB Books.

Kaufman, A. (1989). Exploring Solar Energy: Principles and Projects. Ann Arbor: Prakken.

BACKGROUND REFERENCES AND RESOURCES, continued

Printed Materials, continued

Maycock, P. (1984). "The Expanding PV Industry," Alternate Sources of Energy, May-June, pp. 18-19.

Maycock, P. (1985). A Guide to the Photovoltaic Revolution. Emmaus, PA: Rodale Press.

Mazria, E. (1979) The Passive Solar Energy Book. Emmaus, PA: Rodale Press. (classic)

McCullagh, J.C. (1978). The Solar Greenhouse Book. Emmaus, PA: Rodale. (classic)

Reif, D. (1981). Solar Retrofit. Andover: Brick House.

Thomas Alva Edison Foundation. (1983). Alternative Energy Sources: Experiments You Can Do From Edison. Southfield, MI.

U.S. Department of Commerce, Bureau of the Census. (1980) Solar Heating and Cooling of Residential Buildings, Sizing, Installation and Operation of Systems. Washington, DC: U.S. Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. (1980). Design of Systems. Washington, DC: U.S. Government Printing Office.

Wolf, R. (1983). 20 Simple Solar Projects. Emmaus, PA: Rodale Press.

Slides

"Installing Solar Systems" (4 filmstrips w/tapes)	Prentice-Hall Media 150 White Plains Road Tarrytown, NY 10591
"Simply Passive"	Northeast Solar Energy Association P.O. Box 541, 14 Green Street Brattleboro, VT 05301

BACKGROUND REFERENCES AND RESOURCES, continued

Slides, continued

"Solar Collectors"	Kai Dib Films International P.O. Box 261 Glendale, CA 91209
"Solar Greenhouses"	Northeast Solar Energy Association
"Solar Homes"	James L. Ruhle and Associates
"Solar Power Systems"	James L. Ruhle and Associates P.O. Box 4301 Fullerton, CA 92631

Filmstrips With Audio Tapes

"Solar Energy" (Parts 1 & 2)	Educational Dimensions Groups 792 Pacific Street P.O. Box 126 Stamford, CT 06904

Computer Software

"Science Tool Kit"	Broderbund Software P.O. Box 14947 San Rafael, CA 94913-2947

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE B: OTHER RENEWABLE ENERGY FORMS
TOPIC 1: Wind Energy

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

1. Following instruction, the student will describe the source of wind energy, how it can be applied for useful purposes, and the positive and negative effects of wind energy conversion, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Describe the conditions which create air flow (wind)
   b. Measure wind direction and velocity
   c. Identify wind energy conversion devices and their characteristics
   d. List the positive and negative effects of wind energy conversion systems

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 1a) Describe how solar energy causes air currents to develop.

2. (P.O. 1a) Describe how the natural features of terrain affect wind currents.

3. (P.O. 1a) Have students identify the changes that occur with wind currents because of structures and other changes caused by humans.

4. (P.O. 1a) Have the class construct a wind tunnel to observe and measure the effects of air flow on various objects.

5. (P.O. 1b) Have students measure and record wind direction and velocity for a given site on different days for a period of one month and graph the results.

6. (P.O. 1b) Have students design and construct a device which will measure wind velocity and/or direction.

7. (P.O. 1b) Have the class identify wind direction indicators in use in the community.

8. (P.O. 1c) Have students identify the classes of wind energy conversion systems (WECS) and state their advantages and disadvantages.

9. (P.O. 1c) Describe how WECS produce electricity, heat, or mechanical energy.

10. (P.O. 1c) Have the class construct a model WECS.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

11. (P.O. 1c, 1d) Identify WECS used in the community. Plan a field trip to a site and gather data regarding its use. Describe the effects on the site environment.

12. (P.O. 1c) Have the class test a model (or commercial) WECS and record the electrical output or other energy produced.

13. (P.O. 1d) Have students identify the conditions under which wind flow becomes a hazard or danger rather than a beneficial energy source.

BACKGROUND REFERENCES AND RESOURCES

Printed Materials

Marier, D. (1981). Wind Power for the Homeowner. Emmaus, PA: Rodale.

NYSEO. (1982). New York State Wind Energy Handbook. Albany, NY: New York State Energy Office.

Park, J. The Wind Power Book. Palo Alto, CA: Chesire Books.

Slide Set

"New Sources of Energy" — James L. Ruhle and Associates
P.O. Box 4301
Fullerton, CA 92631

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE B: OTHER RENEWABLE ENERGY FORMS
TOPIC 2: Water Power

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

2. Following instruction, the student will describe sources of water power, describe the processes which convert this energy to productive uses, and analyze potential economic and environmental impacts of increasing use of water power, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. List potential sources of water power which are suitable for conversion to other forms of energy
   b. Describe the characteristics of potential water power sites
   c. List the types and characteristics of turbines used to convert the flow of water to mechanical or electrical energy
   d. List potential economic and environmental impacts of expanding water power contributions to our energy picture

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 2a) Have the class identify locations in the community where water power systems are being used.

2. (P.O. 2b) Have students construct a model of a channel or canal used to divert water to a turbine and study the effects of different flow rates on a turbine.

3. (P.O. 2b,2c) Take a field trip to a hydroelectric plant to study the types of turbines in use, their characteristics, and the amount of electricity generated.

4. (P.O. 2b) Have students construct a model turbine which can be connected to a small DC motor (to be used as a generator), and study the effects of different rotational speeds on the generator output.

5. (P.O. 2c) Construct a model of a turbine and test it for efficiency.

6. (P.O. 2c) Have students determine the requirements for locating and installing a microhydroelectric system. Research the various types and select one which would meet electricity needs.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

7. (P.O. 2d) As a class, study the future of hydropower in the United States and other countries. Project the potential contribution it could make if logical sites were developed. Identify the economic and environmental impacts of extended development.

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE B: OTHER RENEWABLE ENERGY FORMS
TOPIC 3: Bioconversion Energy

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

3. Following instruction the student will describe how bioconversion systems convert solar energy, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. List materials that are the result of bioconversion
   b. Describe the ways in which humans use energy from bio-system products
   c. Calculate the efficiencies of various bioconversion systems
   d. Describe how photosynthesis converts solar energy and chemicals for plant development
   e. Describe the processes used in converting biomass materials to more useful fuel products

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 3a) Have students identify the biomass materials used in their homes, school, and community (e.g., food, fuels, and building products).

2. (P.O. 3a) Describe how biomass materials are converted into other energy forms.

3. (P.O. 3b) Have the class build a model of a methane digester and measure the BTU output. What safety considerations must be observed with the product?

4. (P.O. 3c) Have students calculate the conversion of biomass to other energy forms and determine if it is more economical than using other forms.

5. (P.O. 3d) Have the class list the benefits and potential hazards of conversion of biomass to other uses.

6. (P.O. 3d) Describe how photosynthesis converts solar energy and chemicals to plant material.

7. (P.O. 3e) Have the class make wood gas from sawdust and test the BTU content.

8. (P.O. 3e) Have students investigate the number of wood burning stoves in the community. Locate the sources of wood. Describe the advantages and potential dangers in using wood for heating.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

9. (P.O. 3e) Have the class use biomass materials to produce methanol and test the BTU output produced. What precautions must be taken with this product?

10. (P.O. 3e) Have students operate an internal combustion engine on an alcohol fuel they have produced. Measure the horsepower produced and compare it with other fuels.

11. (P.O. 3e) Have students compare gasoline/alcohol fuel mixtures for their BTU output and effectiveness in internal combustion engines.

12. (P.O. 3e) Have students determine what biomass materials can be used for fuel production. Calculate the effect on food production for different percentages of biomass used for fuel instead of food.

13. (P.O. 3e) Have students identify the effects of removal of forest and farming residues on erosion, depletion of nutrients in the soil, and subsurface water retention.

14. (P.O. 3e) What productive (fuel) uses can be made of waste materials (garbage, manufacturing by-products) and other materials most often placed in landfills? Discuss the pros and cons of different conversion technologies.

BACKGROUND REFERENCES AND RESOURCES

Printed Materials

New York State Energy Research and Development Authority. (1978). Methane Recovery From Sanitary Landfills. Report 78-13. Albany, NY.

U.S. Department of Agriculture. (1980). Small-scale Fuel Alcohol Production. Washington, DC, March.

U.S. Department of Energy, Solar Energy Research Institute. (1980). Fuel From Farms - A Guide to Small-scale Ethanol Production. Washington, DC, February.

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE B: OTHER RENEWABLE ENERGY FORMS
TOPIC 4: Ocean Energy Resources

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

4. Following instruction, the student will describe the energy resources which occur in the oceans and the ways in which those resources can be used to benefit humans, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Name the features of currents, tides, and waves which occur in the oceans
   b. Describe the cyclical nature of currents and tides
   c. Explain ocean thermal and ocean salinity gradient factors
   d. State the ways in which biomass from the oceans can be used to produce energy

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 4a) Use models to illustrate the effects of currents, tides, and/or waves on surface vessels and/or shorelines.

2. (P.O. 4a) Visit an ocean site or large lake where the action of tides and waves is evident. Have students report to the class on the effects and possible uses of these conditions.

3. (P.O. 4a) Have students construct a model of a tidal pool and design an energy conversion device which would make use of tides.

4. (P.O. 4b) Describe how the moon and sun produce variations in the height and duration of tides.

5. (P.O. 4c) Describe the differences in temperature which occur at various depths in the ocean, and how these temperature differentials can be used to produce energy.

6. (P.O. 4c) Have students construct a model using thistle tubes and semi-permeable membranes which will illustrate the effects of salinity gradient on pressure in the tubes.

7. (P.O. 4d) Have students identify the plants and animals growing in the oceans and list the potential energy uses for each of them. Determine the relative advantages and disadvantages of using ocean farming versus terrestrial biomass growth.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

8. (P.O. 4d) Have students research the harvesting of biomass materials from the oceans for conversion to other energy forms. Determine if any harmful effects would occur from such "harvesting."

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE B: OTHER RENEWABLE ENERGY FORMS
TOPIC 5: Geothermal Energy

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

5. Following instruction, the student will trace the development of geothermal energy as a resource, and describe the advantages and limitations of three types of geothermal energy, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Describe Earth's structure and the origin of geothermal energy
   b. Follow the chronological development of geothermal energy applications
   c. Relate the availability and potential use of geothermal energy to geographic areas
   d. List the three types of geothermal energy reservoirs, and state their advantages and limitations
   e. Identify the various methods used to extract Earth's heat energy for practical applications

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 5a) Have students describe various Earth formations and relate the origin of geothermal energy to these structures.

2. (P.O. 5a) Have students build a working model of a geyser. The design should be flexible so that changing characteristics will result in various geyser effects.

3. (P.O. 5a) Using heated rocks, demonstrate how the heat can be transferred to water to form steam. Include a demonstration with a pressure cooker to show how the pressure of Earth's mantle can alter the phase change from water to steam.

4. (P.O. 5b) Chart the use of geothermal resources from their ancient discovery to modern day exploitation. Address health and recreational applications as well as the generation of electricity.

5. (P.O. 5c) Have students research the location of practical geothermal use sites in the United States and/or the world. Discuss the geologic features which contribute to the opportunity to exploit these resources. Explain why geothermal energy is not practical for all geographic regions.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

6. (P.O. 5c) Have students determine if geothermal energy currently is being used in New York State or the local region. Locate the nearest site where this resource is being used. Research the practicality of developing this resource in the immediate area.

7. (P.O. 5c,5e) Review individual residential, small-scale applications through multiple, large-scale electricity generating units for their respective systems utilizations.

