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ABSTRACT

The materials in this guide provide secondary level students (7-12 grade) the opportunity to become aware, knowledgeable, and motivated to find possible solutions to our urgent and complex energy related problems. Five interdisciplinary units are presented in the guide: Uses of Energy, Present and Future Sources of Energy, Conservation of Energy, Environmental Impact of Energy Related Activities, and Energy: Limits-Resource-Finitude. These units are flexible and are to be used by the secondary teacher subject to her/his plans and schedules. Each unit contains an overview, objectives, and suggested activities. The activities include such processes and skills as mathematical estimates, discussion, comparisons, creative writing, and inquiry and discovery activities. Also included in the guide are additional activities, appendices, energy related resources, and energy related terms. (TK)

ENERGY ACTIVITIES AND RESOURCES FOR THE SECONDARY STUDENT

ENVIRONMENTAL EDUCATION PROGRAM
KINGSPORT CITY SCHOOLS
Kingsport, Tennessee
19

SUPERINTENDENT OF SCHOOLS
Dr Ralph E. Evans

COORDINATOR OF ENVIRONMENTAL EDUCATION
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INTRODUCTION

The energy related materials in this publication have been designed for the secondary level (7-12) student. It is composed of several interdisciplinary activities. However, the activities have not been assigned to a specific grade level.

The amount of time devoted to these energy related materials depends on the teacher's plans and schedules. The materials are intended to enrich and enhance the existing curriculum.

The primary purpose of these resources is to create within the student an awareness of our energy related problems through involvement. If students become involved they are more likely to initiate an enthusiasm that will equip them with the tools and attitudes to meet and solve energy related problems which will be with them throughout their lives.

ACKNOWLEDGMENTS

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COMMITTEE

Mrs. Burma Lotts English Teacher	Mrs. Mary Moats Science Teacher
Mr Wesley Moricle Science Teacher	Mr Randall Jones Math Teacher

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Jack Rhoton
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UNIT I

USES OF ENERGY

Overview

Electric consumption and the standard of living have risen together in the American home, where major electric appliances--air-conditioners, clothes dryers, large refrigerators, and freezers--are becoming commonplace. In commerce there has also been an increased use of electrical appliances. In future years we also may use large supplies of electricity for urban mass transit. In fact, the use of energy for transportation has steadily increased. Twenty-five percent of the nation's energy is consumed in moving people and materials, and over 75 percent of this transportation energy goes to operate automobiles and trucks. Industry uses 40 percent of the nation's energy--more than either transportation or commercial and residential functions. Energy is necessary to extract minerals, refine resources, and perform the mechanical work of production. The production of manufactured goods and agricultural products increasingly depends on intensive uses of energy.

Today over 90 percent of our energy demands are met by fossil fuels--coal, petroleum, and natural gas. By the year 2000 they are expected to supply 70 percent and to be supplemented by nuclear power, which will provide another 25 percent. Oil is important for transportation and heat, and coal and natural gas are important for electrical generation and heat.

Objective

The student will develop a concept of the nature and role of energy in our society.

Suggested Activities

1. The student will list the number of light bulbs in his home and their wattage. During one evening, he should note the time each light is turned on and when it is turned off, and from this data calculate the kilowatt hours used by these light bulbs

2. The student will state which industry uses the most electric energy in Tennessee and why.

3. The student will identify any wood products used as a direct energy source in his home.

4. The student will arrange in order the amount of kilowatt hours per unit utilized by the following industries: pulp and paper, plywood, chlorine and caustic, iron and steel, phosphate fertilizers and aluminum.

5. The student will contrast the energy units required per passenger mile for each major form of transportation--automobile, bus, plane and train.

6. The student will describe the power source used to generate electricity for his home, school or city.

7. The student will trace the path of electric power from fuel origin to his home fuse box.

8. The student will discuss the social implication of the energy-use imbalance in the world today.

9. The student will diagram an incandescent light bulb and a vapor lamp, describing how each works He will then contrast their respective outputs of electric light and heat to those produced by other types of lamps, such as fluorescent tubes.

10. The student will diagram a fluorescent tube and explain how it works, contrasting its electric light and heat output to that produced by other types of lamps.

11. The student will describe the process of manufacturing a bicycle, including all energy sources.

12. The student will diagram and discuss at least two methods of space heating, including: oil, gas and electric, including forced-air, baseboard and hot water heat transfer methods.

13. The student will construct a simple radio and describe the sources of energy that could be used to operate it.

14. The student will describe quantities of energy used by basic manufacturing industries such as aluminum, iron, copper, etc.

15. The student will diagram and describe the operation of the internal-combustion engine.

16. The student will diagram and describe the operation of the diesel engine.

17. The student will diagram and discuss the operation of the steam turbine, such as might be found in steam-electric plants.

18. The student will state the percentage of electrical energy used in a specific state by the different classes of customer-residential, commercial, and industrial.

19. The student will compare the percentage of electrical energy used in his state against the percentage of electrical energy used in neighboring states.

20. The student will list several of the largest industrial users of electricity.

21. The student will evaluate the benefits to mankind derived from nuclear power generation. The student will also evaluate the harm which might result from nuclear power generation, including problems of nuclear-waste disposal.

22. The student will discuss the implication of using energy from a nonrenewable source to dispose of solid waste containing usable material.

23. The student will compare the lifestyle of an underdeveloped society with his lifestyle. He will consider the energy consumed, and discuss the difference.

24. The student will describe common food and toiletry packages and containers, listing energy sources required to produce them.

25. The student will discuss the political implications of the energy-use imbalance in the world today.

26. The student will determine the amount of electricity that is needed to supply his home, power his car, etc.

27. The student will build a device such as a light-powered electric motor using a photo cell, to convert sunlight into energy.

28. The student will have brainstorming sessions on how to use or conserve the sun's energy.

29. The student will write a paper on what changes would take place in his home if the electrical energy supply was reduced in half.

30. The student will determine, to the best of his ability, the amount of electrical energy wasted in his home and extrapolate this wasted energy to Kingsport and the nation.

31. The student will obtain data from the Kingsport Power Company so that he can calculate the amount of fossil fuel used to produce the wasted energy in the above activity.

