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ABSTRACT

This publication was designed for teachers to use at all levels in the elementary and secondary schools. In addition, certain portions of it could be used with adult groups. It is composed of numerous interdisciplinary instructional activities related to energy use and conservation. For convenience, the activities are grouped for grades K-3, grades 4-6, and grades 7-12. The appendix contains various items such as checklists, charts, glossary, and selected readings and films for educators. (JP)

FOREWORD

The current world energy crunch is making the American people more aware of the environmental problems that are now and will be besieging them during the remaining years of this century. Our people are facing problems related to overpopulation, energy, food supply, adequate housing, depletion of natural resources, waste disposal, air and water pollution, and the accompanying despoliation of their environment.

One of the best ways to deal with a crisis is to consider it as an opportunity. From this point of view, the energy crisis provides almost endless possibilities for children to learn about the universe, civilization, and themselves. Energy, after all, is what makes all things go. We need to realize that the energy crisis isn't just the newest fad. By studying the energy crisis, students can see where humanity has been, where it is now, and where it might be going. The energy crisis is another chapter in the story of mankind's continuing effort to reshape the world and the inevitable cost of doing that.

We can now see that pollution is not an unlucky accident but simply the natural results of the way we use energy. Clearly we have been able to change things. Has it always been for the better? Can there be too much progress? Can the price be too high? These are some of the questions to be dealt with in many of the interdisciplinary activities included in this resource.

This publication represents another effort on our part to assist local units in the planning of effective environmental education programs throughout North Carolina.

A. Craig Phillips

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February 1974 State Superintendent of Public Instruction

PREFACE

This publication was designed for teachers to use at all levels in the elementary and secondary schools. In addition, certain portions of it could be used with adult groups. It is composed of numerous interdisciplinary instructional activities and an Appendix. For convenience, the activities are grouped--Grades K-3, Grades 4-6, and Grades 7-12. The Appendix contains various items such as checklists, charts, glossary, and selected readings and films for educators.

This material was prepared to provide the teachers a resource from which to draw in developing units of study and lesson plans. The amount of time devoted to these activities depends on the teacher's instructional plans and schedules. It can best be used by integrating it into the existing curriculum.

However, in light of the recently worsening energy crisis, minicourses devoted to this problem could be highly advantageous. Hopefully, such a minicourse would be interdisciplinary including math, science, social studies, and other disciplines.

A word of appreciation is extended to the Division of Science Education for developing this publication.

Jerome H. Melton

Assistant State Superintendent
for Program Services

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INSTRUCTIONAL ACTIVITIES

GRADES K-3

1. Make a list of all equipment in the schoolroom that is powered by electricity.

2. Ask the custodian to come into the classroom and explain how electricity helps him in his work.

3. Make a science display of items that are powered by electricity for classroom use.

4. Ask the student to look for ways that electrical energy is used in his home. Compile a list on the chalkboard during the next day or two.

5. Ask parents to come to the classroom and discuss how they use electricity in their work.

6. Look at the wattage on light bulbs, read the wattage figures, add the amount used and compare home consumption with classroom consumption.

7. Make a reading experience chart containing statements about the conservation of energy.

8. Introduce the spelling of words associated with electricity:

   - watts
   - volts
   - bulb
   - motor
   - plug
   - wire

9. Study parents' occupations and determine how a shutdown in electrical consumption would affect each job.

10. Make a bar graph comparing the amount of electricity consumed by one device with another (light bulb, electric mixers, stove or hot plate, popcorn popper).

11. Begin to explore techniques of electrical energy measurement. Watts and volts are new concepts that must be introduced at an unsophisticated level.

12. Ask students to express their views about conserving electricity in a one-page paper. Provide them with a key word list.

13. Develop a vocabulary of terms associated with electricity:

    - energy
    - power
    - hydro
    - snow
    - rain
    - gauge
    - resistance

14. Let children create projects (paintings, models, etc.) which require a minimum of commercially produced materials (paper, glue, crayons, etc.).

15. Make a display of disposable products (use once and discard) which waste natural resources in terms of raw materials and energy to produce.

16. Have the student list and describe three types of transportation systems such as automobile, plane, and train.

17. Have the student state at least three advantages and disadvantages of using each of the following electric appliances:

- toothbrush
- toaster
- hot water heater
- freezer
- space heater
- air conditioner
- radio
- television
- range
- dishwasher
- microwave oven

18. Have the student list five different appliances used in his home which the family could most easily live without. Ask him to state reasons for each decision and describe what effect this would have on his family.

19. Ask the student to describe five ways in which electric energy has enriched his life.

20. Ask the student to describe five ways in which the automobile harms the environment. He will probably include, but not limit his list to, such factors as sight, smell, and hearing.

21. Have the student put together a collage using energy terms and illustrations found in newspapers and magazines.

22. Have the student demonstrate the heating effect of sunlight by putting a pan or bottle of water in the sun and comparing the temperature with a similar quantity and container placed in the shade.

23. Have the student place a shiny metal object in a candle flame. What is the deposit that appears on the metal? Where does it come from? Could there be a use for it?

24. Involve the class in a discussion about why resources around centers of population often are depleted or overused.

25. The local stores have all announced that due to a transportation strike there will be no more candy bars for an extended period of time. Involve the class in discussing the following questions:

- What will happen to the present supply?
- How will the supply be distributed?

- Will there be restrictions as to how many bars each person will be permitted to buy?
- What will happen to the price?
- What will happen to you emotionally if there are no restrictions and someone ahead of you buys the last box of bars?
- What will you be willing to do to get some of those bars?

GRADES 4-6

1. Ask students to explain why people do not wish to do without those convenience items that consume electricity.

2. Ask students to detail the occupations that provide services which are essential to the survival of a community and how those services consume electrical energy (water pumping stations, sewage treatment plants, scheduling of transportation services).

3. Study the ways electrical energy is produced in the state.

4. Study home consumption of power and determine which appliance is the largest user. Ask your local utility company to help the class find out which industry, plant or single consumer, is the largest single user of power in the community. Does this user benefit the community?

5. Conduct an essay contest entitled, "How Can Energy Be Saved In The State of North Carolina?"

6. Introduce the formulas for power consumption, transmission, and generation. Some science programs present these formulas at this grade level.

7. Discuss reasons why electrical energy is preferred to other kinds of energy for given jobs (clean, easily transported, easily maintained equipment, etc.).

8. Visit some electricity distribution centers. Ask the engineers to explain how electrical energy is distributed. Visit an oil tank storage area, a natural gas control center, etc.

9. Distribute leaflets to homes in the neighborhood, describing the power shortage and indicating ways the children have identified as reasonable methods to conserve power.

10. Ask permission from a local radio station for students to conduct a talk show, featuring ideas on how local citizens could conserve energy.

11. Arrange for students and school administrators to work together to find ways to save energy within the school.

12. Compose short stories or plays around possible results of energy failure, or the energy conservation effort.

13. Write articles, poems, cinquains, haikus, dealing with energy for publication in the school newspaper.

14. Correspond with students in other schools to compare conservation efforts.

15. Collect newspaper and magazine articles on the energy crisis. Use them to discover and graph trends, make bulletin board displays, or for a collage or mobile in an art project.

16. Read power consumption data on appliances. (Consult custodian or local electrician for assistance.) Make a display chart showing how much energy is consumed by each.

17. Have the student list four uses for each of the following fuels:

    - wood
    - coal
    - natural gas
    - oil

18. Have the student list five products made from crude oil and indicate how they are used.

19. Have the student list various forms of freight transportation, beginning with the one which least affects the environment, and continuing in progressive order, to the one with the greatest impact.

20. Have the student compare utility bills from several different households to discover why one family may use more kilowatt-hours than does another. This might be accomplished by having each student in the class bring the family utility bill to class and let others have access to it.

21. Have the student record at least ten ways in which energy is used in his school.

22. Ask the student to list at least five energy sources on which he depends from the time he awakens until his class begins.

23. Have the student inventory several homes within his neighborhood to determine the percentage of homes using the various types of energy--coal, oil, natural gas, electricity for water heating, space heating, and cooking. Report findings on a bar graph.

24. Have the student read his home watt-hour meter and school watt-hour meter daily for one week (month?). Discuss the comparative energy consumption. Graph the results.

25. Ask the student to visit a local drugstore and list ten examples of items he considers "overpackaged." Is transportation or protection of the item, sanitation or ease or use a factor?

    Ask the student also to list ten examples of items he considers to be "properly packaged."

26. Have the student collect packaging entering his household for one shopping day. Bring it to school. Discuss the energy needed to create the total packaging pile. Suggest alternative packaging.

27. Have students bring to school electrically-powered appliances and toys which function solely for recreation or entertainment. Use some method to avoid duplications and decide whether or not battery-powered items should be included.

   a. Have students do research on each item in light of such questions as:

      - How long has this item been on the market?
      - Was it marketed to fill a need, or did its appearance on the market, along with advertising, create its own need?
      - If it indeed fills a need, can we think of alternative diversions which require no energy consumption? These may already exist, or could be created by the students.
      - Explore what the children in colonial days used for recreation. Did they have the same needs for recreation as we have today?

   b. Set up a display of the electrically-powered items and their nonpowered counterparts.

28. Have students keep a record of the number of times (in one week, one day, etc.) trips from home have been made in the family car when, with planning, one trip might have been sufficient. Compile class results and devise a conservation plan for implementing car pools which seem most likely to work.

   a. Have students do creative writing relative to gasoline rationing or curtailment. Example: "How would life in my family be affected if our gasoline supply were cut in half?"

   b. Compute class totals or averages of "unnecessary mileage" before and after conservation plan is implemented. Show comparisons on line or bar graphs.

29. Have students develop a list, from research or background, of all the insulating factors in the home.

30. Have students secure or build an insulation demonstrator. (Materials needed: shoe box; thermometer; light bulb; different forms of insulation, aluminum foil, cotton batting, etc.)

   - Devise as many variations as possible of testing different insulating materials and combinations thereof
   - Use temperatures both inside and immediately outside the demonstrator.

31. Make a class study of the ways in which homes represented are deficient in insulation.

32. Have the class discuss priorities for energy use in the event of a shortage. Describe how to determine, implement, and enforce such a procedure.

33. Have the student describe the history, uses and efficiency of early types of energy:

- man
- beasts of burden for transportation
- windmill
- watermill
- wood

34. Have the class describe the current uses of solar energy:

- photosynthesis
- solar cells
- solar furnace
- solar water heating

35. Have the student construct a map of the world which shows the location of major energy sources (coal, oil, natural gas, wood, uranium, hydroelectric, geothermal).

36. Have the student list the positive and negative considerations surrounding the industrial, commercial, and residential use of energy (coal, oil, gas, wood, nuclear) in terms of:

- pollution
    - air
    - water
    - radiation
    - visual
- location
- impact on people
- economic impact
- mining
- processing
- transportation

37. Have the student try to list as many nonliving things as he can think of that move. Opposite each object, list what energy causes that movement. Discuss whether or not movement in nonliving objects can occur without energy to power that movement.

38. Have the student describe the aesthetic effects of mining, refining, and delivering:

- coal
- oil
- gas
- wood
- hydroelectric energy
- nuclear-generated electric energy

39. Disregarding variables of supply, have the student give the advantages and disadvantages of coal, oil, gas, wood, nuclear materials, and the sun as sources of energy.

40. Have the student demonstrate the effect of concentrating solar energy with a magnifying glass by igniting paper.

41. Have a debate on the following: "Resolved: An individual's use of energy can be limited without undue loss of personal freedom."

42. Have the student describe changes which would occur in his family's activity for an average day if they had no automobile.

43. Have the student describe various methods of transporting energy-producing material from source to point of use, and the effects of that on the environment.

44. Have students construct a set of guidelines for the wise use of rapidly diminishing sources of energy such as coal and oil.

45. Divide the class into four groups and pretend that they are going to set up housekeeping beside a common stream. Their land is contiguous. They will generate their own energy. Group one will set up a coal-fire generating plant. Group two will set up a gas-fire generating plant. Group three will set up a nuclear-generating plant. Group four will set up a hydropowered-generating plant. Each group may oppose the erection of any other group's plan on the basis of pollutants, passage of fuel across their territory, or use/abuse of a common resource such as air or water.

    The aim of this activity is to eventually decide which is the best possible method of generating electricity--whether it should be a common source or several generators and which one. If a common source is selected, whose land will it occupy and what compensation will be provided for the land use?

46. Have the student pretend that he is going on a camping trip 200 miles from home. The length of the vacation is two weeks. He wishes to spend as little money as possible, spend as much time in the wilderness as possible, and contribute as little pollution as he can. Based on these requirements, select a mode of travel, cooking fuel, housing enroute, housing at the campsite, and types of activities during the period at camp.

47. Have the student grow a plant in sunlight, dry the plant, weigh it, and compare the weight with the original seed. Discuss solar energy and plant synthesis.

48. To conserve gasoline, pretend that a decision has been made to reduce the number of automobiles in this country. Have the class draft a set of priorities and regulations to accomplish this as fairly as possible for all citizens.

49. Pretend that an ordinance has been passed ordering all users of electric energy to reduce their use by one-half. Have the student explain what he would choose to do without and why.

50. Have the student list different forms of recreation (boating, skiing, football, hiking, motorbiking, etc.) and discuss the energy form used by each type of recreation. Have him compare similar forms of recreation that do and do not consume energy.

51. Involve the class in a spelling bee that uses words about energy such as: potential, kinetic, heat, light, kilowatt, etc.

52. Have the class discuss the economic and occupational implications of a law that would prohibit the conversion of fossil resources to energy. List items in the classroom that could not be replaced if this type of energy conversion was banned.

53. Have the students speculate on the type of job he thinks was most prevalent when wood fuel was a major source of our nation's energy. Then consider this same problem regarding coal, oil, natural gas, and electricity.

54. Suppose we were able to convert the sun's energy directly. What new types of jobs would be available? Which types of jobs do you think would be eliminated or reduced? Give reasons.

55. Ask the student to list or describe six things he can do to reduce the need for additional energy in his life.

56. Have the student visit a bottling plant and find out what the company is doing about recycling. Discuss energy use and methods and costs of recycling in contrast to throw-away containers.

57. Have the student study magazine advertisements about energy and power and then formulate advertisements that reflect the point of view of the power producer, environmentalist, Mother Earth, manufacturers' association that ask for a personal commitment by citizens to reduce the needs for additional energy in his life. Present the advertisements to the class or some other group of persons and ask for reactions.

58. Involve the class in a discussion on the limits of the earth's energy resources.

59. Have the class discuss the physical effects on the ecosystem if energy were to be made available to man on an unlimited scale.

60. Have the student contrast renewable and nonrenewable resources, including, but not limited to fuel, minerals, and other energy sources.

61. Have the class discuss the relationship between limited energy resources and international trade.

62. Have the class discuss what would be necessary to implement a policy based on unlimited energy.

63. Have the student describe implications for the quality of life under severely restricted energy-resource conditions.

64. Have the student predict the kinds of jobs that would be eliminated if a more severe limit to energy sources were to occur.

65. Have the student predict the kinds of jobs that would become available with the advent of severely limited energy resources.

66. Have the student state at least five ways to make more efficient use of our energy resources.

67. Have the student describe his reactions if he were required to use public transit rather than driving his own automobile.

68. Have the class discuss what restraints might be necessary in regard to energy use in the case of overpopulation of an area or country. Have the student list services that would need to be instituted, and those that would have to be abandoned, as the result of overcrowding.

69. Have the student assume that a definite amount of energy is allotted to meet all his physical and psychological needs. Also, assume that that amount of energy is about half which he presently consumes. Ask him to explain how he would modify his life style to conform to the energy available.

70. Have the class research the life styles of the Australian Aborigines, the Eskimos, and the Kalahari Desert tribes. What are their energy resources? What implications are there for us if we are faced with severely restricted energy resources? How would we modify our life styles? Ask for justification of explanations.

71. Whenever a resource becomes more scarce, the law of supply and demand forces up the price. When it is too expensive for most users, there is a shift to a replacement resource. The shift from oil and gas to coal for the generation of electric power is an example.

    Have the class list ten of their favorite possessions that are made from oil or gas (synthetic fibers, plastics) and then discuss what might happen to the cost and availability of these items as oil and gas become less available.

72. When a resource begins to become scarce, it's due in part to the difficulty in finding it, taking it out of the ground, processing it for use, and transporting it to market.

    Take an energy resource--oil, for example--and discuss what jobs might be created or eliminated as it becomes more scarce; e.g., more jobs for geologists with fewer gas station attendants.

73. Have the student to assume that his energy consumption is going to be cut drastically. Which of the following could he replace easily? Which would be more difficult? Which would be impossible?