8. (P.O. 5c,5e) Have students describe the various systems used to convert geothermal energy to usable energy. The review should range from the simplest heat exchanger units to provide space heating and hot water, to complex phase-change units which drive turbines to generate commercial quantities of electricity. Handling fluids through surface discharge and reinjection technologies also should be addressed.

9. (P.O. 5d) Show a film on geothermal energy and discuss the advantages and limitations of geothermal energy as a heat source.

10. (P.O. 5d) After studying the characteristics of geothermal reservoirs, have students develop a comparative list which describes reservoirs and their respective advantages, limitations, and applications. Projected thermal output from an individual well also should be addressed.

11. (P.O. 5e) Have students research and prepare charts, diagrams, and illustrations which describe methods of extracting geothermal energy.

12. (P.O. 5e) Given a large pot of hot water, have teams of students build working models which will extract the thermal energy.

13. (P.O. 5e) Have students explain how geologists locate potential geothermal sites. Satellite, aerial, sound, photographic, and chemical technologies should be addressed in addition to exploratory well drilling.

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE B: OTHER RENEWABLE ENERGY FORMS
TOPIC 5: Geothermal Energy

BACKGROUND REFERENCES AND RESOURCES

Books

DiPippo, R. (1980). Geothermal Energy as a Source of Electricity. U.S. Department of Energy. Washington, DC: U.S. Government Printing Office.

DiPippo, R. (1981). Geothermal Power Plants: Worldwide Survey. U.S. Department of Energy. Washington, DC: U.S. Government Printing Office.

Slides

"Geothermal Energy"
James L. Ruhle and Associates
P.O. Box 4301
Fullerton, CA 92631
(contact for materials in all energy areas)

Films

"Geothermal Power: Tapping Nature's Energy"
New York State Energy Office
2 Rockefeller Plaza
Albany, NY 12223

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE B: OTHER RENEWABLE ENERGIES
TOPIC 6: Social Issues, Economic and Environmental Impacts, and Projections

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

6. Given instruction, the student will identify social issues, economic and environmental impacts, and projections related to renewable energy technologies, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. State the conditions under which renewable energy sources can and are being used
   b. List the personal and legal barriers to the use of renewable energy sources
   c. Compare and contrast the costs of construction, operation, and maintenance of renewable energy converters with fossil-fueled units and each other
   d. Compare the environmental impacts of renewable energy installations with each other and with equivalent nonrenewable facilities
   e. Identify potential future developments in the renewable energy field

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 6a) Have students identify installations in the community which use renewable energy as "fuel."

2. (P.O. 6a) Have students relate the locations of world population centers with each of the renewable energy forms and interface practicality of use.

3. (P.O. 6a,6e) Identify potential sites and circumstances in which renewable energy sources could be used for the production of usable energy. Estimate the amount of energy which would be available from each source.

4. (P.O. 6b) Have students list the advantages and limitations of the increased use of waste material as an energy resource.

5. (P.O. 6b) Describe the impacts on soil, forest lands, and other natural resources of the use of biomass for energy.

6. (P.O. 6b) Conduct a class discussion on the human and economic impacts of growing crops for conversion to fuel rather than to feed people in the world. Is this an appropriate use of energy?

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

7. (P.O. 6c,6d) Discuss the factors which must be considered if waste and garbage from homes, businesses, and industries are to be used for energy production. What safety precautions must be taken? What costs would be incurred? Would this process increase the lifetime of the local landfill?

8. (P.O. 6e) Have students identify materials which currently are not being used for energy in the community and describe how they might be converted to energy use.

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE B: OTHER RENEWABLE ENERGIES
TOPIC 7: Career Information

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

7. Given resources, the student will describe careers in the renewable energy fields, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. List the careers associated with renewable energy technologies
   b. List the qualifications necessary to obtain a position in one of those careers

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 7a) Have students research the Dictionary of Occupational Titles, publications by labor groups, the New York State Energy Office, and other resources for lists of occupations related to the renewable energy field. Identify those which are scientific, managerial, technical, service and repair, office and other categories.

2. (P.O. 7b) Have each student select one occupation and determine the entrance qualifications, working conditions, salary, opportunities for advancement, and other occupational information. Make a brief report to the class on findings.

3. (P.O. 7b) Have students compare employment in a renewable energy field and a non-renewable energy field.

4. (P.O. 7b) Conduct a class discussion on how the expanded use of renewable energy forms will provide more opportunities for employment than will the use of equivalent energy quantities delivered by fossil-based sources.

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE C: FOSSIL FUELS
TOPIC 1: Petroleum and Natural Gas

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

1. Given information, the student will describe the technical processes and systems of locating, recovering, processing, distributing, and using petroleum and natural gas products, and their proportion of total energy consumption, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. State the circumstances which resulted in the formation of petroleum and natural gas underground
   b. Describe the processes of discovering, drilling for, and extracting crude oil and natural gas from these deposits
   c. State the steps used in the processing of crude oil into the various products used today
   d. State the steps used in processing natural gas for end use
   e. List the ways in which petroleum products are used and their proportion of total energy consumption
   f. List the ways in which natural gas is used and its proportion of total energy consumption
   g. List the products which result from the distillation (cracking) process

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 1a) Have students construct a model or design of rock strata which contains petroleum and/or natural gas.

2. (P.O. 1a,1b,1c,1d) Contact the American Petroleum Institute and the American Gas Association for information on oil and natural gas exploration, and recovery, distillation, and distribution of petroleum products. Have students give an oral report to the class on the steps used in petroleum processing. (See references for addresses.)

3. (P.O. 1b) Have students build a model of a drilling derrick and describe its use in drilling for oil and natural gas.

4. (P.O. 1c) Have students identify the secondary recovery methods in use for petroleum and natural gas. Determine how these methods will increase production and what kinds of cost increases are projected.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

5. (P.O. 1e) Have students measure the efficiency of various engines with the use of different fuels.

6. (P.O. 1e) Have students identify where petroleum resources are located in the United States and in other parts of the world. Identify the locations of major users of petroleum products. Describe the problems in transporting petroleum products to users.

7. (P.O. 1e,1f) Have students list the ways petroleum and natural gas are used in the community. Discuss the advantages and disadvantages of each use.

8. (P.O. 1e,1f) As a class, compare the known reserves of petroleum and natural gas and the rate of use for today's consumers. Based on steady use, identify how long the known reserves will last.

9. (P.O. 1f) Have students identify the locations of natural gas deposits in the United States and in other parts of the world. Identify the locations of major users of natural gas. Describe the problem in transporting petroleum products to users.

10. (P.O. 1g) Have students draw a diagram of one crude oil cracking system and describe how each component is drawn off.

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE C: FOSSIL FUELS
TOPIC 2: Coal

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

2. Given information, the student will describe the technical processes and systems of locating, recovering, processing, distributing, and using coal, and describe the advantages, disadvantages, and environmental problems associated with the use of coal, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Describe the conditions which resulted in the formation of coal deposits
   b. Describe the processes of discovering and removing coal from surface and underground deposits
   c. Describe the different types of coal and the uses for which each type is suited
   d. List the advantages and disadvantages of coal as a fuel
   e. State the problems associated with the release of sulfur dioxide from the burning of certain types of coal and list the problems associated with the resulting acid rain

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 2a) Have students construct a model of rock strata which contains coal.

2. (P.O. 2b) Have students identify where the coal resources are found in the United States and in other countries. Determine the amounts in known reserves and the "ownership" situation.

3. (P.O. 2b) Have students draw a diagram of a surface mine and a diagram of an underground mine. Show differences and similarities.

4. (P.O. 2b) Describe the differences in machines and equipment used in surface mines and underground mines.

5. (P.O. 2c) Have students investigate samples of the different types of coal and describe the characteristics of each.

6. (P.O. 2c) Have students conduct an experiment to measure the amount of heat produced from an equal weight/volume of each type of coal. Compare the results. Compare the residues produced.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

7. (P.O. 2c) Have students gasify and/or liquefy bituminous coal and determine the BTU content of the fuel produced. Describe the advantages and disadvantages of conversion of coal in this manner.

8. (P.O. 2d) Have students compare advantages and disadvantages of coal combustion with the burning of other fossil fuels. Evaluate each finding.

9. (P.O. 2d,2e) As a class, identify the health hazards encountered in coal mining, especially underground mines.

10. (P.O. 2d,2e) Have students investigate the health and environmental hazards associated with coal burning.

11. (P.O. 2d,2e) Have students determine the role which coal plays in international relations between the United States and Canada as well as European countries.

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE C: FOSSIL FUELS
TOPIC 3: Storage and Distribution of Fossil Fuels

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

3. Given instruction, the student will describe how fossil fuels are stored in preparation for transport to end users and the transportation techniques used, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Name the transportation systems used in the sequence of locating, processing, and transporting to the end user
   b. List the ways in which fossil fuels are stored and describe the safety precautions which must be taken to protect both the fuel and people nearby

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 3a) Have students make maps showing the movement of fossil fuels from source to distribution points. Describe the different transportation systems which may be used for each.

2. (P.O. 3a) Have students survey the community to determine the amounts of fossil fuels used and the ways in which they are distributed to each end user.

3. (P.O. 3a) Have the class interview a business representative to determine what effect the availability of fossil fuels had on locating the business or industry in that community.

4. (P.O. 3a) Develop an outline and moderate a discussion on how to reduce our dependence on fossil fuels, particularly imported petroleum products.

5. (P.O. 3a,3b) Have students research accidents which have occurred in transporting fossil fuels. Describe the reported reason(s) for the accidents and project how they might have been avoided.

6. (P.O. 3b) Have students locate storage facilities for fossil fuels in the community or region. Determine the quantities of fuels stored and the period of time those fuels would last if not replenished.

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE C: FOSSIL FUELS
TOPIC 4: Social Issues, Economic and Environmental Impacts, and Projections

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

4. Given information, the student will identify social issues, economic and environmental impacts, and projections related to fossil fuel conversion, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. List the conditions under which fossil fuels are being used
   b. List the personal and legal barriers to the use of fossil energy resources
   c. Compare and contrast the costs of locating, extracting, transporting, and converting fossil fuels with other forms of energy
   d. Compare the environmental impacts of burning various fossil fuels with each other and with renewable energy resources
   e. List the potential future developments in the search for and uses of fossil fuels
   f. Project the impact that fossil fuel energy supplies will have on end users in the residential, commercial, industrial, and transportation sectors

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 4a) Have the class identify the locations of fossil fuel burning facilities in the community and describe the consequences of those plants.

2. (P.O. 4b) Have students research the non-fuel products made from petroleum, coal, and natural gas. Address the social and financial impacts which may result if fuel continues to be the dominant use for these resources as their availability declines.

3. (P.O. 4b) Have the students research the personal and legal barriers to the use of fossil fuels.

4. (P.O. 4c) Have the class list the costs incurred when fossil fuel plants are built, including the transportation facilities needed to bring fuel to the plant.

5. (P.O. 4d) Describe the problems which occur when high sulfur coal is burned and the resulting potential for acid rain.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

6. (P.O. 4d) Have students investigate conditions in the community, area, or region for evidence of harmful effects of burning fossil fuels. Describe the findings to the class or during a school assembly program.

7. (P.O. 4e) Have students research the potential for locating new deposits of fossil fuels in the United States and in the world. Describe why some known sources of fossil fuels are not being used at the present time.

8. (P.O. 4e) Assign students to read scientific or technical bulletins to identify potential uses of fossil fuels and why such uses are not feasible at this time.