32. The student will record in kilowatt-hours the amount of electricity used in his home and determine the distribution of this energy to the various electrical devices in his home and determine which devices could have their use limited.

33. The student will describe what he considers to be the most beautiful and the ugliest site or object in Kingsport. Ask the student to estimate the amount and type of energy used in the creation of both of these sites.

34. The student will make a simple motor and measure the amount of power it produces.

35. The student will list several factors that influence the demand for energy of the residential, commercial, industrial, transportation, and electrical market.

36. Energy is described as the capacity to do work, and work is considered to have occurred when a force causes an object to move.

37. The student will determine what kinds of work are done by the human body. For example:

    a. beating of the heart
    b. circulation of the blood
    c. walking
    d. running
    e. lifting
    f. breathing
    g. typing

38. The student will interview their grandparents or other older members of their community to get some insight into energy use patterns thirty, forty, and fifty years ago to determine:

    a. The size of the community

    b. The energy-requiring devices used by the people.

    c. The differences in lifestyle.

    d. The differences in energy cost

e. The mode of transporation and compare the energy requirements, products of the different modes of transportation today and waste products of the different modes of transportation today.

f. The extent of the concern for pollution and environmental degradation.

g. The ways the lifestyle of the person being interviewed have changed between his childhood and the present and the rate of its occurence.

39. The student will determine the extent energy-using activities in Kingsport contribute to the degradation of the environment:

a. Exhaust gases from internal combustion engines.

b. Smoke from industrial operations.

c. Heated effluent from industrial operations.

40. The student will ask the Kingsport Power Company for a copy of its annual report. The report has a statistical section detailing number of customers by class, energy lost and unaccounted for, and total energy requirements for the system. Calculate the percent of total sales each class accounted for. If available for a number of years, this data could be graphed. What can be reported from such information?

41. The student will divide into the following groups:

a. Manufacturers (Including textiles, aluminum, automobiles);

b. Conservationists, Sirra Club;

c. City, county and state planners;

d. Oil companies, coal mine owners, foresters, teachers, workers.

Each group must assert its right to control the production and use of the energy resources of the world and must defend its position.

42. Estimate the minimum amount of energy you would need for bare existence.

43. Evaluate the effect on the job market of a shift to nondisposable items.

44. Investigate stock-market trends and activities the last two years for three firms that produce energy products, or pollution-control systems. Make a graph of your findings. Who should see this graph? Give it to them.

UNIT II

PRESENT AND FUTURE ENERGY SOURCES

Overview

Between now and 2001, just 27 years away, the United States will consume more energy than it has in its entire history. By 2001 the annual U. S. demand for energy in all forms is expected to double, and the annual worldwide demand will probably triple. These projected increases will tax man's ability to discover, extract and refine fuels in the huge volumes necessary, to ship them safely to find suitable locations for several hundred new electric-power stations in the United States (thousands worldwide) and to dispose of effluents and waste products with minimum harm to himself and his environment. When one considers how difficult it is at present to extract coal without jeopardizing lives or scarring the surface of the Earth, to ship oil without spillage, to find acceptable sites for power plants and to control the effluents of our present fuel-burning machines, the energy projections for 2001 indicate the need for thorough assessment of the available options and careful planning of our future course. We shall have to examine with both objectivity and humanity the necessity for the projected increase in energy demand, its relation to our quality of life, the practical options technology provides for meeting our needs and the environmental and social consequences of these options. "Energy and Power," Scientific American.

Objective

The student will describe the principal energy sources in the environment.

The student will describe new energy sources and more efficient systems utilizing present energy sources which have potential promise for helping to alleviate the world energy crisis.

Suggested Activities

1. The student will name two components of the atmosphere that affects absorption of radiation from the sun.

2. The student will calculate the loss of energy and the efficiency occurring in transfer of energy in an automobile from its engine to the kinetic energy of the entire body.

3. The student will list all energy sources other than the sun and give pros and cons of their energy supplying ability.

4. The student will identify four renewable and four nonrenewal resources and be able to identify the sun as the resource basic to all life's energy.

5. The student will demonstrate that plant organisms are dependent on sun energy for photosynthesis.

6. The student will write a short paragraph briefly explaining the relationship of sun energy to fuel energy.

7. The study will, in writing, compare his community to an electrical circuit and explain what happens if one part stops, changes, etc.

8. The student will develop an experiment using sun energy and explain how his results can be applied to our technological society.

9. The student will make a chart illustrating the development of a given source of power and its delivery to the consumer.

10. The student will describe the limitations and advantages of tidal flows as a source of energy.

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

12. It has been suggested that tidal energy is a large untapped source of energy. The student will 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 recommendation.

13. The student will compare fission and fusion reactors for the production of electricity.

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

15. The student will 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.

16. The student will compile a list of the petroleum products refined from crude oil.

17. The student will collect data on the current rate of energy consumption and predict either the zero supply date or the steady state date for two or more sources of energy.

18. The student will write an essay which compares and contrasts modern and ancient concepts of the sun.

19. The student will describe the use of radioactive isotopes in medicine and industry.

20. The student will compare the employment requirements necessary to deliver comparable energy to a customer using:

    a. Coal
    b. Gas
    c. Wood
    d. Oil
    e. Hydroelectric
    f. Nuclear electric
    g. Coal/Electric
    h. Gas/Electric
    i. Oil/Electric
    j. Nuclear/Hydrogen

21. The student will contrast the effect of the sun-energy-photosynthesis reaction with the respiration use of energy by testing the O_2 production of algae in the light and dark bottles.

22. The student will explain how oil is transported from the Near East to Kingsport?

23. The student will list several basic energy sources and discuss to what degree they are convertible. For example:

a. coal
b. gas
c. oil
d. wood
e. moving water
f. natural gas
g. liquified petroleum products
h. geothermal energy
i. nuclear
j. gasoline
k. sunlight

24. The student will assess each of the energy sources identified above and discuss their advantages and disadvantages--aesthetically, environmentally, economically, and politically.

25. The student will identify energy sources and materials used in his school and estimate the daily per capita use rates of each.

a. Determine the amount of coal used.
b. Determine the amount of electricity used.
c. Determine other sources of energy and the amount used.
d. Determine the total energy demands on a daily basis.