    - electric lighting
    - electric cooking
    - electric heating
    - air conditioning
    - mixer
    - water heating

- washer
- dryer
- synthetic fiber clothing
- automobile
- power lawn mower
- electric toothbrush
- power saw
- dishwasher
- television
- radio
- stereo system

74. Have the class discuss the effect on the job market of a shift to non-disposable items.

75. Have the class discuss the changes in employment which would be needed to introduce improved transportation and housing.

76. Energy from the sun can be converted to electric energy. This source has been suggested as an energy substitute for gasoline to provide power to automobiles. List some of the problems which would take place if automobiles were made to use solar energy. How could the problem be solved?

77. Have students investigate the apparent excessive use of lighting in commercial buildings at night and compare use with need.

78. Have students interview their parents regarding the purchase of major electric appliances. Ask what influences their selection of brand, size, and model. Ask whether the amount of electricity required is considered.

79. Have the student inventory his belongings and list those acquired during the past two years which use energy. Have him list those things which he would like to purchase now.

80. Ask the following question for discussion purposes: "If it is true that some packaging is nonessential, and is thereby a wasteful use of natural resources (raw material and energy), what specific jobs would be affected by the elimination of excessive packaging?"

81. Discuss the jobs that would be affected and the sources of energy that would be made more available if the principal mode of transportation in a city were to change from private automobile to mass transit (buses, trains).

GRADES 7-12

1. Study available sources of energy fuels. What is the generation capacity in various areas of the United States, and the per capita earnings for individuals in those areas?

2. Ask each student to investigate one form of energy, its long-term strengths and weaknesses as an energy source, and its effect on the local community, state, and nation.

3. Discuss with students why individuals are reluctant to give up their conveniences.

4. Construct models of generating facilities (steam, hydro) and determine their efficiency.

5. Study power transformers, their design, use, and long-term effectiveness.

6. Study the relative efficiency of methods used to transport electricity.

7. Produce a chart illustrating the development of a given source of power and its delivery to the consumer.

8. Measure the calories consumed when people exercise. How much food is required to provide a given amount of calories?

9. Explore efficient ways to use foods available locally (i.e., compare foods which must be transported to North Carolina in midwinter to those available locally; does the food value of the imported product justify the fuel consumed in shipping?)

10. Discuss the efficient purchase of those foods which require less energy for production (i.e., human effort, fuel for transport, effort of retailers, etc.).

11. Compare products to find those which most efficiently carry out designated tasks (i.e., a small car may serve two people as well as a large car; a home which is large enough for your family may serve as well as a larger house).

12. Explore effective use of appliances which have been purchased to better the family standard of living.

13. Investigate the effects of available energy supply upon the standard of living in various areas of the United States during the past 40 years.

14. Given a curtailment of energy in the local community, determine which energy consumers should receive first priority. Discuss the criteria used in making these judgments.

15. Study the ways people have been motivated to use more energy in the past. Discuss the possibility of reversing the trend from promotion to reduction of energy consumption.

16. Draw a map showing the sources of fossil fuels in the United States. Discuss how they were formed and present mining techniques.

17. Study the construction of a nuclear electrical generation facility and the process used to generate energy.

18. Compare forms of energy generation to find which are presently economical and which are not. List the reasons why some forms are not economical.

19. Given an opportunity to work with small engines, find the amount of fuel a small engine consumes when it is out of tune, compared to when it is properly adjusted. Measure on a time basis at a given rpm.

20. Compare total energy considerations in the use of hot air blowers which have replaced paper towels in many public washrooms.

21. Determine through weather records of the past year (or years) how many days clothes could have been dried out-of-doors rather than in a clothes dryer. How many kwh does this represent in your community? How many gallons of water does this represent in the hydroelectric reservoir?

22. Determine those events in the last 50 years which have led to utilizing greater amounts of energy. Was the impact on an international, national, state, or local scale? For example, building a national network of freeways; advertising that bigger cars are better; lighting streets for safety, assuming that the more they are lighted, the safer. Many more events can be named and their implications explored.

23. Ask students to evaluate the purchase of a home from an energy consumption point of view (i.e., insulation, cubic feet, storm windows, effective heating system, length of hot water lines and their insulation, etc.).

24. Compare the rental and operational costs of apartments to the purchasing and operating costs of homes. Relate energy consumption in these dwellings to the number of cubic square feet in the residence, the temperature at which the area is maintained, the square feet of uninsulated glass in the residence, and other possible factors.

25. Find which types of clothing retain body heat and remain comfortable in a residence or working place with a reduced temperature. Include clothing that is used for work as well as dress.

26. Compute the alternatives to vehicle ownership. Explore car rental possibilities. Relate car size to particular needs. Determine potential repair and maintenance costs of vehicles. Explore the fuel consumption of different modes of transportation.

27. Investigate the local and statewide political implication of the power shortage. Will people vote against public officials whose actions tend to reduce present convenience? What positions are being taken by elected officials?

28. Introduce young people to the idea of growing some of their own foods, purchasing local foods in season and preserving them, and in other ways making best use of the resources around them. Discuss the most efficient methods of food preservation.

29. Have the student list several of the largest industrial users of electricity.

30. Pose hypothetical problems regarding the energy crisis, such as: "Government has mandated a 50% reduction in electrical, petroleum, and natural gas consumption." Instruct students to establish priorities and work out a solution.

31. Make a study of the effect of lowered urban and highway illumination on crime and vandalism.

32. A recent news report stated that large quantities of scrap aluminum are being exported. Compare the energy cost of recycling scrap aluminum to that of producing from bauxite.

33. Intermediate or older students may attempt to secure an old meter from a local utility company to disassemble. Build a model kilowatt meter out of tagboard, styrofoam, wood, etc. Work out a gearing system so that adjacent dials rotate each other in a ratio of 1:10 (left to right).

34. Have the student describe the aesthetic impact on natural resources caused by recreation development, urbanization, and mineral exploitation.

35. Have the student diagram a fluorescent tube and explain how it works, contrasting its light and heat output to that produced by other types of lamps.

36. Have the student diagram and describe the operation of the internal combustion engine. Call for a discussion on the advantages and disadvantages of the internal combustion engine over other types of engines.

37. Discuss the kind of campaign that would be most effective in reducing electrical energy consumption. Who should pay for the campaign? Is this a negative kind of educational effort (i.e., urging people <u>not</u> to use something)?

38. Involve the class in a discussion on the contrast between the use of rapid transit systems and automobiles.

39. Have the class:

    - Evaluate the benefits to mankind derived from nuclear power generation.
    - Evaluate the harm which might result from nuclear power generation, including problems of nuclear waste disposal.

40. Have the student compare the life style of an underdeveloped society with his life style. He should consider the energy consumed and discuss the difference.

41. Have the student describe common food and toiletry packages and containers, listing energy sources required to produce them.

42. Have the class discuss the political implications of the energy-use imbalance in the world today.

43. Have the class discuss the social implications of the energy-use imbalance in the world today.

44. Ask the student to describe what he considers to be the most beautiful sight or object in his city or community. Ask him also to determine what sources of energy were used in its creation.

45. Ask the student to describe what he considers to be the ugliest sight or object in his city or community. Ask him also to determine what sources of energy were used in its creation.

46. Ask the student to count the light bulbs in his home and list their wattage. Ask him to calculate the kilowatt-hours used by these light bulbs during one evening by noting the time each light is turned on and when it is turned off.

47. Ask the student to trace the path of electric power from fuel origin to his home fuse box.

48. Ask the student to calculate the energy required to move his body weight one mile by walking. Contrast this with energy required to move one mile by bicycle; one mile by automobile.

49. Have the class discuss the limitations and the advantages of obtaining hydrogen by electrolysis and then using it as a basic power source.

50. Have the student describe the limitations and advantages of geothermal sources of energy.

51. Have the student describe the limitations and advantages of tidal flows as a source of energy.

52. Have the class discuss ways to minimize bad effects of obtaining resources such as:

- coal (mines, strip-mining)
- oil (derricks, pipelines, offshore)
- gas (pipelines, pumping stations)
- wood (clear-cutting, transporting)
- nuclear fuels (mining)

53. Using a map of the world and other references, have the student identify locations where geothermal activity might be used as a potential source of energy. Evaluate whether it would be practical to use each of those sources to produce energy. What aesthetic qualities should be considered when planning for the use of a geothermal source for energy?

54. It has been suggested that tidal energy is a large untapped source of energy. Have the student consider himself a member of a commission to evaluate a proposal to use tidal energy. List the problems the commission would study. What would be the recommendations?

55. Have the students describe the waste products which come from the conversion of coal to heat energy.

56. Have the student compare fission and fusion reactors for the production of electricity.

57. Have the student select the one major source of electric power he thinks will be most used in the future, and substantiate that choice.

58. Have the student list ways in which energy consumption can be reduced without decreasing the quality of life.

59. Have the student construct a model that constitutes "the good life" which can be used as a background for making judgments concerning energy-resource use, considering both himself and others.

60. Have the class discuss the ethical implications of one social group using twenty-five times as much of an unrenewable resource as another social group.

61. Have the student state what kind of fuel-fired electric plant he would prefer as a "neighbor" and defend his choice.

62. There are about one hundred million motor vehicles in the United States. Most of the vehicles are for personal use. Have the student pretend he is to write a law which restricts the use of personal autos to reduce air pollution and space pollution. What will he say in the law? What kinds of argument would he anticipate from opponents of this law? How do other countries get along without the automobile?

63. Have the student evaluate the advantages and disadvantages of automobiles powered by internal combustion engines and those with electric propulsion. Formulate a statement as to how future cars should be powered and why.

64. Have the student describe three major methods of transporting petroleum products. Compare the environmental impact of each.

65. Involve the class in a discussion on what advantages might be derived from more equalization of income and consumption relative to production and resources. What should be the responsibilities of each nation in terms of population control, resource consumption, and income sharing?

66. Have the student pretend that he is Secretary of the Interior and must decide upon the best location for an oil pipeline from Raleigh to Charlotte. Locate the line on a map and defend the choice, aesthetically, environmentally, economically, and politically.

67. Have the student list jobs that would be created in a community by the building of:

   - a coal-fired electric power plant
   - an oil-fired electric power plant
   - a gas-fired electric power plant
   - a nuclear power plant

   List jobs that would be displaced by such construction.

68. Energy production is affected by many agencies at the federal, state, and local levels. Have the student locate the names of the agencies at each level and determine their duties and legal status.

69. Have the student define the rights of each individual to power resources.

70. Have a mock discussion of location requirements for a power plant. Choose board of directors; representatives of transportation, labor, city, and state government, environment-protection board, etc.

71. Have students write the State Environmental Protection Agency and ask for laws regulating power plants, manufacturers, trucks, autos, and planes. Compare the laws. Try to determine whether the laws are written fairly.

72. Have students design and conduct a poll to find out how homeowners and residents of apartment houses feel about the advantages and disadvantages of heating with oil, natural gas, coal, or electricity. Compile the results. What do they tell?

73. Do the following:

    - List the arguments favoring nuclear energy over other sources in or near population centers (so that the excess heat produced by the plant can be used by the community).
    - List the arguments why a nuclear energy power plant should not be located near a population center.
    - List ways of using to advantage the waste heat produced by power generating plants.

74. Have the class discuss some alternatives to internal combustion energy.

75. Have the student do research to determine the rate at which energy is being used in the United States.

76. Have the student do research and calculate the percentage of the world's oil, coal, and natural gas owned by the United States and what percentage of the world's output we actually use.

77. Involve the class in a discussion on the ethics of a group or individual who monopolizes a disproportionate share of a resource. Have the class compare the advantages and disadvantages of using fossil hydrocarbon resources as a base for synthetic production rather than as a fuel.

78. Involve the class in a discussion on the merits of land use planning to ease population pressure and to utilize energy resources more efficiently.

79. Have the student, on separate circular charts, compare the consumption of oil, coal, and other energy sources by industry, agriculture, and government.

80. International wars often have been fought because one nation wanted more resources or energy. Review the wars of the world since 1900. Give examples of fighting motivated by the quest for resources.

81. Have the student assume the role of a representative to the United Nations. Argue before that "body" for a more equitable share of the world's resources.

82. Have the student contrast the immediate and long-range effects on the people of Saudi Arabia and Kuwait by the discovery and exploitation of oil in their countries.

83. Discuss ramifications of the Middle East countries refusing to sell oil to the United States. List various ways in which this will affect one's personal life.

84. Have the student assume he is a Congressman. Have him write a law which would restrict fuel consumption and be equitable to all sectors of society.

85. Assume it is decided by our nation that the reproduction rate must be reduced to fifty percent of its present rate in order to assure enough resources to avoid the catastrophes attendant with too large a population for the energy available. Involve the class in a discussion based on this assumption.

86. Assume that all oil deposits in the United States became exhausted. List the jobs that would be eliminated as a result. Discuss the implications for vocational planning.

87. Have the student assume that an orbiting space platform is equipped with devices to convert solar energy to electric energy. List various ways to get that energy to earth.

88. Involve the class in the writing of a proposal for a research project that will help to alleviate a forthcoming local energy crisis. The proposal should include:

    - a problem statement
    - clearly quantified delineation of the need
    - proposed hypotheses or objectives
    - budget procedures
    - personnel needs
    - evaluation design

    Check to see if funds can be found to carry out such a project.

89. Set up a teacher task force and/or student task force and/or community task force or a combination of all three to study and recommend activities and alternatives for energy awareness action.

90. Reward students and staff for participating in car pools by reserving parking for them in a favored spot.

91. Have students list and discuss all of the reasons they can for increased energy consumption since 1900 due to changes in our life style and also have them list the ways in which energy can be reduced.

92. Make or construct audiovisual presentations of energy waste and develop alternative solutions in the school, home, and community.

93. Have art classes put up displays around the school and sponsor a poster contest for the best energy crisis poster submitted.

94. Have music classes evaluate where materials come from to make their instruments.

95. Have English classes sponsor a contest for the best paper or essay on the energy crisis.

96. Ask your students to make and prepare a list of the direct ways young people are going to be affected in the future, such as young drivers, etc.

97. Discuss the effect(s) of the energy crisis on vacation plans.

98. Discuss the effect(s) of the energy crisis on the use of recreational vehicles.

99. Discuss how gasoline production will affect the auto industry and the U. S. economy. Use resource persons from oil companies, colleges and universities, and from other sources to discuss the issue.

100. Have photography classes or the art club take pictures of excessive energy consumption. Sponsor an energy crisis picture contest.

101. List all the ways energy is consumed on a modern farm and compare them with the ways energy was consumed before 1900.

102. Discuss international political energy problems and international "blackmailing" regarding sources of energy.

103. Compile a list of the petroleum products refined from crude oil.

104. Discuss the interrelated energy shortages and other commodity shortages.

105. Visit grocery stores and compare prices of returnable bottles and non-returnable bottles and cans.

106. Check back issues for two years of Time, Newsweek, and U. S. News and World Report for articles on the energy crisis and other shortages. Was the public forewarned?

107. Prepare a newscast dealing with the energy situation from 1900 to the present.

108. Prepare a scenario of the future concerning the energy crisis--one if we conserve--one if we don't conserve.

109. Prepare a list of needed legislation that has so far failed to come about.

110. Study and discuss rate structures of utility companies, such as their practice that encourages a lower rate to larger users. Should this practice be changed?

NOTE: *Consider a minicourse for the high schools on the energy crisis. It would be designed for the junior or senior year of high school with a 30- to 45-hour instructional time block. Concepts introduced in the elementary grades would be expanded and developed.*

ADDITIONAL ACTIVITIES

VALUE JUDGEMENTS

These exercises are designed to give students some insight into their own values. There are no right or wrong answers. When summarizing, these activities should provoke much discussion. The teacher may wish to duplicate these pages for student use.