9. (P.O. 4f) Brainstorm with the class the impacts the declining availability of fossil fuels will have on the different energy use sectors. Be sure to consider not only economic costs but also the required alterations of lifestyles.

10. (P.O. 4f) Have students describe what the world will be like when some of the fossil fuels are no longer readily available. Record their ideas on tape for future use.

11. (P.O. 4f) Have students role play a meeting of OPEC members. Include the worldwide dependency on supply, projected shortage of crude oil, political problems, financial concerns, and how OPEC can control contracts, agreements, and quantities.

12. (P.O. 4f) Have students design and construct a model of a future home that will use a limited quantity of fossil fuels.

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE C: FOSSIL FUELS
TOPIC 5: Career Information

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

5. Given information, the student will describe careers in the fossil fuel field, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. List the careers associated with fossil fuel technologies
   b. List the qualifications necessary to be employed in one of those careers

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O.5a) Have students research the Dictionary of Occupational Titles, publications by labor groups, the New York State Energy Office, and other resources for lists of occupations related to fossil fuel technologies. Identify those which are scientific, managerial, technical, service and repair, office, and other categories.

2. (P.O. 5a,5b) Invite a panel of parents who are employed in fossil fuel related jobs to discuss their careers.

3. (P.O. 5b) Have each student select one occupation from the list above and determine the entrance qualifications, working conditions, salary, opportunities for advancement and other occupational information. Make a brief report to the class or a presentation to a school assembly.

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE D: NUCLEAR FISSION AND FUSION
TOPIC 1: Atomic Theory

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

1. Given instruction, the student will demonstrate an understanding of basic atomic theory and structure, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Define basic nuclear chemistry terms and apply them in verbal and written form
   b. Describe the necessary elements for and differentiate between nuclear fission and nuclear fusion reactions
   c. Describe why a chain reaction is necessary to acquire usable heat energy
   d. Explain why Uranium-235 is used as fuel for fission reactions and sea water for fusion reactions

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 1a) Using a three-dimensional atomic structure model, have students identify the various parts and relate their respective space positions and functions in that structure.

2. (P.O. 1a,1b,1c,1d) Discuss the atomic structure of several materials allowing students to grasp the concept of "free" electrons.

3. (P.O. 1b) Prepare materials for nuclear cloud chambers and demonstrate how to use them. Working in small groups, have students assemble the cloud chambers and observe the beta rays emitted from the nuclear source.

4. (P.O. 1c) Demonstrate a chain reaction by setting up several mousetraps, in a restricted area, which have been "loaded" with ping pong balls. Dropping a "free" ping pong ball will set off others and those, in turn, will set off more, demonstrating the chain reactions concept. **WARNING:** setting this up can be tricky.

5. (P.O. 1c,1d) Have half the students prepare illustrations or models of how U-235 fissions produce heat energy, neutrons, U-238, and other products. Have the other half illustrate or model how deuterium and tritium fuse to produce heat energy, helium, and water.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

6. (P.O. 1d) Have students compare quantities of coal, petroleum, natural gas, wood, biomass, U-235, and other fuels as to their respective energy potentials per volume and weight. This also could be based on equivalents, e.g., 1 pound of U-235 = XXX tons of coal = YYY cords of wood = ZZZ gallons of fuel oil.

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE D: NUCLEAR FISSION AND FUSION
TOPIC 2: Development of Nuclear Fission and Fusion

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

2. Following instruction, the student will describe the development of fission and fusion nuclear energy, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Differentiate between military and peaceful applications of nuclear energy
   b. Describe problems encountered during the early years of fission technology development and current problems with both fission and fusion technology
   c. Relate the chronological development of nuclear fission and fusion energy

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 2a) Have students prepare a bulletin board depicting the peaceful and military applications of nuclear fission energy. Photographs, magazine pictures, periodical and newspaper articles, and three-dimensional models should be included. Areas to be represented: medical applications (treatment of cancer patients), food preservation (irradiation to preserve color, flavor, and storage life), radon detection devices, nuclear accelerators (analysis of water, smoke, blood, etc., for chemical composition and potential toxins), research uses, military applications, and as a heat source for generating electricity.

2. (P.O. 2a,2b,2c) Show a film or videotape which reviews the historical developments related to nuclear fission and fusion energy development and applications. Students, using their notes, should discuss leaders in the field, problems encountered, and energy applications.

3. (P.O. 2a,2b,2c) Have students research and report on the early successes and failures in developing nuclear energy as a technology. Items to address can include countries, people with leadership roles, and the respective discoveries or developments.

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE D: NUCLEAR FISSION AND FUSION
TOPIC 3: Uranium Mining, Fuel Processing, and Fabrication

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

3. Given information, the student will describe the nuclear fuel cycles from source through use to disposal, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Diagram the steps required to prepare and handle nuclear fuel from the source through disposal; fission fuel from uranium ore, and fusion fuel from sea water
   b. Relate the volume of U-235 in fabricated fuel pellets to the amount of uranium ore which must be mined and processed

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 3a) Show a film or video dealing with uranium exploration, mining, and preparation of uranium as a fission nuclear fuel and sea water as a nuclear fusion fuel. Discuss the highlights of the film.

2. (P.O. 3a) Have students, individually or in small groups, research the sequence necessary to prepare U-235 and sea water as fuels. Prepare diagrams showing the steps of exploration, mining, processing, use, and techniques of disposal.

3. (P.O. 3a) Have students work in teams to write letters to companies, organizations, and agencies requesting information on the nuclear fuel cycles. Display and discuss the materials received by the class.

4. (P.O. 3a,3b) Place students in small groups to research and discuss the sequence and related technologies associated with the exploration, mining, and preparation of U-235 and the processing of sea water to obtain deuterium and tritium.

5. (P.O. 3b) After studying the nuclear fuel cycles, have students manipulate data to determine the ratio, percent, respective weights, and volumes of raw, mined uranium ore compared to processed, fabricated uranium fuel pellets for fission reactors. Have them do the same for the acquisition of fusion fuel.

SUGGESTED INSTRUCTIONAL STRATEGIES, continue

6. (P.O. 3c) Have students locate on a national and/or world map the estimated reserves of uranium ore deposits. After determining the number of functioning reactors in the United States and their annual fuel requirements, students are to project the number of years the proven uranium ore resources will last at current rates of utilization.

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE D: NUCLEAR FISSION AND FUSION
TOPIC 4: Reactor Types and Containment Designs

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

4. Given instruction, the student will describe the characteristics of fission nuclear reactors and fusion nuclear containment designs, and describe the present status of development of current fusion containment designs, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. List the major fission nuclear reactor types
   b. Analyze schematic diagrams of the various fission reactor designs and describe the differences and similarities among the various fission reactors
   c. Research each of the current fusion containment designs

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 4a) Have students research and prepare a written list of the major fission nuclear reactor types.

2. (P.O. 4b) Following a presentation on reading and interpreting schematic diagrams, have students analyze the illustrated features of various fission nuclear reactor designs. Have students design and construct small models of selected fission reactor designs, using various laboratory materials or materials they acquire themselves.

3. (P.O. 4b) Have each student select a nuclear-fueled electricity generating plant from the documents provided in class, then prepare and send a letter requesting information such as plant location, type of reactor, operating agency/utility, generating capacity, and population served. Have the students report to the class concerning the information received.

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE D: NUCLEAR FISSION AND FUSION
TOPIC 5: Safety

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

5. Given instruction, the student will describe the characteristics of radioactivity and the necessary safety precautions required when using this technology, and describe the role of the Nuclear Regulatory Commission, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. List the components which make a material radioactive
   b. Explain how radioactivity levels are measured
   c. List the sources of radioactive materials that exist in the environment, both natural and human made
   d. Describe how radioactive materials are handled and transported
   e. List the specific elements resulting from a fission nuclear reaction which are toxic and/or carcinogenic to life forms and relate the effects of radioactivity on the human body
   f. Compare fuel, operating, and waste handling safety procedures with fission and fusion nuclear systems
   g. Describe the Nuclear Regulatory Commission's (NRC) attempt to assure safe and efficient design, construction, and operation of commercial nuclear-fueled electricity generating plants

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 5a) Lead a class discussion on characteristics which make materials radioactive.

2. (P.O. 5b) Describe how a Geiger counter functions and demonstrate how it is used to measure radioactivity. Have students measure and record readings from various radioactive laboratory sources including alpha, beta, and gamma source samples, uranium ore, Fiesta Ware, Coleman lantern mantles, and old luminous watch or clock faces.

3. (P.O. 5b) Have students construct a simple audio Geiger counter which varies in audio level according to the radioactivity level of the tested source.

4. (P.O. 5c) As an individual assignment, have students list the natural and human-produced sources of radioactive materials in our environment, then complete an estimation of the annual radiation doses received from the various environmental sources. Class members can compare their findings.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

5. (P.O. 5c,5d,5e) Divide the class in two groups. Have one group research and report to the class the findings concerning the nuclear accident at Three Mile Island. The other group will be assigned Chernobyl. Discuss events, designs, results, and the actions of persons, agencies, and governments responsible for safe operation of the plants and safety of the general public.

6. (P.O. 5d) Following a film related to the topic, assign students to describe how radioactive materials are handled and transported. These descriptions should include the handling and transportation of uranium ore from mining to processing as fuel pellets, fuel bundles, loading fuel in the reactor, removing spent fuel from the reactor, storing in pools, disposal, and reprocessing for reuse. Decommissioning of nuclear facilities should be addressed.

7. (P.O. 5d,5e,5g) Organize and host an auditorium program on nuclear energy use and safety. This program could take the form of a debate between representatives from pro-nuclear and anti-nuclear groups. It could be a program where each speaker presents a side of the issue, without debate, followed by a question and answer session. Arrange for attendance by combined Technology Education classes or, preferably, the entire school population. If conducted for the entire school, encourage discussion of the topic in other subject area classes, e.g., science, social studies, and health.

8. (P.O. 5e) After researching the topic, have students list on the chalkboard the results of a nuclear-reaction which are toxic and/or carcinogenic to life forms. Discuss the effects if exposure occurs.

9. (P.O. 5f) Compare nuclear fission and nuclear fusion systems from the standpoint of radiation safety. Be sure to encompass the entire process from fuel preparation through operation and waste disposal.

10. (P.O. 5g) Have groups of students send letters to the NRC requesting information about safety requirements for nuclear-fueled plants. Have each group select a different aspect of the safety program and prepare and present an overview to the entire class.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

11. (P.O. 5g) Invite an electric utility company representative to speak to the class concerning the requirements which have to be met under NRC regulations. This presentation should include examples of major and minor regulations encompassing features ranging from security personnel, plant construction, and operator training to day-to-day operations and penalties for noncompliance. Together with the utility representative, or as a separate program, invite an anti-nuclear representative to discuss NRC regulations and the utility company compliance record. Have students discuss the positions expressed by this representative and the utility company representative.

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE D: NUCLEAR FISSION AND FUSION
TOPIC 6: Waste Disposal, Spent Fuel Storage, and Reprocessing

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

6. Given information, the student will list by-products of nuclear fission and fusion reactions and describe the problems of nuclear waste disposal, storage, and reprocessing in the United States and other nations using nuclear energy, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Recognize the names of nuclear fission and fusion reaction by-products and differentiate between low-level and high-level radioactive waste products
   b. Demonstrate an understanding of the issues related to spent fuel storage and reprocessing and compare how the United States and other nations using nuclear energy are handling radioactive wastes
   c. Define permanent storage and reprocessing, and compare and contrast them

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 6a) Prepare a terminology list and have students identify the names of nuclear fission and fusion by-products and designate those which are potential hazards. Have students search resources for descriptions of materials, objects, and volumes of low- and high-level radioactive wastes. Composite lists are to be prepared by small groups of students and shared with the entire class.