26. The following represents promising new sources of electric energy for the future.

a. Liquid metal fast breeder reactor
b. fusion
c. geothermal energy
d. solar energy
e. wind
f. tidal power
g. fuel cells
h. trash power
i. (MHD) magnetohydrodynamics

List the advantages and disadvantages of each of these sources of energy.

27. The student will describe how uranium, thorium, plutonium and other radioactive elements are used as fuel for nuclear reactors:

a. boiling-water reactor
b. pressurized-water reactor
c. high-temperature gas-cooled reactor
d. Breeder reactor

(1) Liquid metal fast Breeder Reactor
(2) Other

28. The student will describe the limitations of geothermal sources of energy.

29. The student will measure the electrical output of a solar cell when it is exposed to direct sunlight and when it is covered. Cadmium sulfide cells are not appropriate because they merely change their resistance in different light levels

30. What aesthetics qualities should be considered for the use of a geothermal source of energy.

31. The student will plan a visit to a nuclear power plant. Find out the type of reactor it is, what fuel is used, what type of condensor cooling is employed (cooling tower, river, etc.), what is the transportation and disposition of spent fuel and radioactive waste. Discuss different types of reactors and cooling methods.

32. The astronauts use solar energy as a primary energy source on the moon. The energy is provided by a conversion of the sun's solar energy to electric energy This source has been suggested as an energy substitute for gasoline to provide power to autos. List some of the problems which would take place if autos were made to use solar energy. How could the problems be solved?

33. The student will list sources of energy used by men in historical sequence. Include nuclear, falling water, wind, natural gas, wood, geothermal, coal, tidal, oil, chemical, solar, electrolysis by nuclear power, and other hydrogen - producing means. How are you going to present this? What does it mean.

34. As a class project, build a fully functioning windmill and show the variety of uses the source of energy can provide and determine its limitations.

35. The student will select a major energy source and examine the transportation of that energy by visiting the actual sites of such transmission. Determine the cost, (environmental, economic, resource use and waste) of the transmission and compare findings with those of other members of the class.

36. The student will describe the concepts of the fusion reaction of:

a. lasers
b. magnetic fields
c. H_2 to H_e (fusion reactions)
e. MHD

37. The student will describe the use of solar energy through reflectors, greenhouse effects, absorption, solar-energy cells.

38. The student will describe concepts of solar energy used by plants.

39. The student will describe the utilization of solar energy by an orbiting space collection system.

40. The student will describe the concept of storing energy:

a. plants store sugar and starch
b. batteries store chemical energy
c. electrolysis can produce H_2 as a fuel which can be used directly in an energy cell to produce electricity with water as a waste or by-product.

41. The student will describe the processes and organizations which would support basic scientific research and applied technological research regarding a better use of energy resources.

42. The student will describe acceptable means of transmitting and storing energy. Include charged particles, laser, microwave and semiconductor transmission; also storing of hydro, fossil-fuel, chemical and nuclear energy.

43. The student will describe how our country could benefit by the reduction and ultimate ending of harmful pollution.

44. The student will describe alternative uses of hydrocarbons if alternative sources of energy are used.

45. Demonstrate a chain reaction using ping pong balls and many mouse traps. Relate it to fission reaction. Explain how it should be done.

46. Heat sugar on a piece of aluminum foil to demonstrate one compound giving off energy as it decomposes. Note how the water bubbles and boils off, leaving a carbon crust. Once the reaction starts, it continues to give off energy.

47. The student will pretend he is the program chariman of a local public-service club. Write a speech to explain a bond issue that calls for construction of a sewage treatment plant.

    a. Identify action groups in the community who might influence decisions concerning construction of such a plant.
    b. Attend a meeting of a municipal planning group.
    c. Collect information from such groups as the League of Women Voters and other organizations that might produce pamphlets and other materials on such a subject.
    d. Interview candidates for local office regarding their position on improvements in the municipal treatment of garbage and rubbish.

48. Obtain a copy of "Sitting of Nuclear Power Plants" from the Atomic Energy Commission. List the major factors involved in the siting of a nuclear power plant and relate each factor to aesthetic considerations.

49. Coal, oil and natural gas are used as essential ingredients in the manufacture of many everyday items, including plastics, synthetic fibers for clothes, etc. Bearing in mind that these hydrocarbons are available only in finite amounts, discuss the energy mix (the relative percentages of different fuels).

50. Discuss the use of sewage and garbage in a municipal composting operation. Identify the roles of sewage and garbage and the complementary effects of each.

51. Use lead foil and electrolyte of Na_2SO_4.

    Let lead electrodes extend from foil which is coiled with cardboard or paper towels to prevent a short circuit. Change the batteries with an electric battery charger. Use a lead storage battery to run a light bulb, electric mower, etc.

52. Go to the City or County Planning Commission. Examine land use plans. Examine topographic maps with drainage patterns and determine the best locations for the county dumps and sewage treatment plants. Compare with actual locations.

53. After determining the site requirements of a nuclear-fueled power plant and after considering human aesthetic needs, design a setting for that plant and build a model of it Then unite a set of guidelines for human aesthetic site requirements.

54. The student will write a proposal for a research project that will help to alleviate a forthcoming local energy crisis. The proposal should include:

a. a problem statement
b. clearly quantified delineation of the need
c. proposed hypothesis or objectives
d. budget
e. procedures
f. personnel needs
g. on evaluation design

Find what sources might be available for funding such a project.

UNIT III

CONSERVATION OF ENERGY

Overview

Amidst the current concern with ways of producing enough energy to meet the staggering projected demands, relatively little attention and research has been directed toward methods of making existing supplies of energy stretch further. Yet by one widely accepted estimate, five-sixths of the energy used in transportation, two-thirds of the fuel consumed to generate electricity and nearly one-third of the remaining energy-amounting in all to about 50% of the energy consumed in the United States-is discarded or wasted heat.

More efficient uses of energy in various sectors may be achieved in the following ways: electric heat pumps for heating and cooling, solar heating and cooling, architectural and engineering practices that build conservation in, use of smaller cars that require less fuel, use of rapid transit, recycling, and each individual practicing the wise use of energy.

Objective

The student will develop a concept of how energy can be used more efficiently.