A. Which of the following functions could you perform adequately in your home without electricity? (circle)

1. cooking
2. washing clothes
3. drying clothes
4. washing dishes
5. opening cans
6. storing food in summer
7. storing food in winter
8. lighting
9. keeping warm in the winter
10. keeping cool in the summer

B. Which do you consider to be the most important? Scale 1 = most, 15 = least

a. Pure water
b. Clean air
c. Reduction in noise levels
d. An understanding of ecology
e. Conservation of our natural resources
f. Developing an environmental life style
g. Elimination of litter
h. Stabilized population growth
i. Refrain from using biocides (pesticides)
j. Wise consumer practices
k. Diminish our energy consumption (electricity)
l. Rational land usage
m. Lessen private and commercial solid waste production
n. Control thermal pollution
o. A sensitivity to one's surroundings (environmental awareness)

Use the following to rank the above according to the scale:

1. ________
2. ________
3. ________
4. ________
5. ________
6. ________
7. ________
8. ________
9. ________
10. ________
11. ________
12. ________
13. ________
14. ________
15. ________

C. Check the column which best describes your attitude toward doing without the following electrical items:

	Very Easily	Easily	With some difficulty	With great difficulty	Impossible
Radio					
Stereo					
Air conditioning at home					
Air conditioning at work					
Dishwasher					
Clothes washer					
Iron					
Electric stove					
Refrigerator					
Lights					
Central heating					
Doorbell					
Electric mixer					
Ice crusher					
Toaster					
Hair dryer					
Television					
Elevators					
Escalators in stores					
Self-opening doors					
Electric guitars					
Electric fans					
Clocks					
Vacuum cleaners					
Electric games					
Microwave oven					
Freezer					
Blender					
Electric blanket					
Typewriter					
Cash register					
Adding machine					
Xerox copier					
Dentist's drill					
Intercom					
Telephone					
Electric toothbrush					
Electric frying pan					
Hot water heater					
Garbage disposal					
Trash compactor					
Power tools					

D. In order to guarantee the continuation of those services which you find difficult or impossible to do without (see C, page 20), it may be necessary for you to accept some of the following. In which order would you accept the following items?:

______ having no more than 2 children

______ living within a 10-mile radius of a nuclear power plant

______ possibility of food contamination

______ occasional brownouts

______ increased cost of electricity

READING ELECTRIC METERS

The purpose of this meter reading information is to provide students an opportunity to practice conservation and see the results, to develop the ability to read accurately electric meters, and to develop in the student a desire to conserve energy.

The student exercise is designed as a two-week activity involving three meter readings. The teacher may wish to have the meters read each day at the same time for more practice, accuracy, and as a means of comparing daily consumptions. (How does a weekday compare to a Sunday? Why?)

The teacher may wish to contact the local power company to see if the school could obtain a used meter for demonstrations.

On some wall of your home--basement, garage, or most often outside--you will find an intricate glass-enclosed device. If you are like most people, you seldom pay any attention to it. Nor do you need to, for modern electric meters perform their job so accurately and reliably that you need never be troubled. But, every month or so, a man from your electric utility company comes to see it, and later you are billed for the exact amount of electricity used.

Meters Measure Electricity. Through your meter's glass enclosure, you can see a revolving aluminum disk and a series of dials and pointers, or digital numbers. Without explanation, they don't make much sense, but they are really quite simple.

The amount of electricity you use determines the speed at which the disk moves. The more electricity you use, the faster it turns. Each revolution represents a portion of an electric energy unit called watt-hour. This watt-hour measurement is transferred from the disk through a series of gears to the digital numbers or pointers on the dials.

Just What Is A Watt-hour? Every hour a 100-watt light bulb burns, it uses 100 watt-hours of electric energy. Since a watt-hour is such a small unit of energy, your electric utility company uses a unit equal to 1,000 watt-hours--a kilowatt-hour--to measure the amount of electricity used.

What Makes Your Meter Disk Turn? There are two sets of connections which cause your meter to register: (1) the amount of current flowing into your house, and (2) the pressure or voltage at which the current is flowing.

Electric current is like water flowing through a pipe. The rate of flow of electrons through a line is measured in amperes. Pressure is the force that pushes electric current through the lines, measured in volts. To determine the electrical power (watts) used, multiply amperes of current by volts of pressure. Your electric bill is stated in watt-hours.

Clock-Like Meter Accuracy. Friction inside the meter is all but eliminated with the use of a magnetic-suspension system which uses a magnetic field to float the disk and its shaft in air. To help maintain accuracy provided by magnetic suspension and other design features, the meter is sealed with filters which keep its interior free of dust and other contaminants that can cause inaccurate meter registration.

Your Meter--A Small Motor. Your meter is basically a small induction motor run by magnetic forces created by electricity in a set of coils. The voltage coil is a winding of wire connected to the power supply lines. The current coil is a winding of wire connected with the household wiring. When current passes through these coils, the disk is forced to turn at a speed exactly proportional to the number of watts (amps x volts) of electrical power being used.

Meter Progress To Meet Your Needs. Meters have changed a great deal in the last 20 years. They have had to. Television, electric heating, more lights, freezers, air conditioners, water heaters, and other new appliances have more than quadrupled the average family's consumption of electric power. Twenty years ago a meter rated at 600 watts was enough to meet average household requirements. Today's meters are capable of handling up to 48,000 watts.

How To Read Your Kilowatt-Hour Meter. The kilowatt-hour meter is an instrument used to measure electrical energy consumed by a customer.

Two types of meters used by the power companies are the digital- and dial-type meters. The digital meter is read directly from left to right as shown in Figure I. Readings on some digital meters are obtained by multiplying by 10.

[8] [2] [9] [0] = 8,290 kwh

[0] [8] [2] [9] [0] = 8,290 kwh

[0] [8] [2] [9] x 10 = 8,290 kwh

Figure I

Digital Kilowatt-Hour Meters

Most meters have four or five dials. (See Figure II, page 24.) The figures above each of the dials indicate the number of kilowatt-hours (kwh) registered by the meter during the time that the hand on that dial made one complete revolution. So, when the hand on the right-hand dial has passed from one figure to the next, 1/10 of 10 kwh, or 1 kwh, has been used.

Be sure to read the meter "backwards"--from right to left--and remember to read the smaller of the two numbers between which the pointer on the dial is standing. This is very important.

Note that the pointers of the 10 and 1,000 dials rotate clockwise, and counterclockwise on the 100 and 10,000 dials.

During the time that the pointer on any one dial is making a complete revolution from 0 to 0, the pointer on the next dial to the left will pass from one figure to the next. Therefore, although a pointer on one dial may appear to have arrived on a given figure, that figure should not be read unless the pointer on the dial to the right has reached or passed 0.

For example, in Figure II, the pointer on the 1,000 dial looks as if it is on the 5, but you should read that dial "4" because the pointer on the 100 dial, to the right, has not made a complete revolution to 0. The correct reading is shown under the dials.

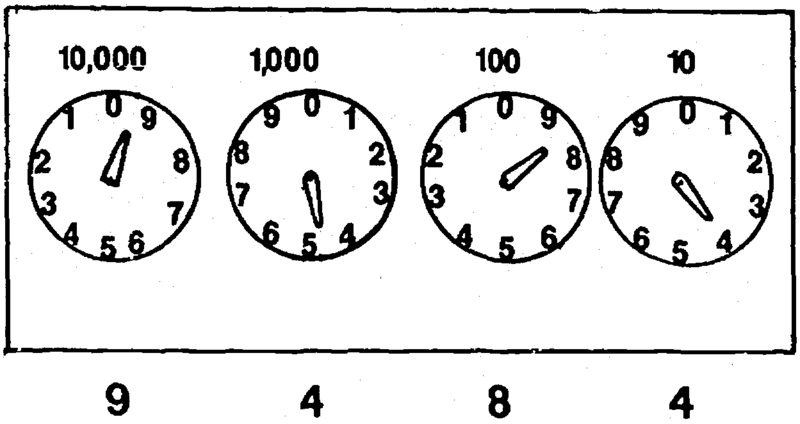


Figure II

Dial Kilowatt-Hour Meter

Kilowatt-Hour Record
(Student Activity Sheet)

Read your kilowatt-hour meter at home and record the reading.	A. ________
Read 1 week later and record the reading.	B. ________
Subtract B from A to determine kwh used during the 1st week of your experiment.	C. ________
During the 2nd week, encourage your family to conserve all the electricity possible. At the end of your 2nd week, again read the meter and record.	D. ________
Subtract D from B to determine kwh used during the 2nd week of your experiment.	E. ________
Subtract E from C to determine how much electric energy your family saved over the previous week.	F. ________

1. Were you successful or did you use more electricity?
2. If you used more, can you explain why?
3. Why would someone with an electrically-heated home have to consider the temperature during the 2 weeks?
4. List all the energy-saving steps your family took.

ENERGY MATHEMATICS

(Grades 7-9)

1. The Red Brick Junior High School used 12,600 gallons of heating oil last year, at which time they kept the thermostats set at 74°F.

   (a) How many gallons of heating oil would they save if they could cut their fuel usage by 20% by keeping the thermostats set at 68°F?

   (b) How much did it cost them for heating oil last year if fuel oil sold for 25¢ per gallon?

   (c) How much will this year's fuel cost, based upon the reduced amount to be used, if fuel oil sells for 30¢ per gallon this year?

   (d) Will Red Brick Junior High School spend less money on their yearly heating by lowering the thermostats, when you consider that they will have to pay more per gallon for fuel oil this year? If so, how much?

2. Dr. Marcus Wealthy owns a 1974 Bercedes Menz which averages 7.8 miles per gallon when driven 70 mph; 9.6 miles per gallon when driven 60 mph; and 10.9 miles per gallon when driven 50 mph. If Marcus drove from Boone to Kitty Hawk, a distance of 403 miles:

   (a) How many gallons of gasoline were used if he drove 70 mph? (answer to nearest 10th of a gallon)

   (b) How many gallons of gasoline were used if Dr. Wealthy kept his speed at 50 mph on the return trip? (answer to nearest 10th of a gallon)

   (c) How many gallons of gasoline did Marcus save by driving 50 mph instead of 70 mph?

   (d) How much money did he save by driving at the slower rate, if gasoline cost 54.9¢ per gallon?

3. The Nonsuch Oil Company ships 200 tons of oil from Bay City, Texas to Wilmington, N. C. each month. They can ship the oil by any of the modes of transportation listed in the chart below:

Price Data for Intercity Freight Transportation
(Bay City, Texas to Wilmington, N. C.)

MODE	COST/TON
Pipeline	$ 27.00
Waterway	30.00
Railroad	140.00
Truck	750.00

   (a) How much would it cost them to ship a month's supply of oil to Wilmington by boat?

   (b) How much would Nonsuch save if they sent the oil by pipeline instead of by boat?

ANSWERS TO PROBLEMS

(Grades 7-9)

1. a.
```
   12,600
      .20
 --------
 2,520.00  gallons saved
```

b.
```
    12,600
       .25
 ---------
     63000
    25200
 ---------
 $3,150.00  fuel cost last year
```

c.
```
   12,600  gallons last year
    2,520  gallons saved
   ------
   10,080  gallons this year
```

```
     10,080
        .30
  ---------
  $3,024.00  fuel cost this year
```

d. Yes, they will spend less money.
```
  $3,150
   3,024
  ------
  $  126  they will save
```

2. a. 7.8/403.0 = 51.66 or 51.7 gallons

b. 10.9/403.0 = 36.97 or 37.0 gallons

c.
```
  51.7
  37.0
  ----
  14.7  gallons saved
```

d.
```
     14.7
     .549
   ------
     1323
     588
    735
   ------
  $8.0703  saved
```

3. a.
```
    200 tons
   $ 30
  ------
  $6,000
```

b.
```
    200 tons
   $ 27
  ------
  $5,400
```

```
  $6,000 by boat
   5,400 by pipeline
  ------
  $  600 saved
```

ENERGY MATHEMATICS

(Grades 10-12)

Power - *The basic unit of power is the watt. For an electrical appliance, the power rating (wattage) is found by multiplying the voltage by the current (in amperes). Thus, a 125-volt appliance drawing 10 amperes has a power rating of 1250 watts. The kilowatt is simply 1000 watts and a megawatt is a million watts (10^6 watts). The horsepower is equivalent to 746 watts.*

We can summarize these facts as follows:

number of watts = volts x amperes

kilowatt (kw) = 1000 watts = 10^3 watts

1 megawatt (mw) = 1,000,000 watts = 10^6 watts

1 horsepower (hp) = 746 watts

Energy - *The basic unit we shall use for energy is the kilowatt-hour (kwh), which is the energy used when a device rated at 1000 watts operates for an hour (or a 100-watt appliance operates for 10 hours). The table below gives various equivalents:*

UNIT OR PROCESS	NUMBER OF KWH
Calorie (diet)	.0012 (1.2×10^{-3})
Calorie (ordinary)	1.2×10^{-6}
British Thermal Unit	2.9×10^{-4}
1 hour of manual labor	.06
Combustion of 1 gallon of gasoline	38.3
Heat 1 gallon of water 1°F	.0024

Examples:

1. Compute how long it will take a 20-amp, 220-volt hot water heater to heat 50 gallons of water from 60°F to 180°F. We shall do the computation in steps as follows:

   Energy required to heat 50 gallons 1°F
   = (50) (.0024) = .12 kwh

   Energy required to heat from 60°F to 180°F (change is 120°F)
   = (.12 kwh) (120) = 14.4 kwh

   Rate at which heater can deliver energy
   = (volts) (amperes)
   = (220) (20) = 4400 watts
   = 4.4 kilowatts

   Thus the number of hours is:

   $$\frac{14.4}{4.4} = 3.3 \text{ hours, or 3 hours and 18 minutes}$$

2. Find the kwh equivalent of driving a large automobile for 1 hour at 70 mph. Let us take 10 miles per gallon as a reasonable figure. Then, the car requires 7 gallons of gasoline to drive 70 miles.

Total energy = (7) (energy equivalent of 1 gallon)
= (7) (38.3)
= 268 kwh (roughly equal to the amount of electrical energy a family uses per week)

<u>Doubling Time</u> - *Some things grow exponentially. That is, while the fractional rate of increase stays the same, because the thing is growing, the absolute rate of increase gets larger and larger.*

Money invested in the bank at compound interest grows this way. You can approximate how long it takes to <u>double</u> your money with this formula:

$$\text{Doubling time (years)} = \frac{70 \text{ years}}{\% \text{ annual increase}}$$

Thus money invested at 5% doubles in about 14 years.

Exercises:

1. If the average American increases his energy consumption about 4.5% per year, how long will it take him to double his rate of consumption?

   Doubling time = ____________________

2. If the American population increases at about 2% per year, how long will it take for the population to double?

   Doubling time = ____________________

<u>Conserving Energy Used To Heat Water</u> - *I know a person who insists that 3 inches of water in a tub is adequate for bathing, but many people fill the tub to a depth of 10 inches.*

How much electric energy is required to bathe in this luxury?

Solution:

Assume the water is heated from 4.5°C to 37.7°C.

Assume also that a tub holding water to a depth of 10 inches contains 189,000 cc of water.

Note: 1 cubic inch = $(2.54)^3$ cubic centimeters.

To compute the watt-hours of electricity, use the formula:

$$(\text{watt-hours}) = \frac{4.18\ (\Delta C)\ V}{3{,}600}$$

$$= \frac{4.18\ (37.7 - 4.5)\ (189{,}000)}{3{,}600}$$

$$= 7{,}285 \text{ watt-hours}$$

How long would this amount of energy operate a 50-watt bulb?

Conserving Energy In Home Heating - *The amount of heat required for a given house increases directly with the square of the difference between the inside and outside temperature. Therefore,* $H=Kd^2$ *(H=heat required; K=constant depending upon the size of the house, how well it is insulated, etc.; d=temperature difference, or inside temperature minus outside temperature).*

Compute the difference in the amount of heat required to heat a house to 72° rather than 65°, if the average winter temperature in Sanford, N. C. is 45°.

Solution:

$$d_1 = 65° - 45° = 20°$$
$$d_2 = 72° - 45° = 27°$$

The heat required at 65°.

$$H_1 = K\,20^2 = 400\ K$$

The heat required at 72°.

$$H_2 = K\,27^2 = 729\ K$$

Therefore, the amount of heat required to heat to 72° is:

$$\frac{729}{400} = 1.8225$$

1.8225 times that required to heat to 65°, or 82% more.

WHO SAID THAT?

Given below are quotes from the writings of various individuals or agencies, all of them dealing with energy-environment issues. The sources are listed first and then the group of quotes. Can you match authors with their words?

A. President Richard Nixon

B. Atomic Energy Commission Chairman, Dixy Lee Ray

C. Consumer Advocate, Ralph Nader

D. Philip Abelson, editor of SCIENCE

E. M. King Hubbert, U. S. Geological Survey

F. Atomic Energy Commission statement to Congressional Joint Committee

G. Massachusetts Institute of Technology Economist, M. A. Adelman

H. S. David Freeman, Director, Ford Foundation Energy Policy Project

I. Excerpt from September ATLANTIC editorial entitled, "Shall We Strip-Mine Iowa and Illinois to Air-Condition New York?"

J. Alvin Weinberg, Director, Oak Ridge National Laboratory

K. Senator Henry M. Jackson

______ 1. "There are two things wrong with coal today. We can't mine it and we can't burn it."

______ 2. "The choice we have to make is whether to continue using large quantities of nonhuman energy, at the same time conserving it and using engineering and technical skills to reduce environmental damage, or to return to something like a slave state, perhaps at a much lower population level, in which some people would have a perfectly satisfactory environment, but most people would live lives of misery and despair."

______ 3. "We nuclear people have made a Faustian compact with society: we offer...an inexhaustible energy source ...tainted with potential side effects that, if uncontrolled, could spell disaster."