2. (P.O. 6b) Have teams of students list and describe how the United States and other countries using nuclear fission energy are handling their radioactive waste problem. Each description must include the issues and concerns related to those particular methods of handling.

3. (P.O. 6c) Divide the class into three teams. Have one team address methods for permanently storing radioactive wastes, the second team address retrievable storage systems, and the third team address spent fuel reprocessing. Each team is to select a spokesperson to present the findings of the team. The presentations are to be followed by class discussion. If the students do not adequately address the issue, conclude the activities with a brief presentation on why the United States terminated its West Valley, New York nuclear fuel reprocessing efforts and has decided to permanently store its high-level nuclear wastes.

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE D: NUCLEAR FISSION AND FUSION
TOPIC 7: Social Issues, Economic and Environmental Impacts, and Projections

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

7. Given instruction, the student will identify social issues, economic and environmental impacts and projections related to nuclear fission and fusion energy use, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Locate the commercial nuclear reactors in New York and the United States on a map
   b. Describe political problems and social issues related to selected reactor locations
   c. Compare the costs to construct electricity generating plants which use hydropower, fuel oil, natural gas, biomass, and nuclear energy as the initial energy source; be sure to include all costs from beginning to end
   d. Compare operation costs and environmental impacts of the above plants
   e. Project the future of nuclear fission as an energy source in New York, the United States, and other countries
   f. Discuss social, economic, environmental, and projections for fusion energy
   g. Project the availability of U-235 as a national and international resource

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 7a) On a New York State map, have students locate and label all commercial electricity generating nuclear reactors. The label should contain the name of the unit, the owner/operator, and the potential electricity output. Include units which are on-line, under construction, and awaiting decommissioning. A class project could involve a United States or international maps with teams of students responsible for a specific geographic area.

2. (P.O. 7b) Have students design and conduct an informal survey of people to determine their knowledge or understanding of nuclear theory, how a nuclear-fueled electricity generating plant works, and of the differences between nuclear bombs and nuclear reactors for generating electricity.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

3. (P.O. 7b) Conduct a class discussion on the political and social impacts of placing nuclear-fueled electricity generating plants in one geographic area and then transporting the electricity produced for use to another geographic area. Describe the positive and negative impacts on people from other areas, and the effect on people of high voltage transmission lines.

4. (P.O. 7b) Have students study communication materials (audio, video, and printed) provided by a pro-nuclear organization and an antinuclear organization. (Example: Atomic Industrial Forum and Environmental Action, respectively.) Have them analyze the data presented, the information which was excluded, the information which is misleading, and the methods of presenting the material.

5. (P.O 7b) Have students follow the unfolding drama of a utility trying to place a unit in service, e.g., Nine Mile Point Unit II, Shoreham, and Seabrook. This could be done by clipping articles from daily newspapers or inviting guest speakers to class.

6. (P.O. 7b,7c,7d) Invite a utility representative and an environmental group representative to discuss construction costs, operational costs, and environmental impacts of all types of electricity generating plants. Rank order the units from most economical to most expensive; least to most politically and socially acceptable; and least to greatest regarding potential environmental impact.

7. (P.O. 7d) Purchase barley seeds and have them irradiated at a local university, hospital, or industrial plant. The irradiation should be done at specific intervals, e.g., 1, 2, and 4 hours. Students are to plant irradiated and non-irradiated seeds and chart their germination and growth. Have them discuss farmland in the Chernobyl area in relation to their findings.

8. (P.O. 7e) Using the knowledge gained in the above learning experiences and additional research efforts, have students discuss and present various points of view on the projected future of nuclear fission as an energy source in the United States and other countries.

9. (P.O. 7f) Have students write letters to fusion research facilities requesting current development status, social and economic concerns, and projections for commercial use. Discuss the material received.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

10. (P.O. 7g) Have student teams select a fusion nuclear containment design to research. Have them write letters requesting photographs and information from the research facility. Display and discuss the materials received.

MODULE II: EXPLORING ENERGY TECHNOLOGIES
SUBMODULE D: NUCLEAR FISSION AND FUSION
TOPIC 8: Career Information

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

8. Given resources, the student will describe careers related to nuclear fission and nuclear fusion energy, to the satisfaction of the instructor.

In order to do this, the student must be able to:

a. List careers in the field of nuclear fission and fusion energy
b. List the educational requirements for careers related to fission and fusion energy

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 8a,8b) Have students investigate careers associated with fission and fusion energy. Due to the futuristic and research nature of fusion, most positions will require advanced degrees in physics, engineering, mathematics, and science. Discuss the educational and personal requirements for such positions and the often high-stress, high demand levels placed upon employees and how this affects their families. Also discuss the low salaries and long, irregular hours often associated with such jobs.

BACKGROUND REFERENCES AND RESOURCES

Books

Cohen, B.L. (1983). Before It's Too Late - A Scientist's Case for Nuclear Energy. New York: Plenum Press.

Denton, J.C. (1976) and N.H. Afgan, Future Energy Production Systems, Vol. 2, New York: Academic Press.

Gross, R.A. (1984). Fusion Energy John Wiley and Sons.

Hulme, H.R. (1969). Nuclear Fusion. London: Wykeham.

Hunt, V.D. (1982). Handbook of Energy Technology. New York: Van Nostrand Reinhold.

Krenz, J.H. (1976). Energy: Conversion and Utilization. Boston: Allyn and Bacon.

BACKGROUND REFERENCES AND RESOURCES, continued

Meador, R. (1978). Future Energy Alternatives. Ann Arbor, MI: Ann Arbor Science.

Nero, A.V. (1979). A Guidebook to Nuclear Reactors. Berkley, CA: University of California Press.

Brochures and Booklets

Atomic Industrial Forum (1983). "Electricity from Nuclear Power." Atomic Industrial Forum, Washington, DC.

Atomic Industrial Forum (1977). "Plutonium in Perspective." Atomic Industrial Forum, Washington, DC.

Edison Electric Institute. (1983). "Nuclear Power: Answers to Your Questions. "Washington, DC: Edison Electric Institute.

Energy Information Administration. (1989). Spent Fuel Pool Maximum Capacities and Inventories for Nuclear Power Plants as of December 31, 1987. Washington, DC: U.S. Department of Energy.

Johnson, T. (1983). "Nuclear Waste - A Better Way to Bury It?" Popular Science, May.

Moore, J.S. (1983). Nuclear Power Industry Scrambles to Survive, "High Technology," July.

U.S. Council for Energy Awareness. (1989). Electricity From Nuclear Energy. Washington, DC: U.S. Council for Energy Awareness.

U.S. Department of Energy. (1987). Atoms to Electricity. Washington, DC: U.S. Department of Energy.

U.S. Department of Energy. (1988). Site Characterization Plan Overview: Yucca Mountain. Washington, DC: U.S. Department of Energy.

U.S. Department of Energy. (1989). Transporting Radioactive Material: Answers To Your Questions. Washington, DC: U.S. Department of Energy.

BACKGROUND REFERENCES AND RESOURCES, continued

U.S. Department of Energy. (1986). Transporting Spent Nuclear Fuel: An Overview. Washington, DC: U.S. Department of Energy.

COURSE: ENERGY AND POWER TECHNOLOGY
MODULE III: EXPLORING POWER TECHNOLOGY

OVERVIEW OF MODULE

Goal

The student will be introduced to a wide variety of internal combustion engine designs, external combustion engine designs, and principles of fluid power.

A description and a brief analysis of the basic operating systems, and their advantages, limitations, and uses will be given. The instruction is to be introductory only as there are courses in Transportation Systems, Land Transportation, and Aerospace in the curriculum which address these topics in detail.

Description

Energy conversion devices, in the form of engines, are a primary source of increased capability for our technological society, particularly in the field of transportation. The wide variety of designs indicate specific characteristics necessary to perform different functions. This module is designed to instill a general awareness of the wide design variety, rather than skill in the maintenance or repair of engines. A few specific mechanical skills can be included, but should not take priority over the content coverage, which is to address how energy can be converted from one form to another.

Skills, Knowledge, and Behaviors to be Developed

The student will be able to:

1. Describe various internal combustion engine designs
2. Describe external combustion engine designs
3. Describe basic principles of fluid power

MODULE III: EXPLORING POWER TECHNOLOGY
SUBMODULE A: INTERNAL COMBUSTION ENGINES
TOPIC 1: Reciprocating Engine Design

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

1. Following instruction, the student will be able to analyze the function of reciprocating engine design and construction, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Name the primary engine components and explain their function
   b. Describe the major engine systems of lubrication, cooling, ignition, fuel, combustion, and exhaust
   c. Describe common and innovative cylinder block designs

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 1a) Have the students conduct a laboratory experiment of "Engine Analysis," using small engines such as those in lawn mowers. Groups of students could work on larger engines. The goal should not be to make the engine run, but rather to disassemble and assemble the engine in order to gain an understanding of how it works. Torque wrenches and proper clearances are not a priority in this objective, although they could be included if the instructor desires.

2. (P.O. 1a) Using a cut-away model of an engine, have the students identify the working parts on a worksheet.

3. (P.O. 1a) Provide a plastic model kit of the "Visible V-8" or some other engine model and have a group of students construct it.

4. (P.O. 1b) Have the students analyze the various engine systems on display boards containing the major parts. Students could be involved in the planning and assembly of such a board.

5. (P.O. 1b) Have each student research the various engine systems in their family car, lawn mower, recreational vehicle, etc., using reference manuals. Have students complete a worksheet that asks specific questions concerning each system.

6. (P.O. 1b) Develop a series of tests to perform on a stationary engine that analyzes various systems, such as oil pressure check with gauge, scope analysis of the ignition system, carburetor adjustment, and exhaust analysis for pollutants.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

7. (P.O. 1c) Have the students find articles from magazines, manuals, diagrams, and textbooks about as many different cylinder block designs as possible. Make copies of each and display on a bulletin board. Discuss differences and similarities.

8. (P.O. 1c) Using old motor manuals, have the students trace the history of four, six, V-6, straight eight, V-8, and other block designs commonly used in automobiles.

MODULE III: EXPLORING POWER TECHNOLOGY
SUBMODULE A: INTERNAL COMBUSTION ENGINES
TOPIC 2: 2- and 4-Stroke Cycle Engines

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

2. Following instruction, the student will be able to analyze the similarities and differences between 2- and 4-stroke cycle engine designs, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Describe the flow of the fuel/air mixture, and the position of the engine components in 2- and 4-stroke cycle engines.
   b. Give examples of 2- and 4-stroke cycle engine use and reasons for cycle selection in that particular application.

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 2a) Make acrylic, working overhead projector models of a combustion chamber and have the students position the piston and valves in each cycle for 2- and 4-stroke cycle engines.

2. (P.O. 2a) Include an analysis of engine cycles when conducting an "Engine Analysis," described on page 71.

3. (P.O. 2a) Analyze cycle differences on a transparent engine, preferably, a transparent engine that operates.

4. (P.O. 2b) Have the students bring in advertising pictures of various products with engines (e.g., chain saws, snowblowers, lawn mowers, marine engines, and dirt bikes) and discuss why a 2- or 4-stroke cycle engine was selected.

5. (P.O. 2b) Have some students conduct the "Engine Analysis" on 2-stroke cycle engines and some on 4-stroke cycle engines. Encourage groups to explain the similarities and differences.