The student will practice the wise use of energy.

Suggested Activities

1. The student will visit the local recycling plant (Tri-Cities Waste Paper Company) and devise a means of measuring the amount of energy saved from a ton of recycled newspaper.

2. Students will demonstrate through mathematical estimates and predictions how man has changed the earth's surface to a nonproductive condition by removing energy or natural resources from it.

3. The student will identify ways man in his community has wasted power supplies in the areas of wood, coal, oil, and gas.

4. The student will investigate his local community and determine or weigh the effect of natural resources on the quality of life.

5. The student will list ways to practice conservation of electricity in his home.

6. The student will make a comparison between the amount of electricity used in his home today as opposed to five years ago.

7. The student will compare the advantage and disadvantage of mass transportation of all kinds and determine which method will save natural resources, yet be convenient.

8. The student will investigate the relative efficiency of methods used to transport electricity.

9. The student will list 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.

10. The student will construct models of generating facilities (steam, hydro) and determine their efficiency.

11. The student will compare forms of energy generation to find which are presently economical and which are not. List the reasons why some forms are not economical.

12. The student will, 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.

13. The student will compare total energy considerations in the use of hot air blowers which have replaced paper towels in many public washrooms.

14. The student will 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?

15. The student will list and describe ways his community can better manage electrical energy consumption.

16. The student will develop programs which will promote concern for avoiding exploitation of our energy resources.

17. The student will plan and carry out activities to improve the energy management of the school.

18. The student will use various media to present evidence for the need to improve the management of our energy resources.

19. The student will project the total environmental cost of different modes of transportation that could be used for moving goods and/or people and select the one or the combination of modes which will provide an optimum balance in terms of energy conservation, environmental poisoning and human convenience.

20. The student will list convenience products (including packaging items) which he uses daily, describe their impact on our energy reserves and identify related habits he can develop to conserve energy.

21. The student will be introduced 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.

22. The student will list ways in which energy consumption can be reduced without decreasing the quality of life.

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

24. The student will list and discuss all of the reasons they can for increased energy consumption since 1900 due to changes in our life style. Also have students list the ways which energy can be reduced.

25. The student will make or construct audio-visual presentations of energy waste and develop alternative solutions in school, home, and community.

26. The student will visit grocery stores and compare prices of returnable bottles and nonreturnable bottles and cans.

27. The student will prepare a scenario of the future concerning the energy crisis--one if we conserve--one if we don't conserve.

28. The student will read articles in recent periodicals that deal with energy problems (i.e., Alaskan pipeline, offshore oil, gas rationing, etc.).

29. In his message to Congress on June 4, 1971, former President Nixon called for a broad range of government actions that would ensure an adequate supply of clean energy for the future. The are:

To facilitate Research and Development for Clean Energy

- A commitment to complete the successful demonstration of the liquid metal fast breeder reactor by 1980.
- More than twice as much Federal support for sulfur oxide control demonstration projects in the fiscal year 1972.
- An expanded program to convert coal into a clean gaseous fuel.
- Support for a variety of other energy research projects in fields such as fusion power, magnetohydrodynamic power cycles, and underground electric transmissions.

To make available the Energy Resources on Federal Lands

- Acceleration of oil and gas base sales on the Outer Continental Shelf, along with stringent controls to protect the environment.
- A leasing program to develop our vast oil shale resources, provided that environmental questions can be satisfactorily resolved.
- Development of a geothermal leasing program beginning this fall.

To assure a Timely Supply of Nuclear Fuels

- Begin work to modernize and expand our uranium enrichment capacity.

To use our Energy More Wisely

- A new Federal Housing Administration standard requiring additional insulation in new federally insured homes.
- Development and publication of additional information on how consumers can use energy more efficiently.
- Other efforts to encourage energy conservation.

To Balance Environmental and Energy Needs

- A system of long-range open planning of electric power plant sites and transmission line routes with approval by a State or regional agency before construction.
- An incentive change to reduce sulfur oxide emissions and to support further research.

To Organize Federal Efforts More Effectively

- A single structure within the Department of Natural Resources uniting all important energy resource development programs.

30. The student will consider the actions presented by the former President.

31. The student will investigate what part or parts of the former President's program have become a reality since his statement to Congress was made two years ago.

32. The student will assume he is President of the United States. The student will draw up his own energy policy on how this country could meet its energy needs for the future.

33. The demand for energy could be moderated in the years ahead by the adoption of energy conservation measures. The student will write several conservation measures that he thinks would save energy for the future in the areas of:

    a. Transportation
    b. Industrial
    c. Utility Market
    d. Residential
    e. Commercial

    Would these measures change our lifestyles? If so, how?

34. The student will record in kilowatt-hours the amount of electricity used in his home and determine the distribution of this energy to the various electrical devices in his home and determine which devices could have their use limited.

35. The student will identify and explain the energy-related advantages of riding a bicycle compared with driving a car when making a short trip.

36. The student will determine why many people prefer to drive a car even when a trip is not particularly demanding by bicycle.

37. The student will determine the number of cars in the school parking lot which belongs to faculty, administrators, and students.

    a. The student will determine the number of faculty, administrators, and students.
    b. The student will determine the average number of riders per car.
    c. The student will determine a method of increasing the average number of riders per car so the use of fuel can be reduced.

38. The student will keep careful records for a week to determine the number of hours lights are on in the school when they are not needed.

39. The student will suggest ways to avoid wasting electricity used with unnecessary lighting.

40. The student will scrutinize the various energy-requiring activities which occur in his home to determine if all are essential.

41. The student will suggest changes in energy use patterns in his home to lower the energy requirements.

42. The student will determine those laws affecting the energy-requiring activities in his community.

a. The student will determine who makes these laws.
b. The student will determine in what ways residents of the community influence the creation of these laws.

43. The student will determine if we should guarantee the rights of each citizen to his opinions and set of values.

44. Assume the role of your School Board. A decision must be made to cut the school year by 20 days in order to save energy. Develop a plan that will have a minimum effect on students' education and meet necessary contractual requirements as well as save energy.

45. Plan on energy awareness day program for your school. You might include short slide presentations, movies, speakers, contests, displays and posters.