______ 4. "Unlimited resources of energy, however, do not imply an unlimited number of power plants. It is as true of power plants or automobiles as it is of biological populations that the earth cannot sustain any physical growth for more than a few tens of successive doublings. Because of this impossibility, the exponential rates of industrial and population growth that have prevailed during the past century and a half must soon cease. Although the forthcoming period of stability poses no insuperable physical or biological difficulties, it can hardly fail to force a major revision of those aspects of our current social and economic thinking that stem from the assumption that the growth rates that have characterized this temporary period can somehow be made permanent."

______ 5. "The Atomic Energy Commission may not validly license a nuclear power plant for operation under the Atomic Energy Act or under its own regulations unless the plant possesses an ECCS (Emergency Core Cooling System) whose effectiveness is established. Continued operation of a nuclear power plant under the Act and Commission regulations requires assurance of an effective ECCS." ....

"The operating heads of the ECCS research programs at the Commission's primary safety research centers (Oak Ridge National Laboratory and Aerojet Nuclear Company) have stated that compliance with the IAC (Interim Acceptance Criteria) does not assure effectiveness of an ECCS and that there is insufficient scientific evidence to support the conclusion that an ECCS of current design (including those installed on the nuclear power plants which are the subject of this action) will, in fact, operate as intended."

______ 6. "It is characteristic of a democratic form of government that major legislation is usually not enacted unless public opinion has crystallized in support of it. When an issue has dramatic appeal, far-reaching legislation is often enacted quickly. When issues are complex and nonemotional, the government moves slowly, if at all. An example of the latter attitude has been the government's treatment of the energy problem. Our national security, financial stability, and standard of living are at stake, but the federal response has not been commensurate with the need. Until recently, most of the talk about energy has been about the problems that will arise in 1985 or 2000. This has the effect of pigeonholing the matter. Who can sustain a high level of excitement about the year 1985?"

______ 7. "The principal contribution of nuclear energy to meeting these goals will be through the production of electric power which, at this time, is only about ¼ of total energy production. Therefore, while nuclear power now produces about 4% of the electricity in this country, less than 1% of the national energy consumption in 1972 was from nuclear sources. Looking ahead, the atom is expected to provide 10% of our total energy needs by 1985 and 25%-30% of total energy by the year 2000. If we consider only electric generation, then nuclear is expected to provide 50%-60% by the end of this century."

______ 8. "A major factor contributing to our present energy crisis is that the necessary research and development efforts which could have provided us with the technological options and capabilities we now need so desperately were not undertaken in the past."

______ 9. "It is somewhat confusing that concern over nuclear plant safety has increased recently. Some explanation is undoubtedly to be found in sensationalist publications...but the most important reason appears to be the widespread lack of knowledge of both the excellent safety record of the nuclear power industry and the extreme efforts, unprecedented in any other industry, to assure that nuclear plants are designed, constructed, and operated with the highest attention to public and employee safety."

_____ 10. "The world 'energy crisis' or 'energy shortage' is a fiction. It makes people accept higher oil prices as imposed by nature, when they are really fixed by collusion."

_____ 11. "As America has become more prosperous and more heavily industrialized, our demands for energy have soared. Today, with 6% of the world's population, we consume almost a third of all the energy used in the world. Our energy demands have grown so rapidly that they now outstrip our available supplies, and at our present rate of growth, our energy needs a dozen years from now will be nearly double what they were in 1970." ...

"If we are to be certain that the forward thrust of our economy will not be hampered by insufficient energy supplies or by energy supplies that are prohibitively expensive, then we must not continue to be dependent on conventional forms of energy. We must instead make every useful effort through research and development to provide both alternative sources of energy and new technologies for producing and utilizing this energy."

Answers:

1-H; 2-I; 3-J; 4-E; 5-C; 6-D; 7-B; 8-K; 9-F; 10-G; 11-A

ENERGY BINGO

This simple *ENERGY BINGO* game is designed to provide students an entertaining way to become more aware of their surroundings and what can be done locally by themselves and others to aid in energy conservation.

1. Duplicate and provide a sheet for each student.
2. The student is to mark each block with an X when he actually finds what is described.
3. This should be an overnight home/school assignment.
4. The student receives 1 point for each square marked and a 5-point bonus for each complete diagonal, vertical, or horizontal row. He also receives a 4-point bonus for completing the 4 inner squares or 4 corner squares (but only 4 points, he cannot get 8 points for both). Total possible points=<u>110</u>.

<u>Optional</u>

- After completing the game, have each student shade the blocks that represent wasting energy and leave the blocks that represent energy conservation clear (or color blocks 2 different colors).
- Have a class discussion on why some save and some waste energy.
- To better meet the needs of her students, the teacher may consider making her own game or revising this one to a larger or smaller version.

E	N	E	R	G	Y
Room w/thermostat set above 68° (summer--below 78°)	Small portable electric space heater in use (electric fan in summer)	Color TV with instant-on feature	Car idling with no driver	Overheated public building (in summer-overcooled)	Car speeding over 55 mph (estimate)
Door or window open w/ heat or air conditioning on	Room or building where thermostat is lowered to 60° at night (80° in summer)	Lights on in an unoccupied room	Electric toothbrush in use	Open refrigerators in supermarkets	Washing machine using cold water only
Car accelerating smoothly and slowly	Solid state (no tubes) black & white TV	Dripping hot water faucet	House with no storm windows or storm doors	Lights on at midday in a hallway	Car coming to a quick stop (tires squealing)
Electric blanket in use	Car with only one passenger	Nighttime illumination of a public building	Water heater w/ thermostat set above 140° F	Gas pilot light burning	Outside light burning during the day
Mobile home or mobile classroom without underpinning	Car accelerating rapidly (tires squealing)	Car with a V-8 engine	Large wattage bulb used where a smaller one would do	Window air conditioner (in winter-without outside plastic cover)	Self-cleaning oven
Compact car with small 4-cylinder engine	Fluorescent tubes instead of incandescent bulbs	Frost-free refrigerator	TV or radio playing with no one in the room	Car easing to a smooth stop	Electric knife in use

*TEST YOUR EQ**

Take this quiz to check your knowledge and understanding of energy-environment issues. Circle your answers, then turn to the next page to see how well you have done.

1. How much of the energy used in gas stoves supplies the pilot lights?

   a. 10% b. 25% c. 50%

2. How much of the energy stored in coal burned in a power plant can be delivered to the customer's home as electricity?

   a. 1/3 b. 2/3 c. all of it

3. What fuel is presently our most extensively used energy source?

   a. coal b. petroleum c. natural gas

4. What fraction of radiation to which Americans are exposed comes from nuclear power plants and nuclear fuel reprocessing plants?

   a. 0.001% b. 0.1% c. 10%

5. How much of the energy stored in crude petroleum is lost in the series of processes between the oil well and a moving car?

   a. 20% b. 60% c. 90%

6. What fraction of the world's energy consumption occurs in the U. S.?

   a. over 10% b. over 20% c. over 30%

7. How long would a 100-watt light bulb burn on the energy needed to manufacture one throw-away soft drink can or bottle?

   a. 10 minutes b. 5 hours c. 20 hours

8. Where would you be exposed to more ionizing radiation?

   a. on a coast-to-coast jet flight for 5 hours

   b. at a nuclear power plant site boundary for 5 hours

   c. in your living room watching color TV for 5 hours

9. Which of the following fuel resources is in the greatest danger of exhaustion?

   a. coal b. petroleum c. natural gas

10. In the year 2000, American total energy demand will be:

    a. the same as today

    b. twice as much as today

    c. three times as much as today

*Energy Quotient

ANSWERS: Score 1 for each correct answer.

0 - 5	Poor
6 7	Fair
8 - 10	Good

1. (c) Approximately half of the gas used in a gas stove is used to fuel the pilot lights because pilot lights burn continuously.

2. (a) One-third of the coal's energy gets to the customer's home. Further losses in the customer's appliances results, on the average, in a 94% net loss in the energy before it is ultimately used.

3. (b) In the U. S. 46% of our energy comes from petroleum. Natural gas contributes 32% and coal accounts for 17%. Dams and nuclear power plants account for most of the remaining 5%.

4. (a) Nuclear power plants account for almost none of the radiation to which Americans are exposed. The average American is exposed to:

   40,000 times as much radiation from outer space
   60,000 times as much from his immediate surroundings
   25,000 times as much from his own body
   100,000 times as much from his house if it is made of stone

5. (c) 94% of the energy in the gasoline from crude petroleum is lost in making your car move. The efficiencies of the most important steps where energy is lost are:

   producing the crude oil 96%
   refining 87%
   gasoline transport 97%
   engine thermal efficiency 29%
   engine mechanical efficiency 71%
   rolling efficiency 30%

   The total efficiency of the system is found by multiplying the six factors together--6%.

6. (c) More than 1/3 of the world's energy is consumed by the 6% of the world's population residing in the U. S.

7. (b) A 100-watt lamp could burn for 5 hours on the energy used to manufacture a disposable can or bottle.

8. (c)

	Relative amount of radiation
Nuclear power plant	1 unit
Jet flight	2 units
Watching color TV	10 units

9. (c) Natural gas reserves in the U. S. are expected to be exhausted in about 40 years. Petroleum should last for a century. Coal, 500 years or so.

10. (b) For more than a century, American demand for energy has doubled, on the average, every 20-25 years.

APPENDIX

CONSERVATION OF ENERGY AT HOME

In order to reduce consumption of energy in the home, the following steps are important:

- Ascertain the general principles of energy conservation.
- Translate these principles into specific activities.

This section provides tools for this process:

- General Tips for Home Energy Conservation
- A Home Checklist for Energy Conservation

1. General Tips for Home Energy Conservation

- *Determine the importance of "convenience."*

  Today's homes are stocked with countless objects which we commonly refer to as "modern conveniences." Some conveniences greatly increase comfort and efficiency in the home (refrigerators, water heaters); others, like electric toothbrushes and power tools, merely cut down on the amount of physical energy required to do a certain job. Try to determine which home conveniences would be most expendable in a severe energy shortage.

- *Identify the biggest energy users.*

  In order to save energy efficiently, it is important to know which appliances use the most energy in the home. The chart following these tips shows the relative energy consumption of common household appliances. The greatest energy (use) is for home heating and water heating.

  The energy required to heat homes represents about 57.3% of all home energy consumption. Good insulation can markedly reduce this percentage. Heating water consumes about 15% of all energy used in the home. Water heaters are usually out of sight and we don't turn them on and off like other appliances. Reducing the temperature control on water heaters can increase energy savings.

  To determine the biggest energy users in the home, rate electric appliances on a scale from 1 to 10. Make "savings reminder" labels for home appliances. Electrical equipment that requires only nominal kilowatt consumption would, of course, be labeled in the "1" category. Big power-meter accelerators such as clothes dryers and color TV's would be rated at 5, 6, 7, or higher on the scale.

- *Make energy economy a design principle.*

  When remodeling homes, consider the energy factor in the changes you are making. For instance, most home lighting is incandescent.

Fluorescent lighting is generally twice as efficient as incandescent lighting, and may be used effectively in baths, laundries, kitchens, and workshops. Types of insulation will effect home heating efficiency. Develop a list of new equipment which might be wise to consider in home remodeling.

Concentrate on fuel savings when using family cars.

The most recent nationwide crisis in energy supply has been the shortage of gasoline. Motorists can improve driving economy by reducing the weight carried in the vehicle (heavy tools and equipment), keeping the vehicle in peak operating condition, maintaining constant speed in city driving, etc. In addition to these specific actions, a general change in transportation habits will also improve fuel economy. Develop a list of ways that families can shorten the distance they travel in their cars.

WHERE THE WATTS GO

	Approx. Average Monthly Kwh Use
Range	200
Water Heater (Family of 4)	600
Refrigerator-Freezer (Standard)	100
Food Freezer (20 cu. ft.)	100
Dishwasher (Includes hot water)	100
Waste Disposer	5
Coffee Maker	10
Toaster	5
Electric Frying Pan	15
Clothes Dryer (5 loads a week)	100
Automatic Washer (Not Including hot water)	15
Iron	20
TV (Black-and-white)	30
TV (Color)	50
Stereo-Radio	40
Radio	15
Electric Blanket	25
Furnace Fan	90
Lighting	150

WHAT IS A KWH?

Kwh stands for kilowatt-hour. Electric power is measured in watts, like gasoline is measured in gallons. All electric appliances and light bulbs are sized, or rated, in watts. Some time ago, someone took the Greek word "kilo" (meaning 1,000) and joined it to "watt." The term kilowatt is simply an easy way to say 1,000 watts. A kilowatt-hour, then, is 1,000 watts of power used for one hour. One kilowatt-hour will run a 100-watt light bulb for 10 hours.

2. A Home Checklist for Energy Conservation

Heating

_____ Set heating thermostat at 68°-70°.

_____ Turn thermostat down at least 10° at night.

_____ Eliminate use of home air conditioning. If air conditioning must be used, adjust settings so it does not come on below 78°-80°.

_____ Keep furnace filters clean for more efficient operation.

_____ Close fireplace damper when not in use.

_____ Open or close drapes to help control indoor temperatures.

_____ Do not use oven for heating the kitchen.

_____ Insulate homes. An uninsulated home requires twice the energy for space heating.

_____ Install weatherstripping around all windows and doors.

_____ Use storm windows, or cover windows with plastic, during colder months.

_____ Move obstructions away from cold air returns or hot air vents.

_____ Thermostats should not be placed on cold walls or outside walls.

_____ Before leaving on winter vacations, lower thermostats to 55°. During summer, all windows that face the sun directly should be shaded.

_____ Keep baseboards and heating surfaces clean and unobstructed by furniture or draperies.

_____ Minimize the use of portable electric space heaters.

_____ Keep humidity as normal as possible (45%-50%) by using exhaust fans in high moisture areas.

_____ Minimum settings of 55° should be maintained on thermostats when leaving for a period of time; i.e., vacations, moving from the residence, etc.

_____ Close foundation vents on the windy side of the house during cold weather.

_____ Shut off registers and heat vents in unused rooms (check to be sure there are no items in the room vulnerable to freezing).

_____ Cover outside section of wall-mounted air conditioning units with plastic to prevent air leakage.

Water

. *General*

_____ Reduce water heater thermostats to 140°.

_____ Turn electric water heaters off if you plan to be gone from home more than one day.

_____ Take showers when possible, instead of baths; make them brief, and turn faucet on to minimum practical water flow.

_____ Use less water for tub baths.

_____ Drain and flush your hot water tank at least once a year to prevent buildup of sediments.

_____ Repair dripping faucets and leaking toilet fixtures.

. *Dishwashing*

_____ Wash only full loads in dishwasher.

_____ Use shortest cycle for load being washed.

_____ For hand dishwashing, use a tub of rinse water rather than running water.

<u>Lights and Appliances</u>

. *General*

_____ Turn off all lights not in use.

_____ Reduce bulb wattage where practical.

_____ Eliminate yard lights. Turn on porch lights only when expecting visitors. Eliminate exterior Christmas lighting.

_____ Turn off all unused television, radio, stereo, etc.

_____ If you have a choice between color and black-and-white television, use the black-and-white set.

_____ Use sunlamps, hairdryers, electric haircurlers, etc., only when essential.

. *Laundry*

_____ Cut down on use of clothes dryers. Hang clothes outside when possible.

_____ Dry full loads, but avoid overloading.

_____ Set drying temperature for fabric.

_____ Clean lint trap in dryer after every load.

_____ Use full loads in washer.

_____ Set water level controls to load size.

_____ Set water temperature for fabric.

_____ Use cold water when appropriate.

. *Cooking and Refrigerating Foods*

_____ Preheat oven only when necessary.

_____ Choose pans to fit units and cook with covers.

_____ Keep oven door closed until food is done.

_____ Clean kitchen exhaust fan and run only when necessary.

_____ Use pressure cookers.

_____ Plan menus requiring less cooking.

_____ Use self-cleaning ovens as little as possible.

_____ Don't use ovens to heat kitchens.

_____ Set refrigerator temperature to maintain 35°-40°.

_____ Defrost refrigerator when frost is ¼" thick.

_____ Be sure doors seal on refrigerator and freezer.

_____ Clean condenser coil regularly.

_____ Cool foods before refrigerating or freezing.

_____ Don't overload refrigerator or freezer.

_____ Limit opening and closing of refrigerator and freezer.

_____ Keep refrigerator away from heating equipment and direct sunlight.

Driving Hints

_____ Maintain speed at less than 55 miles per hour.

_____ Avoid use of auto air conditioner and other power accessories except as safety requires.

_____ Keep car engine tuned.

_____ Use proper air pressure in tires.

_____ Use radial tires on vehicles to increase gas mileage.

_____ Use mass transit, or organize car pools; when driving to and from work, avoid one-person use of cars.

_____ Plan shopping to reduce the number of trips. One 50-mile trip is more efficient than five 10-mile trips because of engine warm-up.