MODULE III: EXPLORING POWER TECHNOLOGY
SUBMODULE A: INTERNAL COMBUSTION ENGINES
TOPIC 3: Compression Ignition (Diesel)

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

3. Following instruction, the student will be able to differentiate between compression ignition engines and other types, and explain why they are the preferred engines, to the satisfaction of the instruction.

   In order to do this, the student must be able to:

   a. Describe the function and theory of compression ignition
   b. Give examples of current uses and explain the reasons for these uses

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 3a) Develop an acrylic, working overhead projector model of a diesel engine and have a student describe the sequence of operation.

2. (P.O. 3a) Have students conduct an "Engine Analysis" on a small diesel engine.

3. (P.O. 3b) Have the students brainstorm common uses of diesel engines and describe why they are used.

4. (P.O. 3b) Discuss the popularity of diesel engines in passenger cars in the late 1970s, and offer reasons for their decreasing popularity now.

MODULE III: EXPLORING POWER TECHNOLOGY
SUBMODULE A: INTERNAL COMBUSTION ENGINES
TOPIC 4: Gas Turbines

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

4. Following instruction, the student will be able to analyze and explain the function of gas turbine engines, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Differentiate between gas turbines and other engine types
   b. Review nozzle and turbine blade design configurations
   c. Differentiate among fuels, oxidants, and propellants
   d. Describe prospective uses of gas turbines
   e. Review the advantages and limitations of gas turbines

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 4a) Have students make an acrylic working model of a gas turbine using compressed air as the energy source.

2. (P.O. 4b) Have students research and design turbine blades or turbine nozzles. Using compressed air in a wind tunnel, observe the effects created by the various designs.

3. (P.O. 4c) Discuss the differences among fuels, oxidants, and propellants. Provide specific examples of each and how they are used to drive gas turbines.

4. (P.O. 4d) Have students research past and present uses of gas turbines.

5. (P.O. 4d) Take a field trip to an airport to view a gas turbine.

6. (P.O. 4d,4e) Have students brainstorm current and potential uses of gas turbines citing advantages and limitations of each.

MODULE III: EXPLORING POWER TECHNOLOGY
SUBMODULE A: INTERNAL COMBUSTION ENGINES
TOPIC 5: Airstream, Reaction (Jet) Engines

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

5. Following instruction, the student will be able to analyze and explain the function of jet engines, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Describe the differences between jet engine design and other engine types
   b. Explain where ram jet, pulse jet, turboprop, and turbojet engine design is used and the reasons why

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 5a) Obtain a demonstration jet engine testing apparatus and have the students conduct an experiment with it.

2. (P.O. 5a) Have a group of students develop a chart or acrylic model of various jet engine designs. This could be part of a class research project where different groups would develop different designs and share them with the class on presentation day.

3. (P.O. 5b) Take a field trip to a large airport or military installation to study jet aircraft engines.

4. (P.O. 5b) Conduct an analysis of popular commercial aircraft designs and identify the type of jet power in each.

MODULE III: EXPLORING POWER TECHNOLOGY
SUBMODULE A: INTERNAL COMBUSTION ENGINES
TOPIC 6: Rocket Engines

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

6. Following instruction, the student will be able to analyze the similarities and differences in the design rocket of engine systems and the design of other internal combustion engines, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Define rocket engines as distinct from jet engines
   b. Describe key systems and combustion techniques used in solid and liquid propellant rocket engines
   c. Relate the history of and possible future for rocket engine use

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 6a) Place the students in a small groups to develop a display of rocket engines in use today. Have them compare rocket engines to jet engine design.

2. (P.O. 6a) Make a bulletin board display, having the students citing the advantages, disadvantages, and differences of other engine designs.

3. (P.O. 6b) Involve the class in an Estes rocket design and launch, either individually or in small groups. Ensure that rocket construction has not been used as a problem-solving exercise in some other class to avoid activity repetition.

4. (P.O. 6b) Using a demonstration engine for liquid propellant rocket engines, have the students fire it as a laboratory experiment. Do the same for a solid propellant rocket engine.

5. (P.O. 6b) Research current rocket engine design and classify them as solid or liquid propellant engines.

6. (P.O. 6c) Have the students make a time line showing significant milestones in the development of rocket engines (e.g., Goddard, German buzzbombs, Sputnik, Apollo program, moon landing, and space shuttle). This time line could be combined with other topics, with students working in groups to develop a comprehensive historical display of many facets of power development.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

7. (P.O. 6b, 6c) Search current A-V catalogs for early documentary movies that show the successes and failures of early rockets. Present to the class.

8. (P.O. 6a, 6b, 6c) Write NASA and Young Astronauts program for materials to be used for this topic.

MODULE III: EXPLORING POWER TECHNOLOGY
SUBMODULE A: INTERNAL COMBUSTION ENGINES
TOPIC 7: Innovative Engine Designs

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

Following instruction, the student will be able to describe several innovative engine designs and what may keep them from being widely used or accepted, to the satisfaction of the instructor.

In order to do this, the student must be able to:

a. Define innovative design
b. Give possible reasons why these designs do not hold more prominent place in today's technology

(Note: Possible innovative designs you could select include the Wankel engine and General Motors free-piston engine.)

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 7a) Involve a small group of students in a research project on one or more innovative engine designs and have them report to the class. Require charts, diagrams, pictures, etc. Incorporate the use of a video camera, overhead projector or opaque projector.

2. (P.O. 7b) Have the students brainstorm where these innovative designs might be used in the future, citing advantages and limitations of each.

BACKGROUND REFERENCES AND RESOURCES

Books

Atteberry, P.H. (1978). Power Mechanics, South Holland, Ill.: Goodheart, Wilcox Co.

Bohn, R.C., et. al. (1986). Energy, Power and Transportation Technology. Encino, CA: Bennett & McKnight.

Chilton's Guide to Small Engine Repair (1983). Radnor, PA: Chilton Book Co.

BACKGROUND REFERENCES AND RESOURCES, continued

Books, continued

Day, J. (1980). Engines: The Search for Power. New York: St. Martin's Press.

Duffy, J.W. (1972). Power, Prime Mover of Technology. Bloomington, IL: McKnight. (classic)

Geil, J.J. (1976). Energy and Transportation: Power. Englewood Cliffs, NJ: Prentice Hall.

Grannis, G.E. (1979). Modern Power Mechanics. Indianapolis: Bobbs-Merrill Pub.

Gray, J.A. (1988). Small Gas Engines. Englewood Cliffs, N.J.: Prentice-Hall.

Hires, B., et al. (1985). Small Engine Repair. Stillwater, OK: Mid-America Vocational Curriculum Consortium.

Inboard Engines, Transmissions, and Drives Service Manual, 3rd Ed. (1989). Overland Park, KS: Interter Pub. Co.

Meyer, C.F. (1986). V-ters Guide for Small Engine Repair. Columbia, S.C.: Dept. of Ed.

Norbye, J.P. (1971). The Wankel Engine. Radnor, PA: Chilton. (classic)

Old Outboard Motor Service Manual, 1st Ed. (1983). Overland Park, KS: Interter Corp.

Purcell, J.F. (1982). From Hand Ax to Laser: Man's Growing Mastery of Energy. New York: Vanguard Press.

Rizzo, L. (1982). Small Gas Engines Explained. Garden City, NY: Bergwall.

Schwaller, A.E. (1989). Transportation, Energy, and Power Technology. Albany, NY: Delmar Publishers, Inc.

Stephenson, G.E. (1986). Power Technology. Albany, NY: Delmar Publishers.

BACKGROUND REFERENCES AND RESOURCES, continued

Stone, R. (1985). Introduction to Internal Combustion Design. Basingstoke: Macmillan.

Suess, A.R., et al. (1976). Introduction to Power Systems. Beverly Hills, CA: Bruce.

Weathers, T. (1983). Fundamentals of Small Gas Engines. Reston, VA: Reston Pub. Co.

Video

"Transportation Systems Explained." Bergwall, P.O. Box 238, Garden City, N.Y. 11530.

MODULE III: EXPLORING POWER TECHNOLOGY
SUBMODULE B: EXTERNAL COMBUSTION ENGINES
TOPIC 1: Steam Engines

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

1. Following instruction, the student will describe how external combustion devices produce, transmit, and use power for useful purposes, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Identify equipment which uses steam to produce power in the community
   b. Describe the principles of steam engine operation
   c. Name the major components of steam turbines and the function of each
   d. List various fuels used to produce heat for steam engines
   e. Calculate the work performed by a steam engine

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 1a) Ask students to identify sites in your community where steam engines (piston and turbine types) are being used. Describe each engine's type and purpose.

2. (P.O. 1a) Some steam-powered locomotives have been re-built and are used for specific, unique purposes such as short-run tourist attractions or for powering local small industries. Have students locate any of these in your community.

3. (P.O. 1b) Have students design and construct a device which demonstrates the action that occurs in the "expander" of a piston steam engine.

4. (P.O. 1b) Have students compare and contrast the action of a steam piston engine with that of a steam turbine using commercially available laboratory steam engines.

5. (P.O. 1c) Have students prepare operating diagrams of the reciprocating steam engine and the steam turbine. Compare and contrast the components and their functions.

6. (P.O. 1d) Have students identify the fuels and calculate the conversion efficiencies used in steam generating plants and describe the advantages and disadvantages of each.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

7. (P.O. 1e) Given a steam engine of known horsepower, have students calculate the work (in ft. lbs./sec.) performed by the engine in moving 1 ton of freight a distance of 1 mile on a level track.

MODULE III: EXPLORING POWER TECHNOLOGY
SUBMODULE B: EXTERNAL COMBUSTION ENGINES
TOPIC 2: Steam Turbines

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

2. Following instruction and research, the student will describe how the steam turbine functions to transmit energy, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. List the components of the steam turbine and the function of each
   b. Explain the similarities and differences between steam turbines and steam engines
   c. Describe why steam turbines are larger and operate at higher speeds than steam engines or water turbines

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 1a) Locate sites in the community where steam turbines are operating. State the purpose of each and the fuel used to produce steam.

2. (P.O. 1a) Give students charts or diagrams of a typical steam turbine. Have them list the components of a typical steam turbine and describe the function of each.

3. (P.O. 1b) Compare and contrast the components and functions of the steam turbine parts with the parts of the steam engines identified in the previous sub-module.

4. (P.O. 1b) Explain the greater efficiencies of the steam turbine as compared with the steam engine.

5. (P.O. 1c) Give students charts or diagrams of a steam turbine. Have them identify the high and low pressure stages and describe what changes occur as the steam passes through the turbine.

MODULE III: EXPLORING POWER TECHNOLOGY
SUBMODULE B: EXTERNAL COMBUSTION ENGINES
TOPIC 3: Stirling Engine

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

3. Following research, the student will describe a Stirling engine, how it differs from other engines, and how it may be used in the future, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. State the characteristics of a Stirling engine
   b. Describe the operating cycles of this engine
   c. Differentiate between the Stirling and other engine designs
   d. Project the future use of Stirling engines

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 3a, 3b) Have small teams of students operate a laboratory model Stirling engine and note its characteristics and how it operates.

2. (P.O. 3a, 3b, 3c) Show students illustrations of a Stirling engine. Have them describe how it operates and how it differs from other engines.

3. (P.O. 3d) Have students research and report on the Stirling engine's future especially as it relates to the use of solar, methane, and other renewable energy forms.