46. What considerations should be made when members of your family purchase major electric appliances? Ask what influences this selection of brand, size and model. Ask whether the amount of electricity required is considered.

47. To conserve gasoline, a decision has been made to reduce the number of automobiles in this country. The student will draft a set of priorities and regulations to accomplish this as fairly as possible for all citizens.

48. The students will read their home watt-hour meter and school watt-hour meter daily for one week (month). Discuss the comparative consumption. Graph the results. Refer to page 27 to learn how to read an electric meter.

UNIT 4

ENVIRONMENTAL IMPACT OF ENERGY RELATED ACTIVITIES

Overview

The so called "energy crisis" of 1973 was more than a crisis of supply and demand. It was also a crisis of choice, and it pointed up with particular intensity the kinds of hard choices which increasingly permeate all corners of resource and environmental policy: choices between alternative uses of our natural endowments, when one kind of exploitation or enjoyment interferes with another; choices between exploitation in general and the maintenance of environmental integrity; and choices among the respective qualities of air, land, and water environments, when to maintain or improve one means to degrade another.

A partial list of resources-related instances of choice and conflict in the spotlight for the past few years would include the Alaska pipeline, design and siting of power plants, automotive and industrial emission standards, offshore drilling, deepwater terminals, strip-mining, and the definition of air and water purity. Each of these subjects arouse high passions, resolute pursuit of extreme positions, submergence of fact, and decision requirements worthy of a Solomon's act and conscience.

Objective

The student will correlate the results of various energy-related activities with environmental degradation.

Suggested Activities

1. The student will investigate one form of energy, its long-term strengths and weakness as an energy source, and its effect on the local community, state, and nation.

2. The student will describe the aesthetic impact on natural resources caused by recreation development, urbanization, and mineral exploitation.

3. Have the class:

   - Evaluate the benefits to mankind derived from nuclear power generation.

   - Evaluate the harm which might result from nuclear power generation, including problem of nuclear waste disposal.

4. The class will 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)

5. The student will state what kind of fuel-fired electric plant he would prefer as a "neighbor" and defend his choice.

6. There are over one hundred million motor vehicles in the U.S. Most of the vehicles are for personal use. The student will 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?

7. The student will pretend that he is Secretary of the Interior and must decide upon the best location for an oil pipeline from Kingsport to Knoxville. Locate the line on a map and defend the choice, aesthetically, environmentally, economically, and politically.

8. The students will 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.

9. The student will do the following:

   a. 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).

   b. List the arguments why a nuclear energy power plant should not be located near a population center.

   c. List ways of using to advantage the waste heat produced by power generating plants.

10. The class will discuss some alternatives to internal combustion energy.

11. The student will be able to present three arguments for and three arguments against allowing the development of a nuclear power plant to be located in Hawkins County.

12. The student, using his imagination, will write five pros and cons of the following situation. It has been discovered that in his community a rich supply of oil exist.

13. The student will recognize and site evidence for an environmental problem of destruction of natural resources in Kingsport: air, land, water, scenic beauty, by industry, highway builders, sign clutters, overpopulation, etc.

14. The student will list four pros and cons of atomic energy as a means of producing electricity.

15. The student will discuss the pros and cons of building the Alaskan Pipeline.

16. The student will list five environmental losses caused by the production of electricity.

17. The student will list five ways how electricity has improved his standard of living.

18. The student will be able to list three problems in moving electricity from production plant to consumer. The student will be able to list natural resources used to produce electricity.

19. The student will be able to discuss hydroelectric dam's environmental impact on the following areas:

    a. Transportation
    b. Population growth
    c. Natural resources
    d. Leisure time
    e. Economic factors
    f. Land use changes

20. The student will discuss the pros and cons of converting our present hydrogenerating plant into a nuclear plant.

21. The student will collect data on solid fossil fuel reserves and discuss the environmental impact of utilizing these reserves in various energy consumption modes.

22. The student will compare the energy (calories) used in cultivating an acre of land with that produced by crops and discuss such "trade offs" in terms of impact on fossil fuel reserves.

23. The student will write a paper showing what he thinks is the most pressing energy problem today and why.

24. The student will describe the harmful and/or the beneficial effects of each of the following:

    a. Pesticides
    b. Oil
    c. Radiation
    d. Chemicals
    e. Depletion of natural resources
    f. Landscape degradation

25. The student will describe the harmful and/or beneficial effects of the following types of power plants:

    a. Plant burning coal
    b. Plant burning oil
    c. Plant burning natural gas
    d. Hydroelectric
    e. Nuclear
    f. Geothermal
    g. Tidal
    h. Solar cells

26. The student will describe the harmful and/or beneficial effects of the following:

    a. In Air
        (1) Carbon monoxide
        (2) Sulfur oxides
        (3) Nitrogen oxides

(4) Lead oxides
(5) Hydrocarbons
(6) Particulates
(a) Effect on climate
(b) Greenhouse effect
(c) Trends

b. Water
(1) Industrial wastes
(a) Lead, mercury, chlorine
(b) Mining and manufacturing acids
(i) strip-mining
(c) Oil
(d) Radioactive wastes
(e) Pesticides
(2) Municipal wastes
(a) Garbage
(b) Sewage
(c) Eutrophication
(d) Detergents
(3) Agricultural wastes
(a) Fertilizers
(i) Agricultural-nitrogen-phosphorus-washoff
(ii) Nitrogen from automobiles
(b) Silt washoff
(c) Pesticides

c. Solid waste
(1) Types of sewage treatment
(a) Primary
(b) Secondary
(c) Tertiary
(2) Recycling

d. Thermal
(1) Bacteria
(2) Algae
(3) Fish

e. Noise

f. Visual (road signs, etc.)

27. The student will suppose the Kingsport area needs more electric energy. Establish a set of criteria (rules or standards that you would apply to judge the desirability or undesirability) that might be used in studying where to locate a plant.

Include these elements in the criteria:

a. Location of plant
b. Prevailing wind direction
c. Water sources
d. Fuel sources
e. Economic impact
f. Environmental
g. Political impact

28. a. The student will construct a design for the most effective, yet practical exhaust muffler for:

   (1) Trucks
   (2) Automobiles
   (3) Motorcycles
   (4) Lawn mowers
   (5) Outboard motors
   (6) Chain Saws

   b. Compare for noise level the original equipment mufflers on automobiles and motorcycles with "replacement modifications" intended to produce improved performance or "better sound."