_____ Allow engine to warm up while driving at moderate speeds, rather than while idling.

_____ Accelerate slowly and smoothly from a stop, rather than making "jack rabbit" starts.

_____ Maintain a steady highway speed in harmony with traffic conditions.

_____ Carry no unnecessary weight in car.

_____ Walk or ride a bicycle as an alternative to driving.

. *Water*

_____ Check all outside connections leading to the mobile home for leaks. These could be underground connections, faucets, lead-in hoses/pipes/tubing, and actual connections to the mobile home.

_____ Check the hot water heater for any leaks which might have occurred while the mobile home was in transit. If it is an electric water heater, revent and close off all vents leading to outside air. CAUTION: *If you have a gas water heater, do not close off any vents.* With either type of water heater, seal off entry door to avoid air leakage into the water heater closet.

_____ Check all faucets and pipes when practical for leaks which might have occurred during transit or from worn-out faucet parts. One drop of water per second could add up to 1,200 gallons of water consumption per month, which shows up on your bill! Wrap all exposed pipes with insulation. Use heat tapes only if absolutely necessary.

. *Heat*

_____ If you are just moving the mobile home to its new location, try to place it on the downwind side of trees, bushes, cut-ground bank, or hill.

_____ Place a layer of gravel (preferably small size; i.e., ¼" crush or "buckshot") under the mobile home and cover with heavy plastic sheets or other vapor-proof barrier.

_____ Wrap all heat and cold air return ducts with insulation. Seal all joints or cracks to prevent outside air from being drawn into the heating system.

_____ Seal all cracks or fiberboard breaks on the bottom of the trailer to prevent cold air seepage into the home. Seal the anchor/support beams and the subsequent crack where the two halves of a double wide mobile home are joined. Check all seals around "expansion" or "tip-out" rooms.

_____ Skirting around a mobile home is a must. The skirting should be vented to prevent mildew, but close off all vents on windward sides of your mobile home during the cold weather season.

. *Gas Heaters and Appliances*

_____ Check all lead-in pipes and pipes to the heater and appliances for leaks. This will not only prevent costly consumption of gas, but is a sound safety measure.

_____ Check the heater and all appliances for gas leaks, and make sure that pilot controls are functioning correctly.

_____ Check all electrical portions of the heater to be sure that the blower and thermostat are operating correctly.

A CHECKLIST FOR ENERGY CONSERVATION IN SCHOOL BUILDINGS

This list is not all-inclusive, but rather, a sample of some measures which reduce consumption of electricity and oil products. Any of the following activities might be initiated in a school building, keeping in mind two important factors: (1) the health and safety of students and employees, and (2) the prevention of vandalism.

Lighting

. *Daylight Hours*

_____ Do not turn on lights in instructional areas unless it is essential to the teaching-learning process. Faculty members are in the best position to adjust lights according to needs (off during class discussion, on for reading and writing, etc.).

_____ Avoid turning lights off for very short intervals. The energy surge required when the light is turned back on is greater than the energy saved.

_____ Do not turn on lights in outside covered play areas and walkways.

_____ Reduce lighting by 1/3 in interior gyms, locker rooms, shower rooms, shop rooms, libraries and general work areas by turning on one row of lights at a time until a safe level of lighti · is reached.

_____ Turn off lights in nonproductive areas, except 1 · minimum safety requirements (cafeteria, hallways, storage rooms).

_____ Do not plan Christmas trees or holiday displays that require electric lights.

. *Evening Hours*

_____ Do not use exterior lights except at outside stairs and entry ways in use.

_____ Use only ½ the lighting capacity of hallways and stairwells in use.

_____ Reschedule 50% of housekeeping cleaning to daylight hours. Request night custodians to light only the areas they are working in.

_____ Schedule all school meetings during daylight hours. Encourage community groups using the school building to reschedule their meetings during daylight hours.

General Use of Electricity

_____ Keep television sets, radios, typewriters and other office equipment turned off when not in use.

_____ Reduce by 1/3 the use of electrical appliances in home economics classes and consolidate use of refrigerators to one in each room.

_____ Reduce by 1/3 the use of power tools in classroom shops.

Heating, Ventilating, and Air Conditioning

. *Air Conditioning*

_____ Immediately discontinue the use of air conditioning systems.

. *Ventilating*

_____ Do not turn on ventilating systems until ½ hour after the buildings have been occupied.

_____ Shut off ventilating systems immediately after classes are dismissed for the day.

_____ Do not use ventilating systems for evening occupancy.

. *Heating*

_____ Control office and classroom temperatures at no more than 70° during occupancy. Utility companies are recommending reducing the temperature to 68° if possible.

_____ Maintain temperature of gyms, shops, and restrooms at 66° during occupancy.

_____ Do not heat interior hallways and/or storage rooms.

_____ Encourage students and employees to wear warmer clothing to accommodate cooler temperatures.

_____ Maintain heating in buildings at 55° during unoccupied times. This especially applies to evenings, weekends, and holidays during the heating season.

_____ Constantly inspect heating systems to guarantee maximum efficiency.

- _____ Check filters to make sure they are clean (monthly).
- _____ Check oil burner nozzles for proper combustion (monthly).
- _____ Check steam supply systems for steam leaks (weekly).
- _____ Check boiler return systems, including vacuum pumps and water injection controls (monthly).
- _____ Clean boiler fire tubes and sections to keep them free of a build-up of fly ash (monthly).

_____ Report immediately any needed repairs for heating systems and temperature controls that cannot be accommodated by in-house engineers.

_____ Persuade students to prevent heat from escaping unnecessarily through open doors.

Athletic Events

_____ Schedule all junior varsity events during daylight hours.

_____ During night varsity games, minimal lighting (one bank of lights) should be used until 10 minutes before game time, during half time and immediately upon completion of the game. Full lighting should be used during regulation play.

Motor Vehicle Use--Fuel Conservation

_____ Reduce the number of business trips and limit speed to 55 miles per hour.

_____ Cut down on field trip scheduling. Do not, however, cancel game buses for rooters unless you are sure that many students won't make the trip in cars as a result. Fuel allotments may well cause curtailment of extra trips.

_____ Encourage students to use school buses, municipal buses, bicycles, or their own two feet to and from school, and to leave their cars at home.

_____ Encourage teachers to use public transportation and/or organize car pools to and from work.

The following charts are presented as an aid to the teacher in developing materials for units on the energy crisis. The teacher may use them for reference, duplicate them for student use, or use them in whatever way that is most helpful.

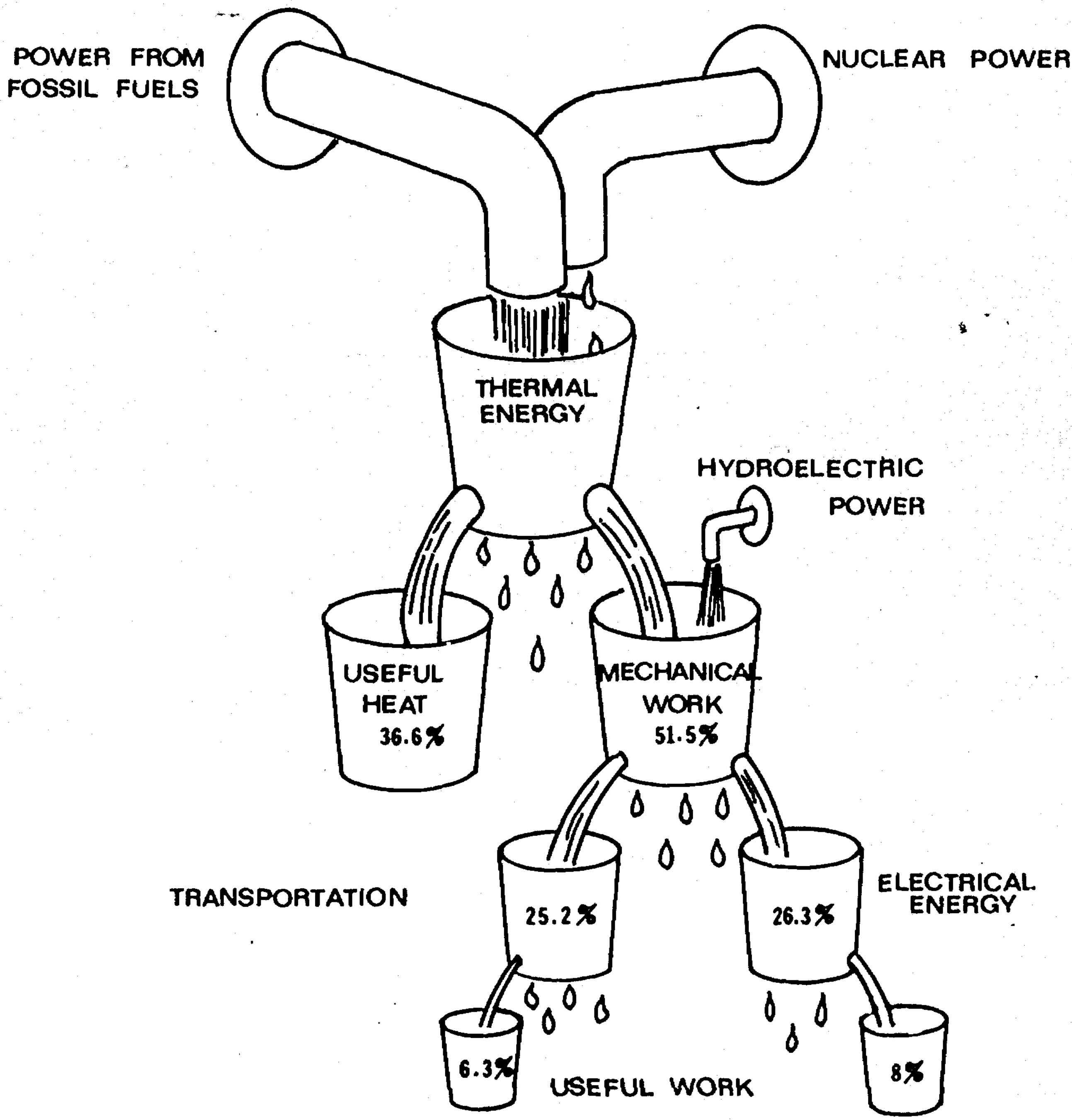
Environmental Effects of Electrical Power Generation

Energy Sources	Effects on Land	Effects on Water	Effects on Air	Biological Effects	Supply
Coal	Disturbed land Large amounts of solid waste	Acid mine drainage Increased water temperature	Sulfur oxides Nitrogen oxides Particulates	Respiratory problems from air pollutants	Large reserves
Oil	Wastes in the form of brine	Oil spills Increased water temperature	Nitrogen oxides Carbon monoxide Hydrocarbons	Respiratory problems from air pollutants	Limited domestic reserves
Gas		Increased water temperature	Some oxides of nitrogen		Extremely limited domestic reserves
Uranium	Disposal of radioactive waste	Increased water temperature		None detectable in normal operation	Large reserves if breeders are developed

Changes In Production Or Consumption Per Capita

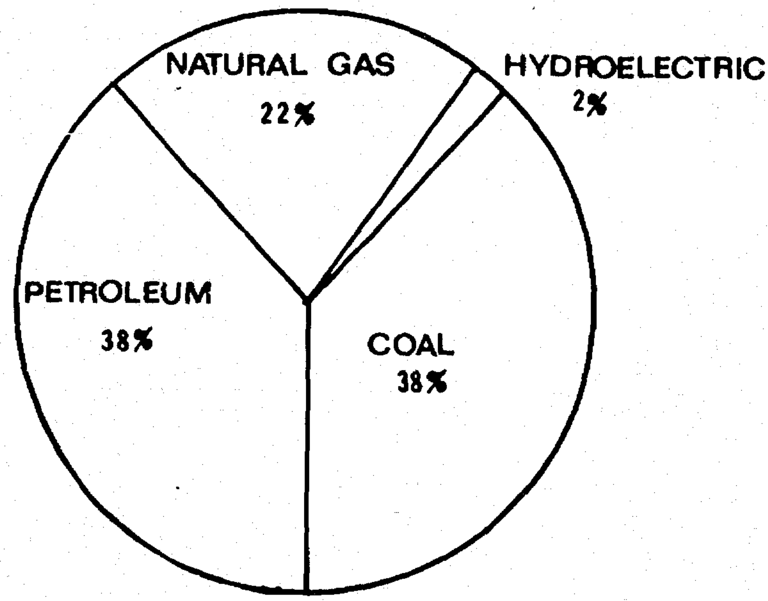
Item	Period	%Increase
Nonreturnable beer bottles	1946-69	3,778
Synthetic fiber (consumption)	1950-68	1,792
Plastics	1946-68	1,024
Airfreight -- ton-miles	1950-68	593
Nitrogen fertilizers	1946-68	534
Synthetic organic chemicals	1946-68	495
Chlorine gas	1946-68	410
Aluminum	1946-68	317
Detergents	1952-68	300
Electric power	1946-68	276
Pesticides	1950-68	217
Total horsepower	1950-68	178
Wood pulp	1946-68	152
Motor vehicle registration	1946-68	110
Motor fuel (consumption)	1946-68	100
Cement	1946-68	74
Truck freight -- ton-miles	1950-68	74
Total mercury (consumption)	1946-68	70
Cheese (consumption)	1946-68	58
Poultry (consumption)	1946-68	49
Steel	1946-68	39
Total freight -- ton-miles	1950-68	28
Total fuel energy (consumption)	1946-68	25
Newspaper advertisement (space)	1950-68	22
Newsprint (consumption)	1950-68	19
Meat (consumption)	1946-68	19
New copper	1946-68	15
Newspaper news(space)	1950-68	10
All fibers (consumption)	1950-68	6
Beer (consumption)	1950-68	4
Fish (consumption)	1946-68	0
Hosiery	1946-68	-1
Returnable pop bottles	1946-69	-4
Calorie (consumption)	1946-68	-4
Protein (consumption)	1946-68	-5
Cellulosic synthetic fiber (consumption)	1950-68	-5
Railroad freight -- ton-miles	1950-68	-7
Shoes	1946-68	-15
Egg (consumption)	1946-68	-15
Grain (consumption)	1946-68	-22
Lumber	1946-68	-23
Cotton fiber (consumption)	1950-68	-33
Milk and cream (consumption)	1946-68	-34
Butter (consumption)	1946-68	-47
Railroad horsepower	1950-68	-60
Wool fiber (consumption)	1950-68	-61
Returnable beer bottles	1946-69	-64
Work animal horsepower	1950-66	-84

ENERGY: Flow Chart



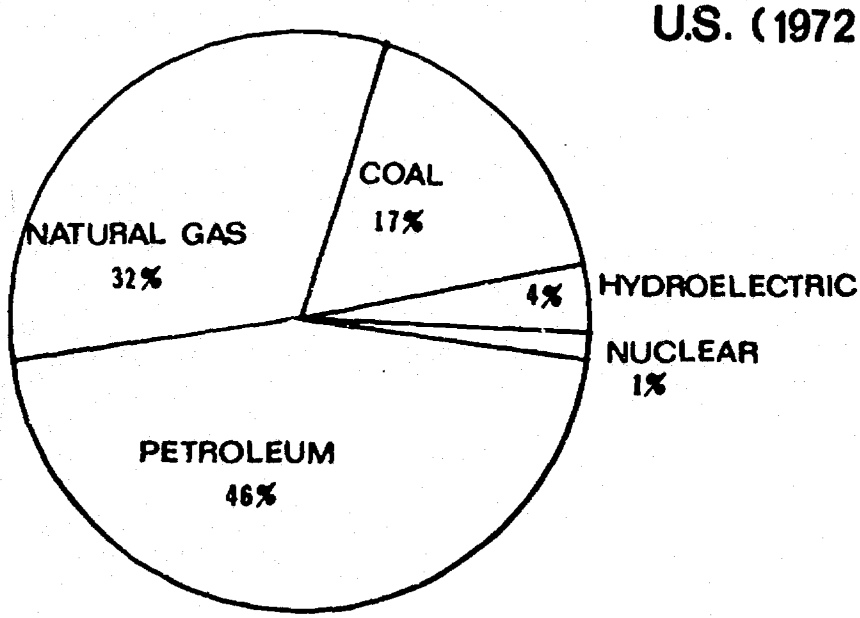
WASTED ENERGY = 49%

Where Do We Get Our Energy?