MODULE III: EXPLORING POWER TECHNOLOGY
SUBMODULE C: FLUID POWER
TOPIC 1: Hydraulics

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

1. Following instruction, the student will describe and demonstrate how hydraulics are used to transfer energy and describe the differences and similarities of hydraulic and pneumatic systems, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Explain the properties of fluids
   b. Define and use fluid power terminology, e.g., force, pressure, and flow
   c. List major components of hydraulic systems
   d. Explain how control devices are used in hydraulic systems
   e. Measure pressure variations developed with control devices
   f. Read hydraulic system diagrams, identify symbols, and draw component symbols
   g. Operate a self-constructed or commercial device which illustrates knowledge of hydraulic system components

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 1a) Have students research and explain the properties of fluids.

2. (P.O. 1a) Fill a cylinder with water, oil, or other fluid. Place a tight-fitting plug on top of the cylinder after displacing all the air. Try to compress the fluid. State why this cannot occur.

3. (P.O. 1a) Use a water gun to demonstrate hydraulic principles. Bring in several types to analyze differences in design.

4. (P.O. 1b) Write the name of a displacement pump on one side of a card. Write the description on the other side. Read the description to the class. Have students name the type of pump described. Do this for all fluid power terms.

5. (P.O. 1c) Using commercial hydraulic power units, have students identify and describe the following components: reservoirs, hydraulic oils, pumps, motors, types of valves, filters, hoses, hydraulic cylinders, and torque converters.

6. (P.O. 1c) Describe the similarities and differences between the components of various hydraulic systems.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

7. (P.O. 1d) Using two types of positive displacement hydraulic pumps, have the students experiment to determine the pressures of each.

8. (P.O. 1d) Describe the advantages and limitations of fluid power transmission systems compared to mechanical systems.

9. (P.O. 1e) Read the pressure on the gauge when the pump is not running; then turn on the pump and read the gauge again. Adjust the control devices and note any variations in the readings.

10. (P.O. 1f) Have students locate hydraulic systems on machinery found on farm vehicles, cars, boats, trucks, industrial equipment, or in laboratory applications.

11. (P.O. 1f) Have students locate fluid power applications in industry, transportation, service sectors, offices, hospitals, and other facilities.

12. (P.O. 1g) Individually or in small groups, have students design and construct a device to propel water.

MODULE III: EXPLORING POWER TECHNOLOGY
SUBMODULE C: FLUID POWER
TOPIC 2: Pneumatics

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

2. Following instruction, the student will describe how pneumatics are used to transfer energy and describe the differences and similarities of pneumatic and hydraulic systems, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Describe the properties of fluids
   b. Define and use fluid power terminology, e.g., force, and pressure
   c. List major components of pneumatic systems
   d. Explain how control devices are used in pneumatic systems
   e. Measure pressure variations developed with control devices
   f. Read pneumatic system diagrams, identify symbols, and draw component symbols

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 1a) Describe how the properties of gases and liquids are similar and how they are different.

2. (P.O. 1b) Make a list of the components used in a typical pneumatic system and have the students state the function of each, using appropriate terminology.

3. (P.O. 1c) Have students study sample components of pneumatic systems and identify the following: compressor, manifold valve, directional control valve, input and outputs, single and double acting cylinders, flow meter, and adjustable control valves.

4. (P.O. 1d) Have students connect single and double acting cylinders and observe their actions with control valves.

5. (P.O. 1e) Connect a complete pneumatic system and have students record the flow rates for single and double acting valves and for manual and solenoid controlled valves.

6. (P.O. 1f) Have students locate pneumatic systems found on machinery such as farm vehicles, trucks, industrial equipment, or in laboratory situations.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

7. (P.O. 1f) Individually or in small groups, have students design and develop model systems which will move and control small objects with the use of pneumatics.

BACKGROUND REFERENCES AND RESOURCES

Brochures and Booklets

Fluid Power I (1982). Cleveland, OH: Parker-Hannifin Corp.

Hydraulics (1982). Moline, IL: Deere & Co.

Hydraulics I, (1981). Minneapolis, MN: Technical Systems, Inc.

Hydraulics II & III (1983). Minneapolis, MN: Technical Systems, Inc.

Fluid power terms to know:

compressor	liquids
cylinder	pneumatic
density	pressure
fluid	pump
force	specific gravity
gases	valve
hydraulic	

Formulae: $P1V1 = P2V2$

Where P = pressure
V = volume
Pressure $= \frac{\text{Weight}}{\text{Area}}$

COURSE: ENERGY AND POWER TECHNOLOGY
MODULE IV: TYPES OF ENERGY AND POWER CONVERSION SYSTEMS

OVERVIEW OF MODULE

Goal

The student will understand the first and second laws of thermodynamics as they relate to energy use. The student will be able to provide examples of where and how each law applies.

Description

Fundamental laws of physics apply to energy conversion. All energy conversion systems must be designed to take these laws into consideration. It is important to recognize that all conversions technologies operate at less than 100 percent efficiency; that is, the total energy input will always be greater than the energy output. Some secondary energy uses can be found for energy which has already performed one function, but some forms are too diffuse to be used efficiently.

Skills, Knowledge, and Behaviors to be Developed

The student will be able to:

1. Define and demonstrate the first and second laws of thermodynamics
2. List and describe fuel conversion systems
3. Describe basic electricity generation theory
4. Name the various processes used in the production of electricity
5. Describe other methods of producing electricity

MODULE IV: TYPES OF ENERGY AND POWER CONVERSION SYSTEMS
TOPIC 1: Laws of Thermodynamics

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

1. Given instruction the student will state and apply first and second laws of thermodynamics, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Define the first and second laws of thermodynamics
   b. Relate how these laws apply to our use of energy
   c. Demonstrate the first and second laws of thermodynamics

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. la,lb) Discuss the first and second laws of thermodynamics with students providing as many examples as possible of how these laws apply to our daily use of energy. List the examples as they are discussed.

2. (P.O. la,lb) Have each student research the laws of thermodynamics, state them in common terminology, and prepare a written list of examples for each law.

3. (P.O. 1c) As a class project, bring a specific quantity of water to a full boil. Measure the temperature. Transfer the water to another container and again measure the temperature. Calculate the percentage of heat successfully transferred. Have students explain why there is "lost" heat, where it went, and how it was "lost".

MODULE IV: TYPES OF ENERGY AND POWER CONVERSION SYSTEMS
TOPIC 2: Fuel Conversion Systems

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

2. Given instruction, the student will analyze the combustion process for conversion of a chemical fuel to heat and mechanical energy, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. List the steps of conversion that the chemical energy in fuel must go through to meet a need
   b. Analyze the steps required in fuel conversion by calculating the efficiency of each step and the overall conversion efficiency from fuel to end uses

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 2a) As a class, list in sequential order the steps required to convert chemical fuel energy to do a desired task.

2. (P.O. 2b) Using a mathematical model, demonstrate to the class how energy dissipates during conversion from one form to another. Show how and where various percentages are dispersed and the resultant percentage of energy that is usable to meet desired needs.

3. (P.O. 2b) Have students select a specific combustion conversion system and analyze its efficiency according to the laws of thermodynamics. For example, determine the actual proportion of energy in gasoline that is used to move a car. Begin with 100 percent being the chemical energy in the gasoline and follow the efficiency of conversions through each of the systems – engine, clutch/transmission, gearing, etc. – until reaching the final step of forward motion of the vehicle.

4. (P.O. 2b) Have students research and analyze other conversion systems such as: 1) coal to incandescent lighting, 2) fuel oil to residential space heating, and 3) nuclear fuel to electricity.

5. (P.O. 2b) In the laboratory, produce alcohol fuel from biomass. Mix the alcohol in various proportions with gasoline. Using a dynamometer and a small engine, test the various fuels for energy output and performance. Have students describe the steps in the cycle from fuel combustion to the output of heat and mechanical energy.

MODULE IV: TYPES OF ENERGY AND POWER CONVERSION SYSTEMS
TOPIC 3: Commercial Electricity Generation

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

3. Given instruction, the student will describe basic electricity generation theory; related social, economic and environmental impacts and projections; and careers related to the commercial production of electricity, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Demonstrate an understanding of the generation of electricity
   b. Explain how electricity is commercially generated
   c. State the social, economic and environmental impacts, and projections associated with electricity generation
   d. List careers related to the commercial production of electricity

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 3a) Using a coil of wire, bar magnet, and milliammeter, have students demonstrate how electricity is generated.

2. (P.O. 3a) Using various coils of wire, assorted bar magnets, iron bars, dry cell, and milliammeters, have students experiment with generating electricity. Procedures and observations are to be recorded for class discussion or instructor/peer evaluation. Experiments should include: a) generating direct current; b) generating alternating current; c) producing large and small amounts of current; d) using permanent magnets and electromagnets to generate electricity; e) using a magnetized core and a magnetized field to generate electricity. Each observation should include a description of the energy form(s) which were converted to electricity.

3. (P.O. 3a) Generate electricity with a hand-cranked generator. Have students measure and/or observe output through use of a meter or lamp. Describe the inter-relationships of the conversion system.

4. (P.O. 3a) Using an automobile alternator or generator, have students produce electricity. Describe the conversion processes.

5. (P.O. 3b) Have students describe how electricity is generated. Emphasis should be placed on the conversion of energy forms such as gravity to electricity (hydropower) or chemicals to electricity (coal, fuel oil, and natural gas).

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

6. (P.O. 3b) Visit a local electricity generating plant (hydro, gas, coal, oil fired, or nuclear) and identify the major components of a commercial generating plant.

7. (P.O. 3c) Conduct a class discussion concerning the social, economic and environmental impacts, and future projections related to the use of electricity. Be sure to include in the discussion:

   a. the convenience to the user when many things are electrically controlled and operated;
   b. the rapidly increasing cost of electricity and the effect upon lifestyle when more of one's salary has to be spent for electricity use but salary does not increase proportionally;
   c. the social, economic, and environmental impacts of constructing new electricity generating facilities, including the use of declining supplies of fossil fuels and nuclear fuels;
   d. the low end-use conversion efficiency when electricity is used for everything. Address appropriate uses of energy forms, e.g., using electricity where it is most necessary (running motors and providing illumination) and using other forms to produce heat;
   e. energy use from the "energy in" and "energy out" (efficiency) position rather than human ease, simplicity, and comfort positions;
   f. the future impacts if people continue to disregard conservation efforts and insist upon an ever-expanding quantity of products being electrically operated for convenience; and
   g. project a future with strong conservation efforts and the maximum use of renewable energy sources for producing electricity and heat.

8. (P.O. 3d) Invite a representative to discuss the many jobs necessary to supply electricity on a commercial scale. Discussion should include education and experience required, working conditions, opportunities for advancement, and salaries.

MODULE IV: TYPES OF ENERGY AND POWER CONVERSION SYSTEMS
TOPIC 4: Other Methods of Producing Electricity

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

4. Given instruction, the student will describe the processes used in the production of electricity and produce electricity with batteries, fuel cells, thermo-electric sources, thermionic sources, and magnetic processes, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Use cells and/or batteries to produce electricity
   b. Describe how a fuel cell functions
   c. List thermo-electric sources
   d. List thermionic sources
   e. Distinguish among various magnetic processes and produce electricity

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 4a) Have students construct cells or batteries using assorted materials and chemicals. Measure voltage and amperage output for short terms and project the expected life of each unit assembled.

2. (P.O. 4b) Have students make charts, illustrations, teaching aids, overhead transparencies, or hand-out materials related to fuel cells and how they function.

3. (P.O. 4b) Have teams of students research, build, and test a model fuel cell. Record the electrical outputs.

4. (P.O. 4b) Have individual students research present fuel cell applications and technological status. Specific examples of where and how they are used must be included.