29. The student will design a tax depletion allowance for industries and power producers that utilize geothermal and solar power.

30. The student will design and make drawings of a system that could use waste to heat and cool office buildings in Kingsport. Assume the system will burn 390 tons a day of solid waste and allow for future expansion to burn 1600 tons a day.

31. The student will write an advertisement designed to persuade the public that environmentalists are responsible for the nation's energy crisis. State a rule for including slant, bias, inaccurate information and unfair economic implications in such an ad.

32. The student will visit local industry and discuss methods of trapping possible pollutants with industrial leaders and environmentalists. Discuss how the pollutants are either used or disposed.

33. The student will visit the local sewage treatment plant on Industry Drive. Try to find answers to these questions:

   a. Is the waste treatment plant primary?

   b. Is the waste treatment plant secondary?

   c. Do industries dump wastes into the community treatment plant?

   d. Do industries bypass the community's waste treatment?

   e. Do homeowners dump untreated wastes into local water sources?

   f. Is some waste bypassed into local water sources during normal dry weather?

      (1) What percent?______________

      (2) How often?________________

   g. In wet weather, when lines and plants may be filled by storm flow, is some sewage bypassed into water sources?

      (1) What percent?______________

      (2) How often?________________

h. Does the waste treatment plant have enough employees to operate it efficiently on a 24 hour basis?

i. Does the waste treatment plant have enough employees to operate it efficiently on a 365 day basis?

j. Does the waste treatment plant provide on-the-job training?

34. List possible ways of using waste gas produced by the sewage treatment plant.

35. The students will present arguments for and against locating a nuclear energy plant near a large population center.

36. The student will 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.

37. Using a noise level meter (decibel meter), check the noise level at various places in the community--downtown street level, lunchroom, gym, freeway, etc.

38. Several measures might be taken to reduce our dependence on foreign oil--they are:

- Speed completion of pipeline for supplying petroleum from Alaska.

- Stimulate maximum production of domestic oil and gas.

- More nuclear energy development.

- Dig more coal.

- Encourage research on alternative energy sources: solar, nuclear, fusion, coal, gasification.

- Provide incentives to develop commercial coal gasification and liquefaction.

- Provide incentives to industry to substitute the use of coal for oil and gas in industrial and utility application.

- Assist development of commercial stock gas scrubbing, thus permitting the use of high sulfur oil and coal.

- Reduce product import requirements by facilitating through land use policies the siting and construction of new refineries and power plants.

a. The student will describe the aesthetic, environmental, economic, and political impact each of the above measures would have.

b. The student will discuss how much he thinks the American people are willing to pay, in terms of resources, consumer prices, national security, and environmental quality, to satisfy our growing energy demand.

39. Converting fossil and nuclear fuels into energy leads to:

- air pollution
- water pollution
- creation of solid wastes
- land disruption
- aesthetic degradation

a. The student will discuss what impact each of these damages have on the environment.

b. The student will discuss ways how energy can be produced more efficiently.

40. One of the major problems on increased use of coal is the technical and economic problem of meeting air pollution control standards for So_2. There are three ways to administer an So_2 air pollution control program.

- Place identical limits on the amount of So_2 in the stock gas of all power plants and industries, with the emission standard designed to achieve the required air quality at the worst location. This method would impose standards more strict than necessary on small sources or sources in areas where air quality is higher than the most polluted area.

- Impose variable emission standards on sources, depending on their location and how much control is necessary to achieve the air quality standard in that location. Thus, sources in the heavily polluted areas would generally be subject to stricter controls because of the multitude of sources.

- A third method of control, applicable only to very large sources which dominate an area (such as large power plants in rural areas) is supplemental control systems, which do not require So_2 control as long as ambient air standards are not violated, as determined by a monitoring network or dispersion calculations. If So_2 levels approach the standard, or if meterological conditions predict poor dispersion conditions the plant would be required to reduce emissions by reducing production or shifting to low sulphur fuel temporarily.

a. Which of the above methods would you select to administer an So_2 air pollution control program for Tennessee? Defend your selection.

41. The student will research and prepare presentations for each of the roles presented below:

You are a large distributor of oil in a metropolitan area. You are located in the area accessible to the transportation facilities listed below. You wish to transport the oil to your distribution plant with maximum efficiency and the least adverse effects on the environment. Representatives from the following transportation facilities present their "sale pitch" to you and your directors:

a. Railroad
b. Trucks
c. Freighters
d. Pipelines

Which means will you choose and why?

42. The students will, on a world map, locate important sources of energy fuels and major energy users.

43. The student will find out what people in his community think should be done to control auto pollution. Make findings known to legislators. Invite a city councilman to visit the class so that the issue can be discussed with him.

UNIT V

ENERGY: LIMITS - RESOURCE - FINITUDE

Overview

Our country and the rest of the world is faced with a growing energy problem. We are fast using up energy resources which cannot be replaced. With needed energy in short supply or subject to limited use because of economic reasons, it is becoming increasingly difficult to meet our energy demands.

Sound and timely decisions on energy policies must be made in order to avert critical energy shortages which could endanger the world's economic well-being and cause substantial hardships to all citizens.

Objective

The student will develop a concept that the earth is essentially a closed system and that it does not have the ability to produce an infinite amount of energy resources.

Suggested Activities

1. The student will discuss energy problems that will be serious by the year 2000 if current practices are not changed, and suggest necessary changes.

2. The student will discuss any changes in his/or her life style as a result of the so called gas shortage this summer (1974).

3. The student will use various media to demonstrate how man's desire for economic gains affected energy resources.

4. The student will organize, present and criticize a debate showing how short-term energy gains could produce long-term losses.

The student will solve the following problems:

5. If we have a reserve supply of coal equaling 10 billion tons and a population of 1,000,000, how long will the coal last if each person uses 6 tons per year.

6. Make up similar problems using other natural resources:

   a. Petroleum
   b. Uranium
   c. Coal, etc.

7. The student will identify and describe the physical effects on the ecosystem if energy were to be available on an unlimited scale.