World (1968)

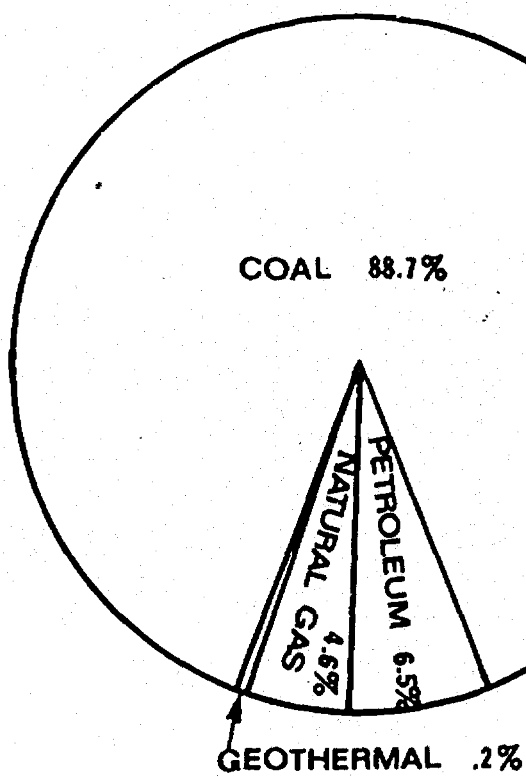
U.S. (1972)

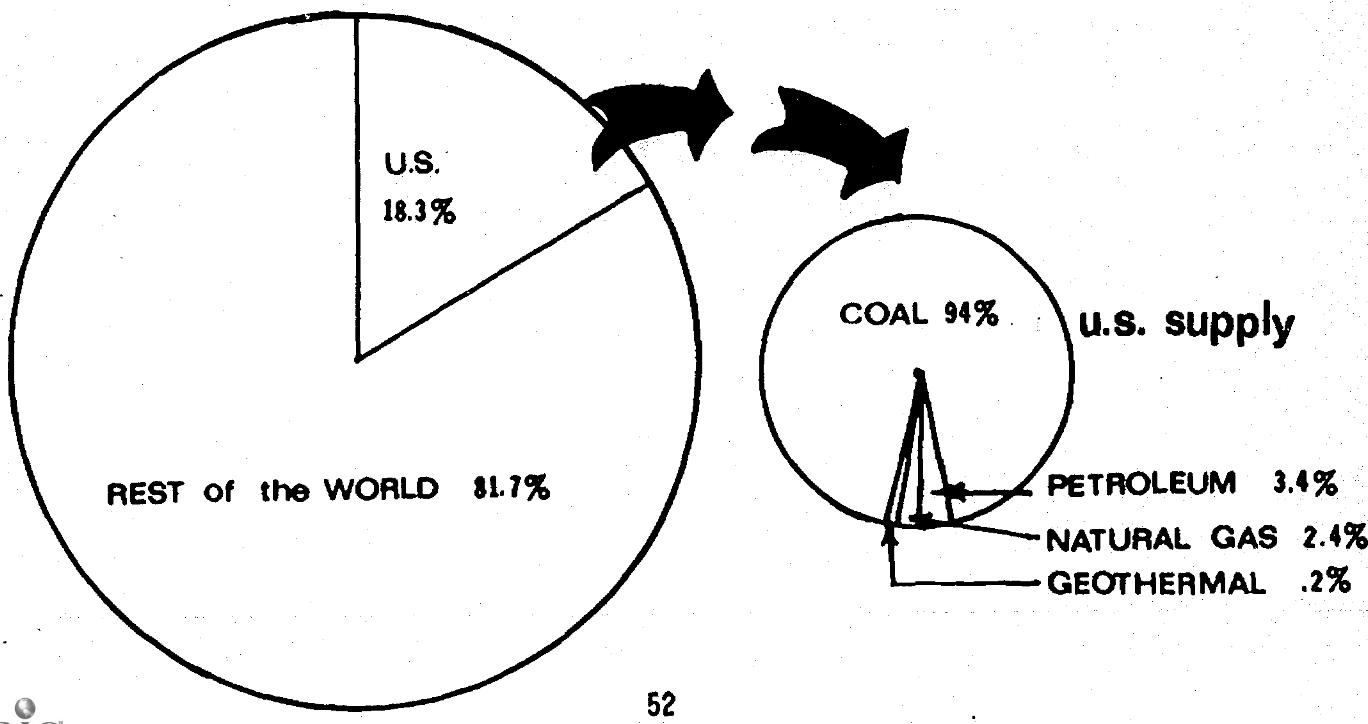


Energy-Environment Facts

What are the forms of our Non-Nuclear energy supply?

world supply

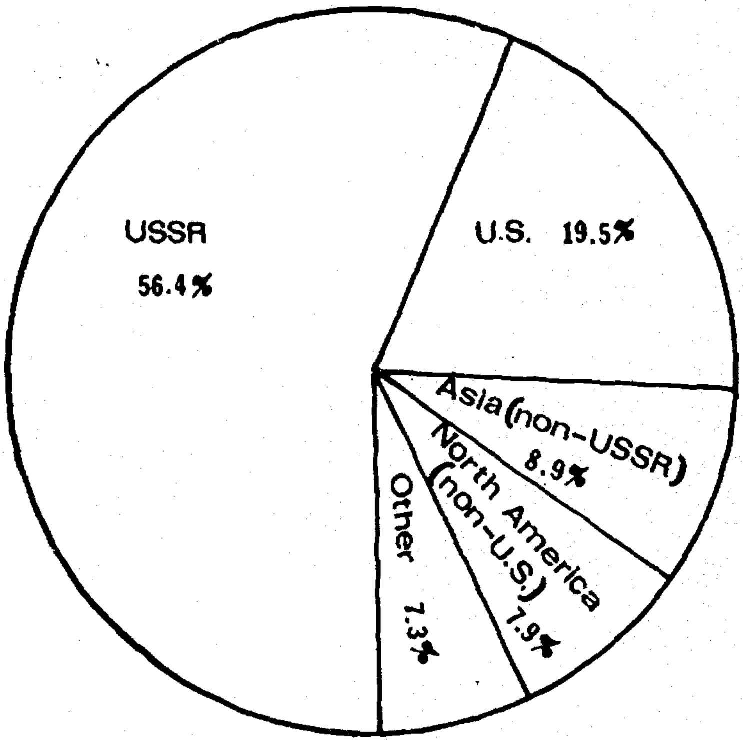


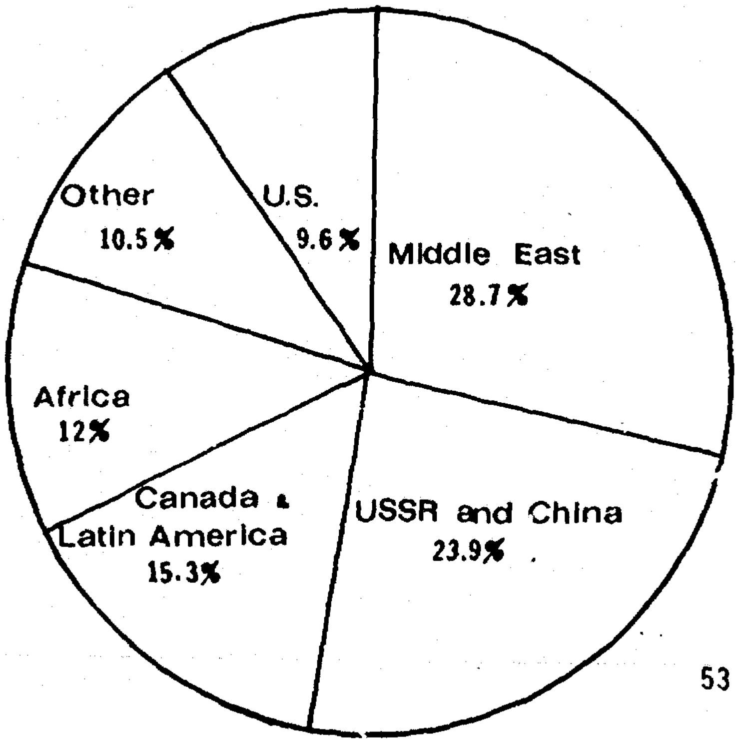


u.s. supply

World Distribution of Coal and Petroleum

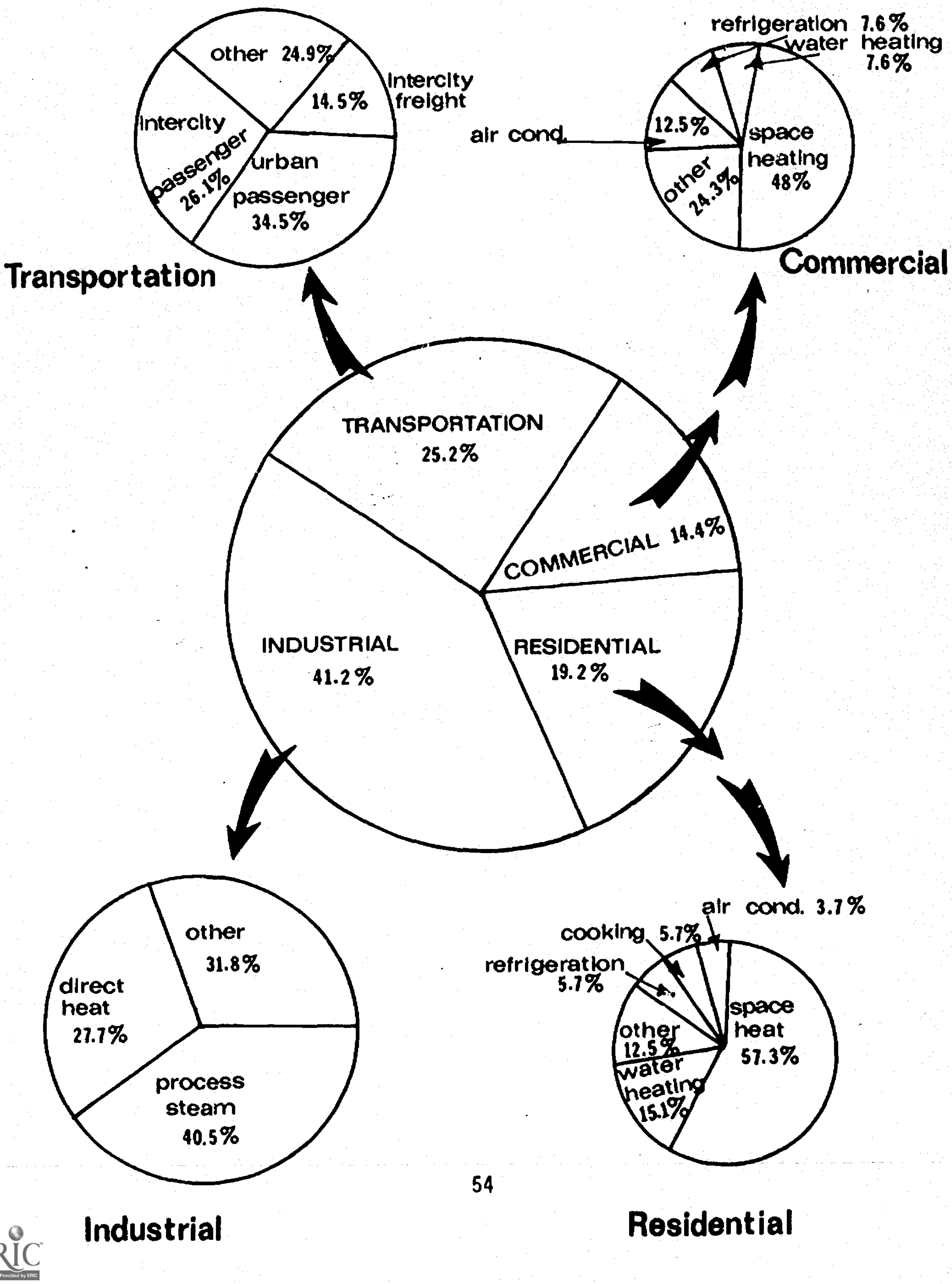
Coal



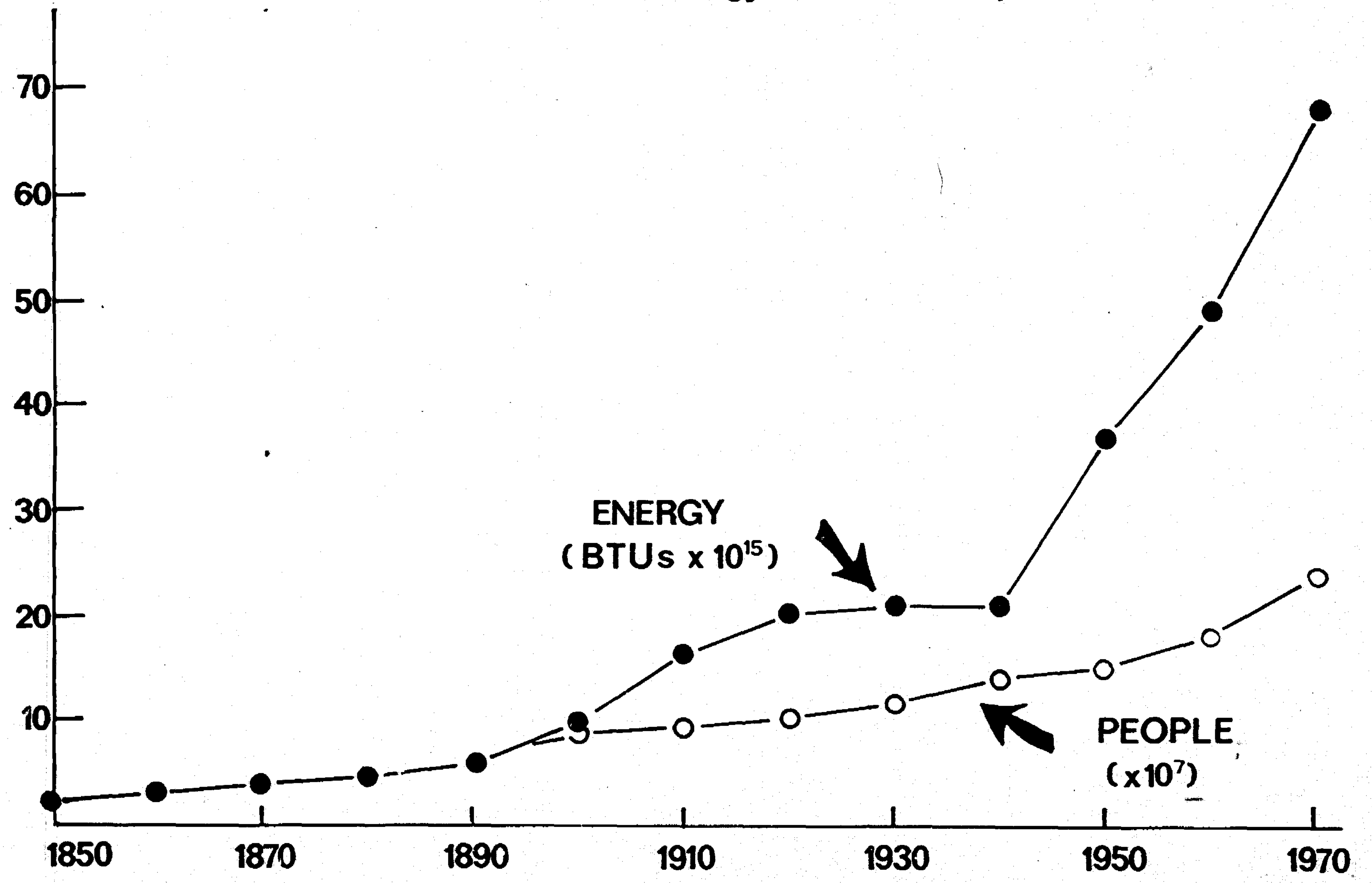


Petroleum

How Does the U.S. Use Its Energy?



Growth of American Energy Use and Population



GLOSSARY

Acre-Foot: A volume of water one foot in depth covering an area of one acre.

Activation: The process of making a material radioactive by bombardment with neutrons, protons, or other nuclear particles or photons.

AEC (The U. S. Atomic Energy Commission): The independent civilian agency of the federal government with statutory responsibility for atomic energy matters. Also the body of five persons, appointed by the President, to direct the agency.

Alpha Particle (Symbol α): A positively charged particle emitted by certain radioactive materials. It is made up of two neutrons and two protons bound together. Hence, it is identical with the nucleus of a helium atom. It is the least penetrating of the three common types of decay radiation.

Ampere: Unit of electric current approximately equivalent to the flow of 6×10^{18} electrons per second.

Ampere-Hour: The amount of electricity flowing per hour through a conductor when current in it is one ampere.

Atom: A particle of matter whose nucleus is indivisible by chemical means. It is the fundamental building block of the chemical elements.

Background Radiation: The radiation in man's natural environment, including cosmic rays and radiation from the naturally radioactive elements, both outside, and inside the bodies of humans and animals. It is also called natural radiation. The term may also mean radiation that is unrelated to a specific experiment.