5. (P.O. 4c, 4d) Discuss the heat-activated chemical-to-electric energy converters (thermo-electric and thermionic). Have students select a converter and develop an information file on the topic or device.

6. (P.O. 4e) Discuss other magnetic processes used to produce electricity other than generators or alternators (magnetohydrodynamics - MHD).

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

7. (P.O. 4e) Have students build and experiment with an MHD unit. This can be done in the lab with equipment borrowed from the science department. Using a large, super-strong magnet, such as a radar permanent magnet, and metal plates for collecting electrodes, gases can be moved through the magnetic field and a small amount of electricity can be produced for a short period of time.

MODULE IV: TYPES OF ENERGY AND POWER CONVERSION SYSTEMS
TOPIC 5: Social, Economic and Environmental Impacts and Careers Related to Non-typical Methods of Producing Electricity

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

5. Given instruction, the student will discuss the social, economic, and environmental effects of non-typical methods of producing electricity, and describe related careers, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. List the present and future effects of non-typical methods of producing electricity on society, the economy, and the environment
   b. Compare traditional and non-traditional systems relative to future applications
   c. List careers available in the area of non-typical methods of producing electricity

SUGGESTED INSTRUCTION STRATEGIES

1. (P.O. 5a) Discuss the social, economic, and environmental impacts of advanced technologies used to produce electricity.

2. (P.O. 5b) Have students compare the newest technologies with the traditional turbine-to-generator methods of producing electricity. Relate present laboratory and field conversion efficiencies and project future applications.

3. (P.O. 5c) Have students investigate the requirements necessary to pursue a career in these technological areas used to produce electricity.

COURSE: ENERGY AND POWER TECHNOLOGY
MODULE V: ENERGY CONSERVATION PRINCIPLES

OVERVIEW OF MODULE

Goal

The student will be able to recognize inefficient uses of energy, select appropriate conservation techniques, and make judgments about the economics of energy conservation.

Description

Everyone uses energy; everyone has the responsibility to make informed choices about uses of energy. This module identifies major energy loss problems and describes the steps individuals may take to implement conservation techniques. A major component of this process is the attitudes people have about using and conserving energy. Students will have the opportunity to identify their own energy use patterns and make recommendations for saving energy. They also will analyze energy use in the home, at school, and in the transportation, commercial, and industrial sectors, and make recommendations for more efficient use of energy.

Skills, Knowledge, and Behaviors to be Developed

The student will be able to:

1. Define and use energy conservation terms
2. State principles of energy conscious design
3. List ways of reducing energy consumption in all sectors of society
4. Evaluate personal lifestyle in terms of energy use
5. Contribute to energy conservation efforts in the home or school

MODULE V: ENERGY CONSERVATION PRINCIPLES
TOPIC 1: Definition, Terms, and Importance

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

1. Given information, the student will define energy conservation and related terms, describe the current state of energy conservation and explain its importance for future generations, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Identify the major inefficient uses of energy in our economy
   b. Define energy conservation and related terms
   c. Identify energy conservation activities that could have an effect on extending non-renewable resources
   d. Draw a diagram of some type of energy-using device and show energy input, energy losses, and energy output
   e. Analyze the importance of energy conservation to ensure adequate energy resources for future generations

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 1a) Show filmstrip, film, slide series or television tape addressing energy options and choices. Have students discuss the choices presented and relate which decision they would make.

2. (P.O. 1a) Have students research and write a report on the efficiency of various electricity generating plants (e.g., coal, fuel oil, nuclear, and hydroelectric).

3. (P.O. 1a) Have students brainstorm what they feel are major energy wasters in our society.

4. (P.O. 1a) Have students develop and conduct a survey on what the general public thinks are major energy wasters in our economy. Compare with number three above.

5. (P.O. 1b) Have students test various insulation materials for heat transfer.

6. (P.O. 1b) Have students bring in materials for recycling to use in an energy conservation experiment.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

7. (P.O. 1b) Have students determine through experimentation the relative R and U values of various materials.

8. (P.O. 1c) Have students conduct an energy audit of their homes using various computer software packages.

9. (P.O. 1c) Have students conduct an energy audit of the school, a local business, or a home in the community. Make recommendations about conservation measures to be taken.

MODULE V: ENERGY CONSERVATION PRINCIPLES
TOPIC 2: Energy Conscious Design

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

2. Following instruction, the student will describe design principles related to energy conservation, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Name design characteristics related to energy conscious design
   b. Give examples of energy conscious designs in transportation, construction, manufacturing, and electricity/electronics
   c. Appraise the impacts of improved energy designs on energy utilization in the different energy sectors

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 2a) Have students design and construct a scale model passive solar home.

2. (P.O. 2a) Have students build a clay model of a vehicle and test it in a wind tunnel to assess the design features and relate it to energy design principles that support conservation.

3. (P.O. 2a) Discuss the features of your school in relationship to energy conscious design.

4. (P.O. 2a) Have students find the miles per gallon of fuel of a school bus and an average family car. Multiply miles per gallon by the number of people transported. Which form of transportation appears to be most energy efficient?

5. (P.O. 2b) Have students construct models, from kits or from scratch, that trace the evolution of change in home design and construction, cars, appliance designs, electronic parts, etc.

6. (P.O. 2b) Use audiovisual materials to help show the evolution of design and construction of new products, and the effects of energy use.

7. (P.O. 2b) Have students record the energy efficiency of several appliances in local stores. Compare new appliances by brand names and models. Also compare new appliance ratings with those of appliances that have been around for a number of years.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

8. (P.O. 2b) Have students list several design features found in a local mall or store that attempt to address energy conservation.

9. (P.O. 2c) Invite a guest speaker from one of the major sectors to talk about job opportunities related to energy conscious design.

10. (P.O. 2c) Have students read the local newspaper to find careers related to energy and share their findings with the class.

11. (P.O. 2c) Have students design and construct a scale model of a hybrid vehicle and state its advantages and disadvantages.

12. (P.O. 2c) In small teams, have students design and construct a model of a super-insulated home wall. Each design should be different and reflect students' research efforts.

13. (P.O. 2c) Have students make a display of new insulation materials available on the market. Information should include the R value, U value, cost, toxicity, and moisture absorbability.

MODULE V: ENERGY CONSERVATION PRINCIPLES
TOPIC 3: Residential, Commercial, Industrial, and Transportation Sectors

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

3. Given information, the student will relate the history of energy use in the four major sectors of society, (residental, commercial, industrial, and transportation); list ways to reduce energy consumption in each sector; state why energy conservation is important for the future of our society; and discuss careers in energy conservation, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Give examples from each of the four major sectors of our society
   b. Trace the energy use and applications from past to present in the major sectors
   c. Identify the potential long-range impact of energy conservation on our society
   d. Describe energy conservation devices that have been used to increase efficiency in the various sectors
   e. Explore careers in energy conservation

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 3a) Have students list several different examples of residential structures, commercial buildings, industrial plants, and types of transportation in the community or region.

2. (P.O. 3b) Have the class develop a timeline of energy applications for each of the major sectors.

3. (P.O. 3b) Show a film that traces the evolution of energy use in the different sectors.

4. (P.O. 3c) Have students calculate fuel consumption of different vehicles at different speeds in the area of land transportation.

5. (P.O. 3c) Have students role play the design, production, and advertising of an energy efficient car that will get 100 miles per gallon of fuel. Such fuel sources as gasoline, electricity, pedal power, or biomass can be considered.

6. (P.O. 3c) Have students list several technological developments or new products that can be purchased to help improve energy conservation in the home.

7. (P.O. 3d) Have students visit a local home improvement center and report to the class on materials which help reduce energy consumption.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

8. (P.O. 3d) Discuss and list the changes that have taken place in the transportation sector.

9. (P.O. 3d) Have students construct a heat exchanger unit.

10. (P.O. 3d) Visit a home under construction that is being built with energy conservation in mind.

11. (P.O. 3d) Invite a guest speaker from the energy field (e.g., petroleum engineer, salesperson, forester, and transportation consultant) to address and discuss recent energy conservation efforts and developments.

12. (P.O. 3e) Have students select an energy related career in one of the major energy sectors and prepare a report for the class. The report should include educational requirements, skills required, expected income, and future outlook.

MODULE V: ENERGY CONSERVATION PRINCIPLES
TOPIC 4: Personal Commitment

PERFORMANCE OBJECTIVE/SUPPORTING COMPETENCIES

4. Following class discussion, the students will evaluate their lifestyles in order to make recommendations for lowering everyday energy use, and describe careers related to energy conservation, to the satisfaction of the instructor.

   In order to do this, the student must be able to:

   a. Compile a list of personal energy use
   b. Identify energy wasters within one's own home
   c. Identify basic practices that will promote energy savings
   d. Understand how their energy consumption affects the world, and recognize the necessity for personal committment to energy conservation
   e. List careers related to energy conservation

SUGGESTED INSTRUCTIONAL STRATEGIES

1. (P.O. 4a) Have students keep a log for a week of daily electrical energy use of personal devices (e.g., radio, television, washer, and hair dryer).

2. (P.O. 4a) After a class discussion on energy forms, applications, and daily use have students record all the energy they use during a given period.

3. (P.O. 4a) Discuss the energy in calories obtained from food. Compare calories in relationship to BTUs.

4. (P.O. 4a) Have students read their electric or gas meter and compute daily, weekly, and monthly cost.

5. (P.O. 4a) Have students list the types of energy used to produce the lunch they eat in school.

6. (P.O. 4b) Have students use their personal energy log and compare their energy use with a grandparent or an older adult in the community. Have students record the differences and report them in class.

7. (P.O. 4b) Assign students to read sections of A Diary of an Early American Boy by Eric Sloane that deal with energy. Compare how personal energy reliance has changed since the period of time about which Sloane writes.

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

8. (P.O. 4c) Have students use the computer program "Watts in the Home" developed by the New York Power Authority. The exercise will teach them about home energy conservation.

9. (P.O. 4c) Have students conduct a home energy audit using computer software and support materials.

10. (P.O. 4c) Have students list several appliances in their home and compare their energy usage in kWh (e.g., toaster, dryer, range, iron, and water heater).

11. (P.O. 4c) Have students design, construct, and use a draft gauge to find infiltration within their homes. Students should report back to the class observations on the effectiveness of their devices, and the features of their homes which indicated the presence of drafts.

12. (P.O. 4c) Have the class recycle paper, glass, metal, and miscellaneous items.

13. (P.O. 4c) Have students use the computer programs "Heat Loss" and "Energy House" by MECC and the support materials enclosed. The simulations will make students aware of the basic practices needed to promote energy savings.

14. (P.O. 4d) Have students compute several energy conservation measures and equate the savings in dollars that would go into their pocket.

15. (P.O. 4d) Have students estimate the energy wasted in their homes due to unwise use (e.g., lights, television, and stereo left on when no one is near) and equate the potential financial savings.

16. (P.O. 4e) Have students report on an energy related career of their choice. Information they research must include education and occupational requirements, location of employment, opportunities for advancement, and future job outlooks. The following questions can serve as guides:

    a. What kind of workers help find energy resources?
    b. Who helps recover the natural resources of energy and deliver them to us?
    c. What energy jobs are involved in research and development?
    d. Who would help in conserving energy?

SUGGESTED INSTRUCTIONAL STRATEGIES, continued

17. (P.O. 4c) Have students collect ideas from the past that were old time "wisdoms" on energy conservation (e.g., newspaper as an insulator; rags to stop drafts). Discuss the effectiveness of each.

BACKGROUND REFERENCE AND RESOURCES

Books

Consumer Reports (1982). Money-saving Guide to Energy in the Home. Mount Vernon, NY: Consumers Union.