8. The student will discuss the limits to exponential population growth in a closed system. Included should be the limiting factors of available nutrients, atmosphere and suitable habitats.

9. Have the student discuss how implementing an apparent solution to a pollution problem may increase the demand on the earth's energy resources.

10. Have the student 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.

11. The student will discuss political and social implications of the energy-use imbalance in the world today.

12. The student will do research to determine the rate at which energy is being used in the United States.

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

14. 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.

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

16. The student will assume the role of a representative to the United Nations. Argue before that body for more equitable share of the world's resources.

17. 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.

18. Have the student 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.

19. The student will assume the role of a congressman. Have him write a law which would restrict fuel consumption and be equitable to all sectors of society.

20. 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.

21. Assume that all oil deposits in the United States become exhausted. List the jobs that would be eliminated as a result. Discuss the implication for vocational planning.

22. 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.

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

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

25. The student will formulate a policy that would more equally distribute the energy resources geographically in the world.

26. The student will make a comparison of material received from various states on natural resources and industry, the student will prepare a bulletin board and write a brief report exemplifying the concept that natural resources are equally distributed over the earth or over time and greatly affect the geographic conditions and quality of life.

27. The student will discuss how stress might lead to competition for the basics of existence, recreational facilities and educational facilities.

28. The student will discuss the merits of land-use planning to ease population pressure and to utilize energy more efficiently.

29. Have the student assume that the earth had an unlimited supply of natural resources. Predict the world's population growth.

30. The student will sketch the ideal geologic structure where coal, oil and gas are normally found. Indicate on a map of the world locations containing these formations.

31. The student will discuss why large reservoirs of oil are not likely to be found below the deeper depths of the ocean.

32. The student will write down the rules to be used if he had to redistribute the resources of the world.

33. Assume all energy resources were cut in half. The student will list the ways in which his local government would be affected.

34. The student will describe the governmental unit which should be responsible for determining the rules under which energy or fuel might be rationed.

35. The student will set up the enforcement mechanisms necessary to accomplish orderly reduction in energy use.

36. The teacher will arrange the students in the class equal distance from one another all over the room. After three minutes, discuss their reactions to occupying the space allotted. Then have all of the students move into half the room, and after three minutes, discuss reactions. Keep halving the available space until two square feet per student is reached. Discuss the problems of congestion due to overpopulation.

37. The question about energy reserve is not, "How long will energy last?," but "How long will energy serve as sources for mankind?" What does this mean, and what is your reaction?

38. Have the student assume that all oil deposits in the United States become exhausted. List the jobs that would be eliminated as a result. Discuss the implications for vocational planning.

39. The student will analyze the American life style in comparison with various other life styles to propose a life style which would provide a balance in terms of energy pool and quality of life.

40. The student will discuss the feasibility of discovering and developing new energy sources as others are depleted.

41. The student will propose mechanisms based on the second law of thermodynamics for harnessing the enthalpy to entropy energy flow of the earth system, the solar system and/or the universe. He may also:

   a. evaluate the feasibility of implementing his proposal
   b. prepare a program to present the need for his proposals to his classmates, the community or other groups, or
   c. construct a working model of his proposal

42. The student will project how implementing an apparent solution to a pollution problem may increase the demand on the earth's energy resources.

43. The student will react to the following statement--"A person who drinks two aluminum cans of beer per day and fail to recycle the cans wastes more energy than is used daily by a billion human beings in poorer parts of the world."

44. Do all societies value technological advances? Discuss the ethics of forcing one; one's technological orientation on nations or societies which do not have it.

45. Discuss the influence on world trade as an underdeveloped, resource-rich nation moves toward greater development.

46. The student will describe the changes that occur in political systems where resources diminish.

47. Have a debate on this topic: Resolved: Family structures change in response to limited energy resources. For example, what else is there to do if there isn't electricity for the television set?

48. List all the synthetic substances which use fossil fuels as the base substance necessary for their synthesis. Discuss the advisability of using those hydrocarbon fossil resources as fuels as opposed to using them for the manufacture of synthetics.

49. Describe the relationship of limited energy resources and international trade.

50. Describe the relationship of limited energy resources to social systems such as political, economic, and family.

51. The student will understand the current energy situation by making an inventory of resources and by studying sources, depletion rates, limits and distribution of natural resources.