Beta Particle (Symbol β^-): An elementary particle emitted from a nucleus during radioactive decay, with a single electrical charge and a mass equal to 1/1837 that of a proton. A negatively charged beta particle is identical to an electron. A positively charged beta particle is called a positron. Beta radiation may cause skin burns, and beta-emitters are harmful if they enter the body. Beta particles are easily stopped by a thin sheet of metal.

Boiling-Water Reactor (BWR): A type of nuclear power reactor in which the steam produced by water flowing through the core is used to drive a turbine directly.

Breeder Reactor: A nuclear reactor which produces more fuel than it consumes. In such a reactor, the reactor core is surrounded with a "blanket" of fertile material such as uranium-238 or thorium-232, materials which are not fissionable naturally. Neutrons in excess of those required to sustain the fission chain reaction in the core enter the nuclei of atoms of the fertile materials and render such nuclei fissionable and, therefore, useful as fuel for other reactors.

British Thermal Unit (BTU): The amount of energy necessary to raise the temperature of one pound of water by 1° Fahrenheit at or near 39.2°F.

Calorie: Unit of quantity of heat. The amount of heat required to raise the temperature of one gram of water through 1° Centigrade.

Circuit: The complete path traversed by an electric current.

Coal: A solid, combustible, organic material formed by the decomposition of vegetable material without free access to air.

Coal Gas: An artificial gaseous fuel produced by heating coal in the absence of oxygen. This fuel, known as town gas, can supply about 450 BTU per standard cubic foot. Use of coal gas in the U. S. ceased when inexpensive natural gas became widely available.

Combustion: Burning.

Conduction, Thermal: The transmission of heat through a substance from places of higher to places of lower temperature.

Conductor, Electrical: Body capable of carrying an electrical current.

Conserve: Save.

Crude Oil: Petroleum liquids as they come from the ground. Petroleum liquids were formed from animal and vegetable material which collected at the bottom of ancient seas.

Curie (Ci): The unit of radioactivity. Any quantity of radioactive material in which 37 billion atoms are disintegrating every second is said to have an activity of one curie.

Deuterium: A form of hydrogen atom in which the nucleus contains one proton and one neutron. About 0.0156% of all hydrogen atoms have such nuclei. Deuterium is expected to be the primary fuel for fusion power plants.

Diesel Oil: The oil left after petrol and kerosene have been distilled from crude petroleum.

Electric Current, Heating Effect: When an electric current flows through a conductor of finite resistance, heat energy is continuously generated at the expense of electrical energy.

Electric Power: The rate of doing work. Measured in watts.

Electrical Energy: The energy associated with electric charges and their movements. Measured in watt-hours or kilowatt hours. One Watt-hour equals 860 calories.

Electrometer: Instrument for measuring voltage differences.

Electron Volt (eV): A unit of energy equal to the kinetic energy gained by an electron as it moves through a potential difference of one volt.

Emergency Core Cooling System (ECCS): The system which provides an emergency supply of cooling water to the core of a nuclear reactor in the event that the heat transfer fluid normally used is suddenly lost.

Energy: Energy is the capacity for doing work and, therefore, energy and work are measured in the same units. Commonly used units of work and energy are the joule, BTU, calorie, foot-pound, electron volt, watt-hour, and kilowatt-hour (kwh).

Enrichment: The process of increasing the concentration of fissionable uranium-235 in natural uranium from its normal level of about 0.7% to the concentration required to sustain fission in a nuclear reactor, generally more than 3%.

Exponential Growth: A quantity exhibits exponential growth when it increases by a constant percentage of the whole during a constant time period. A colony of bacteria in which each bacterium divides into two bacteria every ten minutes grows exponentially.

Fahrenheit Degree: 1/180 of the difference between the temperature of melting ice and that of water boiling under standard (760 mm) atmospheric pressure.

Fast Breeder Reactor: A breeder reactor in which the breeding neutrons are traveling at high velocities. The principal nuclear reaction envisioned for most proposed fast breeders is conversion of nonfissionable U-238 to fissionable plutonium-239.

Fission: The splitting apart of an atomic nucleus into two smaller nuclei. The process is initiated by the capture of a neutron by the nucleus of a fissionable atom. The fissioning nucleus, in turn, emits one to three neutrons which can initiate fission in other nuclei, and produce a chain reaction.

Fossil Fuel: Naturally occurring substances derived from plants and animals which lived in ages past. The bodies of these long dead organisms have become our recoverable fuels which can be burned such as lignite, coal, oil, and gas.

Fuel: A substance used to produce heat energy, chemical energy by combustion, or nuclear energy by nuclear fission.

Fuel Cell: A device in which hydrogen is fed to an electrode where it is catalytically converted to hydrogen ions, releasing electrons to flow through an external circuit (the load). The electrons flowing through the external circuit constitute an electric current. When they return to another electrode in the fuel cell, they combine with oxygen atoms which in turn migrate to the first electrode and unite with hydrogen ions to form water. The process is, essentially, the reverse of electrolysis.

Fuel Oils: Fuel oils are the petroleum fractions with a higher boiling range than kerosene. They are generally classified as distillates or residuals. Distillates (Nos. 1, 2, and 4) are the lighter oils used primarily for central heating of homes, small apartment houses, commercial buildings, and for transportation. Residuals (Nos. 5 and 6), often called bunker oils, are heavier, high viscosity oils which usually need to be heated before they can be pumped. They are used in industry, large commercial buildings, and for the generation of electricity.

Fusion: The process in which two atomic nuclei combine to form a larger nucleus whose mass is less than the aggregate mass of the original nuclei. The lost mass appears as energy. Because of repulsive electrical forces between their protons, nuclei will not combine unless they are traveling toward one another at tremendous velocities. Initiation of the process, therefore, requires very high temperatures.

Gamma Rays (Symbol γ): High energy, short wave length electromagnetic radiation originating in the nucleus. Gamma radiation frequently accompanies alpha and beta emissions and always accompanies fission. Gamma rays are very penetrating and are best stopped or shielded against by dense materials such as lead or depleted uranium. Gamma rays are essentially similar to X-rays, but are usually more energetic.

Gas-Cooled Reactor (GCR): A type of nuclear power reactor in which a gas, usually helium, flows through the reactor core, becomes heated, and then gives up its heat to produce steam in a separate vessel. The steam is then used to drive a turbine.

Gas Turbine: An engine which converts chemical energy of liquid fuel into mechanical energy by combustion. Gases resulting are expanded through a turbine.

Gasoline: Petrol. Mixture of hydrocarbons obtained from petroleum.

Generator: A machine for producing electrical energy from mechanical energy.

Geothermal Energy: Heat energy in the crust of the earth believed to have been produced by natural radioactivity. The thermal gradient of the earth's crust is such that the temperature in a deep well or mine increases by about 1°F for each 100 feet of depth. At a place where the average surface temperature is 50°F, a temperature of about 212°F could be expected at a depth of about 16,000 feet.

Half-Life: The time in which half the atoms of a particular radioactive substance disintegrate to another nuclear form. Measured half-lives vary from millionths of a second to billions of years. Also called physical half-life.

Heat: Energy possessed by a substance in the form of kinetic energy, usually measured in calories--in space heating by the British Thermal Unit. Heat is transmitted by conduction, convection, or radiation.

Heat Pump: A device which transfers heat from a colder to a hotter reservoir by the expenditure of mechanical energy when the primary purpose is heating the hot reservoir rather than refrigerating the cool reservoir. A heat pump is a reversed refrigeration apparatus. Heat pumps are far more efficient for residential heating than electrical resistive heating.

High Tension: High voltage.

Horsepower: British unit of power. 1 hp = 746 watts.

Hydro: Prefix denoting water.

Hydroelectric: Electricity production by water-powered turbine generator.

Illumination Of A Surface: The amount of light falling per second on unit area of the surface. Measured in lumens per unit area.

Internal-Combustion Engine: Energy is supplied by a burning fuel which is directly transformed into mechanical energy by controlled combustion.

Irradiation: Exposure to radiation as in a nuclear reactor.

Kerosene: The petroleum fraction containing hydrocarbons that are slightly heavier than those found in gasoline and naptha, with a boiling range between 180° and 300°C. Used today as fuel for gas turbines and jet engines.

Kilowatt (kw): The unit of power equal to 1000 watts. Roughly a power of one kw is capable of raising the temperature of a pound (pint) of water 1°F in one second.

Kilowatt-hour (kwh): The amount of work or energy delivered during the steady consumption of one kilowatt of power for a period of one hour.

Laser-Induced Fusion: A proposed process in which the high temperature required to initiate fusion is produced by bombarding frozen pellets of deuterium and tritium with intense bursts of radiation from one or more lasers.

Liquefied Natural Gas (LNG): Natural gas that has been cooled to about 160°C for storage or shipment as a liquid. Liquefaction greatly reduces the volume of a gas and, thus, the cost of shipping and storage is reduced.

Liquefied Petroleum Gas (LPG): Consists of propanes and butanes recovered from natural gas and in petroleum refining. Its energy content ranges between 2000 and 3500 BTU per standard cubic foot. Sometimes called "bottled gas." Used widely as a fuel for internal-combustion engines when pollution must be minimized and as a substitute for natural gas in areas not served by pipelines.

Liquid Metal Reactor (LMR): A type of nuclear power reactor in which a liquid metal such as sodium flows through the reactor core, is heated, and delivers the heat to produce steam in a separate vessel containing water.

Load: The power and energy requirements on the electric power system in a designated area.

Mega-: A prefix that multiplies a basic unit by 1,000,000.

Megawatt (MW): A unit of power equal to 1000 kilowatts or one million watts.

Megawatt Month: A unit of energy equal to one megawatt of power flowing continuously for an average month of 30.4 days or 730 hours.

Mev: One million (10^6) electron volts. Also written as MEV.

Milli-: A prefix that multiplies a basic unit by 1/1000.

Naptha: A petroleum fraction with a boiling point ranging from 125° to 240°C. Its principal uses are in solvents, paint thinners, and as a raw material for the production of organic chemicals. It is expected to be used more and more as a raw material for the production of synthetic natural gas.

Natural Gas: A gaseous fossil fuel usually found associated with oil. It is made up of about 60% to 80% methane, 5% to 9% ethane, 3% to 18% propane, and 2% to 14% heavier hydrocarbons. Some nonhydrocarbons such as nitrogen, carbon dioxide, and hydrogen sulfide are sometimes present. Propane and the heavier hydrocarbons are usually removed and sold as liquefied petroleum gas. Pipeline natural gas is principally methane and has an energy content of 980 to 1050 BTU per standard cubic foot.

Nuclear Energy: Atomic energy released during a nuclear reaction.

Nuclear Power: Electric power produced from a power plant obtaining energy from nuclear reaction.

Neutron: An electrically neutral particle with slightly more mass than a proton. All atomic nuclei except hydrogen-1 contain neutrons. Because neutrons have no electric charge, they can wander freely through matter. Neutrons are not emitted in radioactive decay of atoms, but are emitted in both fission and fusion.

Oil Shale: A sedimentary rock which contains an oil-yielding organic material called kerogen. When heated, oil shale may yield as much as 60 gallons of oil per ton of rock.

Output: The amount of power and energy delivered from a generating station or stations during a specified period.

Petroleum: Mineral oil. Fractional distillation yields gasoline, diesel, lubricating oil, and other products.

Photosynthesis: The process in which sunlight falling on green plants causes carbon dioxide and water to be converted into more complex organic materials such as glucose.

Photovoltaic Cell: A type of semiconductor device in which the absorption of light brings about a separation of electric charges. Such a separation produces a voltage which can be used to set up an electric current in an external circuit, thus, directly converting radiant energy to electrical energy. Materials which can be used in the construction of photovoltaic cells are silicon, cadmium sulfide, and gallium arsenide.

Power: The rate at which work is done, therefore, the rate at which energy is transferred. Power is measured in units of work per unit of time. Typical units are the watt and the horsepower.

Power Pool: A group of electric power suppliers whose transmission lines are interconnected.

Pressurized-Water Reactor (PWR): A type of nuclear power reactor in which water circulating through the core is kept under sufficient pressure to prevent boiling of the water. The heated reactor water passes through tubes which are surrounded with a vessel containing water which is allowed to be heated to steam which is then used to drive a turbine.

Propane: Inflammable gas obtained from petroleum.

Pumped Hydroelectric Storage: The only means now available for the large-scale storage of electrical energy. Excess electricity produced during periods of low demand is used to pump water up to a reservoir. When demand is high, the water is released to operate a hydroelectric generator. Pumped energy storage returns only about 66% of the electrical energy put into it, but costs less than an equivalent generating capacity.

Radioactivity: The spontaneous change of atomic nuclei from one nuclear species to another. Such changes are always accompanied by the emission of corpuscular or electromagnetic radiation or both. These emissions are called alpha, beta, and gamma radiations. Alpha radiations are positively charged helium nuclei (2 protons and 2 neutrons) having velocities from 5% to 7% that of light. Beta radiations are negatively and positively charged electrons which may have velocities up to about 99.9% of the speed of light. Gamma radiations are electromagnetic, thus, they are of the same nature as X-rays and light.

Reservoir: Water storage lake behind a dam.

Reservoir Capacity: The usable volume of a reservoir available for the storage and release of water for power generation.

Run-Off Season: The period of the year when natural flows in streams are supplemented by accelerated snow and ice melt from mountain packs.

Snowpack: The winter accumulation of snow in mountain areas which will melt and run off into streams and rivers.

Solar Cell: An electric cell which converts radiant energy from the sun into electrical energy.

Solar Energy: The energy produced by the fusion reaction occurring on the sun, which reaches the earth as radiant energy. This energy may be converted into heat or electricity by physical devices.

Spill: The discharge of water through gates, spillways, or conduits which bypass the hydroplant's turbines.

Steam Engine: A machine which is powered by steam. It can be either turbine or reciprocating.

Stream Flow: The rate of water flow past a given point.

Synthetic Natural Gas (SNG): A gaseous fuel manufactured from naptha or coal. It contains 95% to 98% methane, and has an energy content of 980 to 1035 BTU per standard cubic foot, about that of natural gas.

Standard Cubic Foot (SCF): The amount of gas contained in a volume of 1 cubic ft. under a pressure of 1 atmosphere (14.73 lbs. per sq. in.) at a temperature of 60°F.

Thermonuclear Reaction: A reaction in which very high temperatures allow the fusion of two light nuclei to form the nucleus of a heavier atom, releasing a large amount of energy. In a hydrogen bomb, the high temperature to initiate the thermonuclear reaction is produced by a preliminary fission reaction.

Thermostat: An instrument for the purpose of maintaining a constant temperature.

Transmission Lines: Wires or cables through which electric power is moved from point-to-point.

Tritium: A form of hydrogen atoms whose nuclei contain 1 proton and 2 neutrons. Tritium is radioactive with a half-life of 12.4 years and spontaneously changes to helium-3 with the emission of a negative beta particle. Tritium is expected to be used as a fuel in fusion power plants.

Turbine: A motor, the shaft of which is rotated by a stream of water, steam, air, or fluid from a nozzle and forced against blades of a wheel.

Turbogenerator: An electric generator powered by steam turbine engine. The steam created by heat from combustible materials (coal, oil, natural gas or other) or from a heat source beneath the earth's surface (geothermal).

Volt: Unit of electromotive force moving electrical energy through a conductor.

Voltage: The amount of electromotive force of a quantity of electricity, measured in volts.

Voltmeter: The instrument for measuring electromotive force. The unit of measurement is volts.

Watt: The unit of measure for electric power. Wattage of electric power-operated equipment or devices is determined by multiplying required volts by required amperes (volts x amps). (1 horsepower = 746 watts)

Watt-Hour: Work done at the rate of 1 watt for 1 hour.

Watt-Meter: The instrument for measuring electric power. Measurement is in watts.

Work: Work is done whenever a force is exerted through a distance. The amount of work done is the product of force and distance. The metric unit of work is the joule (J). When a force of 1 Newton is exerted through a distance of 1 meter, 1 joule of work is done.

*SELECTED READINGS AND FILMS FOR EDUCATORS**

Introduction

The energy crisis presents both a challenge and an opportunity for the education community; not as an elite enjoying the aura of superior knowledge, but as members of society with a critically important job to do while there is time. Our obligation, as educators, should be to recognize that the energy crisis is real, that it will be with us for a long time, and that through calm action and an understanding of the issues involved, we can cope with this dilemma. The following readings should provide food for thought for school planners, board of education members, administrators, teachers, curriculum planners, and all others interested in education.

Books & Pamphlets

Congressional Quarterly, Inc. ENERGY CRISIS IN AMERICA. Washington, D. C.: The Quarterly, 1973, 93 pp.
A national look at the current energy crisis including recent Congressional studies is presented. Charts, tables, and a bibliography are included.

Curtis, Richard and Logan, Elizabeth. PERILS OF THE PEACEFUL ATOM. New York: Doubleday, 1969.
Negative aspects of nuclear power are presented in this book.