Sloane, E. (1965). Diary of an Early American Boy. Wilfred Frank, Inc. (classic)

Solar Vision (1982). Energy Efficient Construction Methods. Church Hill, NH: Solar Vision Publications.

Thomas Alva Edison Foundation. Energy Conservation Experiments You Can Do From Edison. Southfield, MI.

Wadden, R.A. and P.A. Scheff (1983). Indoor Air Pollution. New York: Wiley.

Filmstrips with Audio Tape

New York Energy Education Project. "Energy Options - Part II - Making Your Choices". New York Power Pool, 3890 Carman Road, Schenectady, N.Y. 12203.

Computer Software

The Energy Center. "Home Energy Audit". Niagara Mohawk Power Corporation, Nine Mile Point, Lycoming, N.Y. 13093.

COURSE: ENERGY AND POWER TECHNOLOGY

SUGGESTIONS FOR STUDENTS WITH SPECIAL NEEDS

Students who are educationally handicapped and appropriately mainstreamed should be exposed to all of the concepts involved in this course. The success of these students may depend, however, on how the information is presented. Different teaching approaches are often the key. Below are some suggestions for assisting students with handicapping conditions to benefit from the instruction provided and to demonstrate their knowledge and skills in relation to the Performance Objectives and Supporting Competencies.

1. Simplify activities. Narrow the scope of material dealing with interpreting technical data and drawings.

2. Explain theories in simple terms.

3. Use demonstrations generously, making them concrete and tangible, rather than verbal and abstract.

4. Arrange for each special education student to work with a more capable student.

5. Provide ample time for task completion. Positively reinforce that part which is done well.

6. Be flexible with homework assignments.

7. The special needs student will most likely require additional review and reinforcement. In order to facilitate the process, enlist the help of the student's special education teacher or building resource person to assist in providing supplemental instruction. Share manuals, textbooks, vocabulary lists and lesson outlines with this person.

8. Allow students to tape record informational lectures.

COURSE: ENERGY AND POWER TECHNOLOGY

BACKGROUND REFERENCES AND RESOURCES

Books

Butti, K.J. and J. Perlin. (1980). A Golden Thread: 2500 Years of Solar Architecture and Technology. Palo Alto, CA: Chesire Books.

Devito, A. and G. H. Krockover. (1981). Activities Handbook for Energy Education. Santa Monica, CA: Goodyear Publishing Co.

Dorf, R.C. (1983). The Energy Fact Book. New York: McGraw-Hill.

Energy In Transition: 1985-2010. (1980). San Francisco: W.H. Freeman Co.

Ford Foundation. (1979). Energy In the Next Twenty Years: Research for the Future. Cambridge: Ballinger Publishing Co.

Fowler, J.M. (1984). Energy and the Environment. New York: McGraw-Hill.

Gibson, D.L. (1983). Energy Graphics. Englewood Cliffs: Prentice-Hall.

Hall, C.W. and G.W. Hinman. (1983). Dictionary of Energy. New York: Dekker.

Hunt, V.D. (1979). Energy Dictionary. New York: Van Nostrand Reinhold Co.

Hunt, V.D. (1982) Handbook of Energy Technology. New York: Van Nostrand Reinhold.

Kleinbach, M.H. and C.E. Salvagin. (1986). Energy Technologies and Conversion Systems. Englewood Cliffs: Prentice-Hall.

Lafavore, M. (1987). Radon: The Invisible Threat. Emmaus, PA: Rodale.

Leckie, J., G. Masters, H. Whitehouse, and L. Young. (1975). More Other Homes and Garbage. San Francisco: Sierra Club Books. (classic)

Loftness, R. L. (1984). Energy Handbook. New York: Van Nostrand Reinhold.

Lovins, A.B. (1977). Soft Energy Paths - Toward a Durable Peace. Cambridge, MA: Ballinger. (classic).

Lovins, A.B. and L.H. Lovins. (1982). Brittle Power: Energy Strategy for National Security. Andover, MA: Brick House.

BACKGROUND REFERENCES AND RESOURCES, continued

Meyers, R.A. (ed.), (1983). Handbook of Energy Technology and Economics. New York: Wiley.

National Geographic Society. (1981). "A Special Report In the Public Interest - Energy: Facing Up to the Problems, Getting Down to Solutions," Washington, DC: National Geographic Society, February.

Penner, S.S. and L. Icerman. (1984) Energy. New York: Pergamon.

Pryde, P.R. (1983). Nonconventional Energy Resources. New York: John Wiley and Sons.

Ruedisili, L.C. and M.W. Firebaugh. (1982). Perspectives on Energy. New York: Oxford.

Schwaller, A.E. (1980). Energy Technology. Worcester: Davis.

Smith, H.B. (1986). Exploring Energy: Sources/Applications/Alternatives. South Holland: Goodheart-Willcox.

Stobaugh, R. and D. Yergin. (eds.). (1983). Energy Future. New York: Random House.

Turner, W.C. (1982). Energy Handbook. New York: Wiley.

Uleck, R.B. (editor-in-chief). (1981). Energy Jobs Handbook. Gaithersburg, MD: Prospect Press.

U.S. Department of Energy. (1983). Energy Projections to the Year 2010. Washington, DC., October.

Wilber, L.C. (1985). Handbook of Energy Systems Engineering. New York: John Wiley and Sons.

Journals

Earth Shelter Living
WEBCO Publishing, Inc.
110 S. Greeley St.
Stillwater, MN 55082 (bi-monthly)

BACKGROUND REFERENCES AND RESOURCES, continued

The Energy Consumer
DOE Office of Consumer Affairs
Washington, DC 20585

EPRI Journal
Electric Power Research Institute
PO Box 10412
Palo Alto, CA 94303

Home Energy Digest/Wood Burning Quarterly
8009 34th Ave., South
Minneapolis, MN 55420

Independent Energy
Alternate Sources of Energy, Inc.
107 S. Central Ave.
Milaca, MN 65353 (10 issues/yr.)

Mother Earth News
Box 70
Hendersonville, NC 28739

Northeast Sun
New England Solar Energy Association
PO Box 541
14 Green St.
Brattleboro, VT 05301 (membership)

Popular Science
Times Mirror Magazines, Inc.
PO Box 257
Boulder, CO 80302

Rodale's Practical Homeowner
33 East Minor St.
Emmaus, PA 18049

Progressive Builder
Solar Vision, Inc.
PO Box 470
Peterborough, NH 03450 (Monthly)

BACKGROUND REFERENCES AND RESOURCES, continued

School Shop
Special Issue "Energy"
April 1984

Solar Engineering and Contracting
PO Box 3600
Troy, MI 48007 (bi-monthly)

Associations, Institutes, Lobbies, and Offices

American Gas Association
1515 Wilson Blvd.
Arlington, VA 22209

American Petroleum Institute
Public Relations Department
2101 L Street, NW
Washington, DC 20006
American Wind Energy Association
1050 Seventeenth Street, NW
Washington, DC 20036

American Nuclear Society
555 N. Kensington Ave.
LaGrange Park, IL 60525

Biomass Energy Institute
304-870 Cambridge St.
Winnepeg, Manitoba CANADA

Edison Electric Institute
90 Park Avenue
New York, NY 10016

Energy Information Administration
United States Department of Energy
Forrestal Building
Washington, DC 20585

BACKGROUND REFERENCES AND RESOURCES, continued

Exxon Co., USA
Public Affairs Department
PO Box 2180
Houston, TX 77001

Fund for Renewable Energy and the Environment
1001 Connecticut Avenue NW, Suite 638
Washington, DC 20036

National Center for Resource Recovery
1211 Connecticut Ave. NW
Washington, DC 20036

National Coal Association
COAL Building
1130 Seventeenth St. NW
Washington, DC 20036

National Science Teachers Association
1742 Connecticut Ave. NW
Washington, DC 20009

New York Power Pool
Power Control Center
3890 Carman Road
Schenectady, NY 12303

New York State Cooperative Extension
Mailing Room, Building 7
Research Park
Cornell University
Ithaca, NY 14853

New York State Energy Office
Agency Building #2
Two Rockefeller Plaza
Albany, NY 12223 (1-800-342-3722)

New York State Energy Research and Development Authority (NYSERDA)
Two Rockefeller Plaza
Albany, NY 12223

BACKGROUND REFERENCES AND RESOURCES, continued

Niagara Mohawk Power Corporation
The Energy Center
PO Box 81
Lycoming, NY 13093

Renewable Fuels Association
499 South Capital St. SW
Washington, DC 20003

Rochester Gas and Electric
89 East Avenue
Rochester, NY 14649

Solar Energy Research Institute
1536 Cole Blvd.
Golden, CO 80401

Union of Concerned Scientists
26 Church St.
Cambridge, MA 02238

U.S. Department of Energy
Technical Information Center
PO Box 62
Oak Ridge, TN 37380

Worldwatch Institute
1776 Massachusetts Ave. NW
Washington, DC 20036

Film and Video Sources

American Association for Vocational Instructional Materials
120 Driftmier Engineering Center
Athens, GA 30602

Bullfrog Films
Oley, PA 19547

BACKGROUND REFERENCES AND RESOURCES, continued

Chevron Chemical Co.
San Francisco, CA

Churchill Films
662 North Robertson Blvd.
Los Angeles, CA 90069

DOE - Film Library
PO Box 62
Oak Ridge, TN 37890

Thomas A. Edison Foundation
Cambridge Office Plaza, Suite 143
18280 W. Ten Mile Road
Southfield, MI 48078

Educational Dimensions Group
792 Pacific Street
PO Box 126
Stamford, CT 06904

General Electric Educational Films
Corporations Park
Building 705
Scotia, NY 12302

Kai Dib Films International
PO Box 261
Glendale, CA 91209

Modern Talking Picture Service
5000 Park Street, N.
St. Petersburg, FL 33709

NASA Lewis Research Center
21000 Brookpark Road
Cleveland, OH 44135 (slides and videotapes)

BACKGROUND REFERENCES AND RESOURCES, continued

NASA
Public Affairs Office
Marshall Space Flight Center
Alabama 35812

National Geographic Films
Washington, DC

Prentice-Hall Media
150 White Plains Road
Tarrytown, NY 10591

James L. Ruhle & Associates
PO Box 4301
Fullerton, CA 92631 (slides)

Shell Educational Services
Box 2463, Room 1541
One Shell Plaza
Houston, TX 77001

U.S. Department of Energy
Film Library
PO Box 62
Oak Ridge, TN 37830

Telecommunications

Addison-Wesley Publishing Company "Einstein"
2725 Sand Hill Road
Menlo Park, CA 94025

Compuserve
500 Arlington Center Blvd.
Columbus, OH 43220

New York Institute of Technology "TechNet"
Northern Blvd.
Old Westbury, NY 11568

BACKGROUND REFERENCES AND RESOURCES, continued

Computer Software

Alabama Department of Economic and Community Affairs
Energy Division
PO Box 2939
Montgomery, AL 36105
(205) 284-8937

American Association for Vocational Materials
120 Driftmier Engineering Center
Athens, GA 30602

Broderbund Software-Direct PO Box 14947 San Rafael, CA 94913-2947	"Science Tool Kit"
HRM Software 175 Tompkins Ave. Pleasantville, NY 10570	"Personal Energy Inventory" "Electric Bill" "Energy Conversions" "Home Energy Savings" "Power Grid"
MECC Software 3490 Lexington Ave. North St. Paul, MN 55126	"Energy House" "Heat Loss"
New York Power Authority 10 Columbus Circle New York, NY 10019	"Power Controller" "Watts in a Home"