Fowler, J. M. and Mervine, K. M. ENERGY AND THE ENVIRONMENT. College Park, Md.: University of Maryland, 1973.
A kit of materials chiefly for science teachers is presented. Among the topics covered are: (1) Energy: Where It Comes From and Where It Goes; (2) Environmental Effects of Energy Use; (3) Resources and New Sources.

Guyol, Nathaniel B. ENERGY IN THE PERSPECTIVE OF GEOGRAPHY. Englewood Cliffs, N. J.: Prentice-Hall, 1971, 156 pp.
This book covers the factors that influence quantities of energy used and the selection of energy sources. World energy supply and demand are covered. Tables and suggestions for additional reading are included.

Hammond, Allen L. and others. ENERGY AND THE FUTURE. Washington, D. C.: American Association for the Advancement of Science, 1973.
The authors present a comprehensive introduction to each of the chief present and anticipated energy sources, the problems of delivering energy to the consumer, energy conservation, and energy policy matters.

Holdren, John and Herra, Philip. ENERGY: A CRISIS IN POWER. San Francisco: Sierra Club, 1971, 252 pp.
A Sierra Club battlebook, this volume deals with our present resources and consumption problems, following up with suggested resolutions. Case studies are included.

*Prepared by: Research & Information Center, State Department of Public Instruction, Raleigh, North Carolina 27611

Meadows, Donella H. and others. THE LIMITS TO GROWTH. New York: Universe Books, 1972.
The concept that growth implies progress is challenged.

Novick, Sheldon. THE CARELESS ATOM. Boston: Houghton-Mifflin, 1969.
Suitable for a high school science student who wishes to explore the matter independently, this book is critical of nuclear power.

Rocks, Lawrence E. and Runyon, Richard P. THE ENERGY CRISIS. New York: Crown, 1972, 189 pp.
The authors deal with the rapid depletion of our natural resources and impending power shortages.

Rodgers, William. BROWNOUT: THE POWER CRISIS IN AMERICA. New York: Stein & Day, 1972, 300 pp.
Rodgers discusses the energy crisis with reference to recent occurrences and data and suggests a sane policy for the future.

Scientific American Editors. ENERGY AND POWER. San Francisco: W. H. Freeman, 1971, 144 pp.
Essays on force, energy, and power resources appear in this volume.

Periodicals

Abelson, Philip H. "Energy and National Security," SCIENCE 179:857, March 1973.
The need for a broad and detailed government policy on energy use is discussed in this editorial. Oil companies cannot be given complete responsibility to demonstrate usage of different energy sources. The government should construct plants because energy is connected with national security, states the author.

Adelman, M. A. "Energy: A Complex Mass of Problems," VITAL SPEECHES 39:516-521, June 15, 1973.
A MIT professor of economics states that the energy crisis is not a question of supply, but rather a question of cost.

"America's Energy Crisis: Ways People and Companies Beat It," U. S. NEWS 75:51-53, September 10, 1973.
Ideas for saving power, gas, and other fuels are catching on.

Aspin, Les. "The Shortage Scenario: Big Oil's Latest Gimmick," THE NATION 216:775-777, June 18, 1973.
The author claims that the petroleum shortage was engineered by major oil companies to increase profits.

Auer, P. L. and Sudan, R. N. "Progress in Controlled Fusion Research," SCIENCE TEACHER 39:44-50, March 1972.
Resource materials on energy, nuclear physics, and fusion are presented. These materials are for secondary school science students.

Berg, Charles A. "Energy Conservation Through Effective Utilization," SCIENCE 181:128-138, July 13, 1973.
How energy consumption could be reduced by efficiency is the topic.

Berg, George G. "Hot Wastes from Nuclear Power," ENVIRONMENT 15:36-44, May 1973.
Radiation effects from nuclear waste disposal are a very serious concern and should be kept in mind by those pushing for nuclear power.

Carter, Luther J. "Alaskan Oil: Court Ruling Revives Canada Pipeline Issue," SCIENCE 179:977-981, March 1973.
Court litigation, the petroleum industry, energy, and the environment are discussed in this article.

"The Control of Lighting Heat," MODERN SCHOOLS, pp. 3-5, April 1973.
The trend toward increased lighting has accelerated the acceptance of heat recovery systems. A heating-lighting-cooling system is a responsible and efficient use of energy for future school buildings.

Cook, Earl. "The Flow of Energy in an Industrial Society," SCIENTIFIC AMERICAN 225:134+, September 1971.
The U. S., with 6% of the world's population, uses 35% of the world's energy. In the long run, the limiting factor in high levels of energy consumption will be the disposal of the waste heat.

Deem, Robert. "Jelly Bean Ecology," SCIENCE AND CHILDREN 10:12-14, March 1973.
The concept of energy consumption can be learned by role playing, using jelly beans as units of energy with children as primary, secondary, and tertiary consumers. Follow-up questions are suggested for further discussion.

Dyson, Freeman J. "Energy in the Universe," SCIENTIFIC AMERICAN 225:50, September 1971.
The energy flows on the earth are embedded in the energy flows in the universe. A delicate balance among gravitation, nuclear reactions, and radiation keep the energy from flowing too fast.

"The Energy Crisis: Time for Action," TIME 101:41-42, May 7, 1973.
Ways for business and individuals to cut consumption and transportation problems are investigated. New energy sources are suggested.

ENERGY DIGEST, all issues. (Published twice monthly by SCOPE PUBLICATIONS, INC., 1132 National Press Building, Washington, D. C. 20004--$125.00 per year.)

"The Energy Savers: Heat Recovery Wheels," MODERN SCHOOLS, pp. 3-5, May 1973.
The operation and benefits of equipment designed to salvage, collect, store, and generally conserve heat energy are described.

"Enough Energy--If Resources Are Allocated Right," BUSINESS WEEK, pp. 50-58, April 21, 1973.
Suggested changes in the allocation of resources are discussed.

Gates, David M. "The Flow of Energy in the Biosphere," SCIENTIFIC AMERICAN 225:88, September 1971.
Solar energy and photosynthesis are the subjects of this article.

Glaser, Peter E. "Solar Energy--Prospects for Its Large-Scale Use," SCIENCE TEACHER 39:36-39, March 1972.
The possibility of solar energy as a solution to the energy crisis is discussed. The advantages of power without pollution are stressed.

Hammond, Allen L. "Solar Energy: Proposal for a Major Research Program," SCIENCE 179:1116, March 1973.
Research needs and problems connected with solar energy are examined.

Hardy, Andrew. "The Energy Crisis of 1593," INTELLECTUAL DIGEST 4:20-21, January 1974.
The article presents a historical perspective to the current shortage. Hardy points out that the wood shortage led to the Industrial Revolution. He suggests that today we may be on the brink of a new technology.

Hirst, Eric. "Energy vs. Environment," THE LIVING WILDERNESS 36:43-47, Winter 1972-73.
A call to reexamine growth goals to reduce energy consumption is made.

Hirst, Eric and Moyers, John C. "Efficiency of Energy Use in the United States," SCIENCE 179:1299-1304, March 1973.
Ways to reduce energy consumption in transportation, space heating, and air conditioning are described. Greater efficiency for energy use from an energy point of view is possible in present circumstances.

Holden, Constance. "Energy: Shortages Loom, But Conservation Lags," SCIENCE 180:1155-1158, June 1973.
It is argued that immediate steps need to be taken in order to buy time until new, clean power sources become available.

Hubbert, M. King. "The Energy Resources of the Earth," SCIENTIFIC AMERICAN 225:60, September 1971.
They are solar energy (current and stored), the tides, the earth's heat, fission fuels and possibly fusion fuels. From the standpoint of human history, the epoch of the fossil fuels will be quite brief.

Katz, Milton. "Decision-Making in the Production of Power," SCIENTIFIC AMERICAN 225:191, September 1971.
It is only recently that men have begun to consider how they can reconcile human needs for energy with the finiteness of the earth. Such a reconciliation will engage all the institutions of society.

Kemp, William B. "The Flow of Energy in a Hunting Society," SCIENTIFIC AMERICAN 225:104, September 1971.
Early man obtained food and fuel from the wild plants and animals of his environment. How the energy from such sources is channeled is investigated in a community of modern Eskimos on Baffin Island.

Kramer, Eugene. "Energy Conservation and Waste Recycling: Taking Advantage of Urban Congestion," BULLETIN OF THE ATOMIC SCIENTISTS 29:13-18, April 1973.

Lincoln, G. A. "Energy Conservation," SCIENCE 180:155-162, April 1973.
This article is directed toward provoking thought on how to attain economic and social objectives while using fewer energy sources.

Loftas, Tony. "Which Way to the Energy Gap?" CERES 6:155-162, April 1973.
The higher cost of energy in the future might well dampen the current ardor for industrialization.

Lovins, Amory B. "The Case Against the Fast Breeder Reactor: An Antinuclear Establishment View," BULLETIN OF THE ATOMIC SCIENTISTS 29:29-35, March 1973.
Environmentalists' lobbies point out that hazards which may result from mistakes in proposed fast breeder reactor for additional energy can be detrimental for mankind. Such projects must be carefully planned and cautiously executed.

Luten, Daniel B. "The Economic Geography of Energy," SCIENTIFIC AMERICAN 225: 164, September 1971.
The human uses of energy are reflected in patterns on the land. The prospecting, recovery, movement and ultimate use of energy resources are governed by the ratio of the benefit to the cost.

McCormack, Mike. "Energy Crisis--An In-Depth View," CHEMICAL AND ENGINEERING NEWS 51:1+, April 1973.
It is argued that the energy crisis can only be resolved with a many-faceted energy R & D program as part of a coordinated national energy policy.

Meinel, Aden B. and Marjorie P. "Physics Looks at Solar Energy," PHYSICS TODAY, 25:44-50, February 1972.
Topics of discussion include electricity, energy, physics, radiation, utilities, and light.

Muffler, L. J. P. and White, D. E. "Geothermal Energy," SCIENCE TEACHER 39: 40-43, March 1972.
The possible utilization of geothermal energy as a partial solution to the energy crisis is discussed.

Novick, Sheldon. "Looking Forward: Saving the Environment Through More Efficient Use of Energy," ENVIRONMENT 15:4-15, May 1973.
How we might clean up our environment and save our resources is the topic of this article, which contains a bibliography.

Phipps, H. Harry. "New Schools Need New Energy Concepts," AMERICAN SCHOOL & UNIVERSITY 45:34-36, January 1973.
Those planning educational facilities should recognize the vital importance of energy conservation and its future effects on both the ecology of the nation and the economics of the school.

"Photosynthesis May Be Source for Fuels," CHEMICAL AND ENGINEERING NEWS 51:20, April 1973.
Among the topics discussed in this article are photosynthesis, resource materials, fuels, fuel consumption, energy, and the environment.

Post, Richard F. "Prospects for Fusion Power," PHYSICS TODAY 26:31-39, April 1973.
Some recent experimental results have given a clearer sense of direction and renewed optimism for research on controlled thermonuclear reactions.

Reid, William T. "Relative Costs of Energy," PHYSICS TEACHER 9:459-461, November 1971.
Resource materials covering economic factors of energy, fuel consumption, and electricity for secondary school science are presented.

Ritter, William W. "Geothermal Energy: Prospects and Problems," JOURNAL OF ENVIRONMENTAL HEALTH 35:432-435, March/April 1973.
An examination of geothermal energy as a means of increasing the United States' power resources with minimal pollution problems is presented.

Rittleman, P. Richard. "The Energy Crisis, How Schools Make It Worse, and Why Boards Must Help Put a Stop to Fuel Waste," AMERICAN SCHOOL BOARD JOURNAL 160:49-52, February 1973.
The major topics covered in this article include fuel consumption, thermal environment, lighting, lighting design, exhausting, and electricity.

Runyon, Richard P. and Rocks, Lawrence. "Lights Are Going Out; Nixon's Energy Proposals," NATIONAL REVIEW 25:728-730, July 6, 1973.
An analysis of the inadequacies of Nixon's "energy policy" is given with suggestions for the future.

"The Schools and The Energy Shortage," INSTRUCTOR 83:18, January 1974.
This timely editorial stresses that the comfort and health of students and teachers should be a primary concern. Further, it cautions against seeking ultimate solutions. Rather, students should be encouraged to understand the issues involved in the energy crisis. Samples of questions for classroom debate and study include: (1) What proportion of our petroleum needs are supplied from our own natural resources?
(2) What is shale? (3) Why isn't more coal used to produce energy?
(4) What are some pros and cons of the Alaskan Pipeline; strip-mining?
(5) What are some alternative sources of energy?

Shepherd, Jack. "Energy 9: The New Values," INTELLECTUAL DIGEST 3:21-22, August 1973.
We may be able to save the quality of our lives by cutting back on the quantity, believes Russell Peterson, former Governor of Delaware. This interview suggests that an era of abundance ends as our energy resources run out and that beginning again calls for a fresh approach to living.

________. "Energy 8: Sun Power," INTELLECTUAL DIGEST 3:19-22, July 1973.
Potentially, the sun is a power source for 2/3 of the U. S. This segment of INTELLECTUAL DIGEST's series on energy urges research investment now for payoff in 10-15 years.

________. "Energy 7: The Alternatives," INTELLECTUAL DIGEST 3:21-24, June 1973.
Has anyone thought of power from natural steam or wind? Geothermal expert, Richard G. Bowen, and windmill advocate, Frank Rom, explore the energy crisis.

________. "Energy 6: The Squeeze," INTELLECTUAL DIGEST 3:20-22, May 1973.
The crisis? Largely the result of government interference, says the chairman of Continental Oil Company. Another perspective (that of an oil industry official) is presented in this exclusive series.

________. "Energy 5: Waste," INTELLECTUAL DIGEST 3:21-24, April 1973.
There are alternatives to "energy-gobbling" skyscrapers. The perceptions of architect Richard G. Stein reveal the efficiencies and joys of natural light and climate. Architecture, which influences energy use more than

any other component of the economy except transportation and the military, can cut back on much of the energy demanded for the operation and maintenance of a building, says Stein.

"Special Report: Energy Crisis," special section. NATION'S SCHOOLS 93:31-54, January 1974.
The section is divided into five parts--coping with the crisis, what schools are doing, ways to start saving energy, news and views on lighting research and design, and if worse comes to worse.

Starr, Chauncey. "Energy and Power," SCIENTIFIC AMERICAN 225:36, September 1971.
Man's expanding need for energy creates difficult economic, social, and environmental problems. The solutions call for sensible choices of technological alternatives by the market and political process.

Summers, Claude M. "The Conversion of Energy," SCIENTIFIC AMERICAN 225:148, September 1971.
The efficiency of home furnaces, steam turbines, automobile engines, and light bulbs all help to fix the demand for energy. A major need is a kind of energy source that does not add to the earth's heat load.

Udall, Morris K. "Future Fuels: Ending the Energy Binge," THE NEW REPUBLIC 168:12-15, June 16, 1973.
Analysis of the current crisis with suggestions for new energy sources is presented.

Weinberg, Alvin M. "Some Views of the Energy Crisis," AMERICAN SCIENTIST 61:59-75, January/February 1973.
Plans for the future, energy sources, and conversion techniques are followed by a bibliography.

Films

The following seven films, if purchased as a package, sell for $1,675. Purchased separately, their cost would be $1,870. The full series rents for $150. Prints are available for preview prior to purchase from NBC Educational Enterprises, 30 Rockefeller Plaza, New York, N. Y. 10020.

"Coal." 27 minutes, 16 mm, color. Purchase--$330; rental--$30.
Our most plentiful fossil fuel but also the dirtiest and most destructive to mines.

"The Environment." 11 minutes, 16 mm, color. Purchase--$180; rental--$20.
A brief introduction to the study of energy as it relates to the central issues of man's relationship with the world in which he lives.

"Future Fuels." 17 minutes, 16 mm, color. Purchase--$240; rental--$20.
By the end of this century new energy sources must be available. As of now, no one seems to be looking very hard.

"Natural Gas." 17 minutes, 16 mm, color. Purchase--$240; rental--$20.
The cleanest of all fossil fuels is also the one in most imminent danger of total depletion in the United States.

"Oil in the Middle East." 20 minutes, 16 mm, color. Purchase--$240; rental--$20.

Full gas tanks, warm houses, and international politics are mixed together as never before as the United States depends more and more on oil from the Arab world.

"Oil in the United States." 38 minutes, 16 mm, color. Purchase--$400; rental--$38.

The automobile, probably the most significant technological development of the 20th century, is rapidly running out of gas. OR is the whole thing a giant conspiracy by the giant oil producers?

"Power." 19 minutes, 16 mm, color. Purchase--$240; rental--$20.

Brownouts, blackouts, and battle over generating plant site locations have failed to dim our insatiable appetite for more and more electricity.