HOW TO READ YOUR ELECTRIC METER

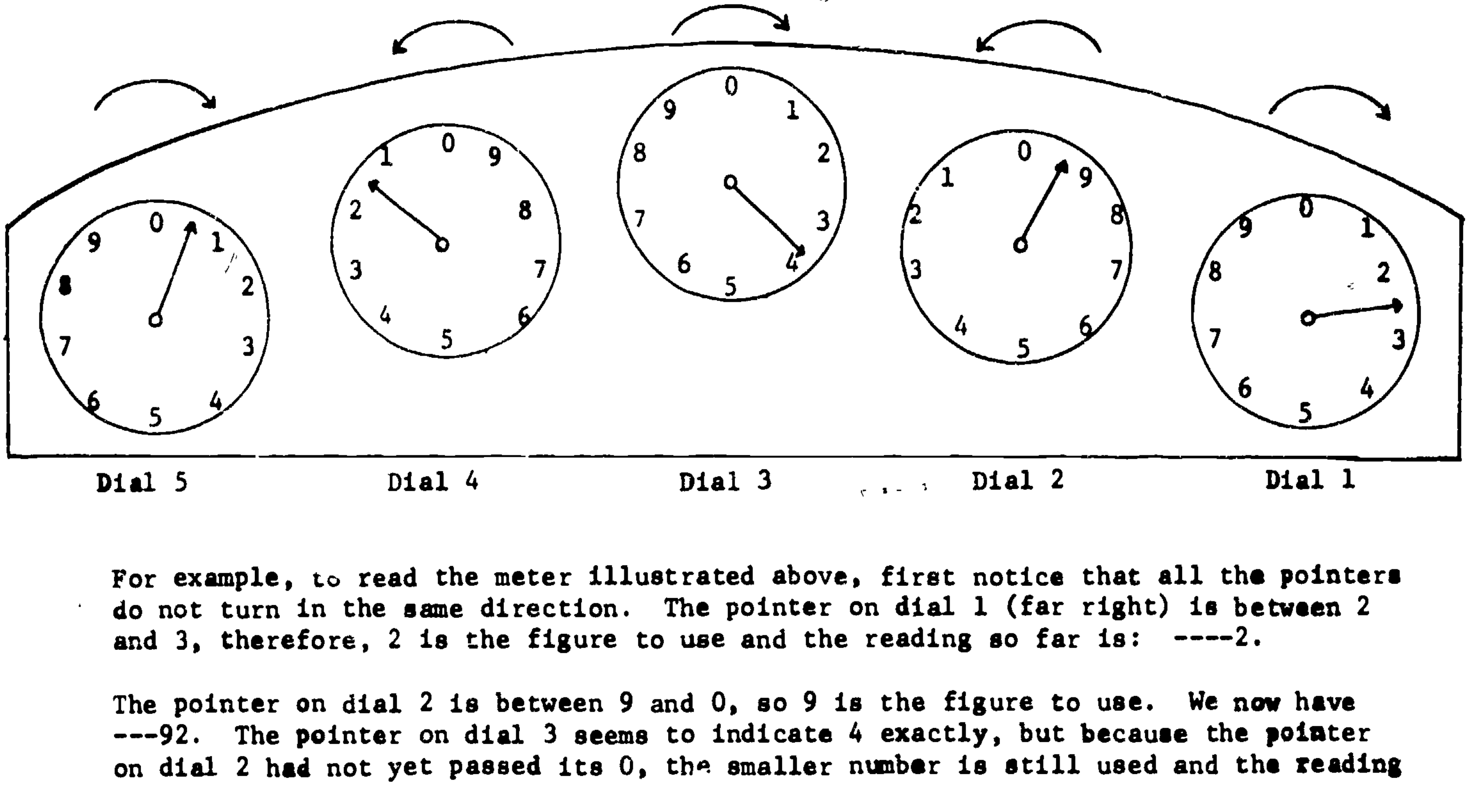
If you really want to see how much wattage you're using a day or a month, learn to read your own meter. To do this, read each dial separately from right to left and write down the figures in that same order.

The number to use for each dial is the one the pointer has passed last, even though the pointer may be nearer to the next number. Sometimes the pointer on one dial will be so near to a number, it will seem to indicate it exactly, but the smaller number is still used until the pointer on the dial next on its right has passed its 0.

Read your own meter and make a record of the figures. Then, when you read it again, subtract the previous reading from the present reading. The difference is the amount of electricity you have used during the time elapsed.

The cost of coal used by electric companies to generate electricity has increased 67 percent in the past year (1973-74). For each additional $2.40 (based on an average heat rate of 12,000 BTU per pound) electricity companies have to pay for each ton of coal, 10 cents is added to an electric bill under each month.

As the cost of coal continues to increase, so will the cost of electricity. Learn more about your meter and how much those modern gadgets send the pointer around the dials. Learn to control the amounts of wattage used and it will help control that bill you get once a month.



For example, to read the meter illustrated above, first notice that all the pointers do not turn in the same direction. The pointer on dial 1 (far right) is between 2 and 3, therefore, 2 is the figure to use and the reading so far is: ----2.

The pointer on dial 2 is between 9 and 0, so 9 is the figure to use. We now have ---92. The pointer on dial 3 seems to indicate 4 exactly, but because the pointer on dial 2 had not yet passed its 0, the smaller number is still used and the reading is 3. We now have --392.

The pointer on dial 4 is between 1 and 2. The figure to use is 1. We now have -1392. The pointer on dial 5 is between 0 and 1. The figure to use then is 0, and the complete reading is: 01392.

ENERGY ENVIRONMENTAL GAMES AND SIMULATIONS

The following energy related games and simulations can be checked out from the Materials Center at Dickson Elementary.

The Energy Environment Game
This game is a representation of reality in which players assume roles of adults in the real world. Students, through a series of meetings, consider society's demand for energy, its potential impact on the environment and possible trade offs. (High School)

The World Energy Game
The objective of this game is to develop energy resources and use them to amass world power points. This game was developed by John Yegge of the Oak Ridge Associated Universities. (High School)

New Town
Up to four players or teams buy land, build factories, homes, stores, vote on parks, schools, parking lots, and experience business booms, fires, floods, and pollution fines. Objectives of the simulation depends upon the level at which it is used with increasing sophistication from junior high through adult.

The Game of Sacrifice
An environmental conflict simulation that divides the class into the kinds of interest groups that make up a real community. Acting on the basis of their own values and attitudes, these groups attempt to reach consensus on the "right" solution to environmental problems which concern the entire community. No group is made up of "bad guys." All want to solve the problems raised in five successive rounds; industrial water pollution, bottle and tin can recycling, downtown traffic jams, expansion of electrical power production and the use of conservation funds. The game includes materials for ten groups to play five rounds. A four-page teacher's guide offers extensive suggestions for procedure and round-by-round discussion as well as ideas for associated research, reports, and creative audio-visual efforts by students to improve communication among groups. (Junior High and High School)

Population
The game is played by two to six players, each representing a country. Each player begins the game with a limited amount of money, a small population and agriculture adequate enough to feed his population. He must acquire resources to develop his country to the fullest potential possible and control its growth so that his population does not outgrow the limits of his country's space and available resources. (Junior High and High School)

Land Use
This simulation game brings out the conflict between the desire for quality housing and the desire for natural resources. In developing the land, groups of participants have the opportunity as planners to discover how they might "blend" with the land and use it with the least possible harm to the environment. (Junior High)

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 Gerald Ford

B. John Sawhill, Federal Energy Administrator

C. Carl Bagge, President of National Coal Association

D. Eric Hirst, Research Engineer, Oak Ridge National Laboratory

E. Dr. Glenn Seaborg, Former Chairman, Atomic Energy Commission

F. Roger Morton, Secretary of the Interior

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

H. Former President Richard M. Nixon

I. Richard Balzhiser, Electric Power Research Institute

J. Forrest Remick, Pennsylvania State University

K. Alvin Weinberg, Oak Ridge National Laboratory

L. E. Douglas Kenna, President, National Association of Manufacturers

1. "We must seek a new and more imaginative way of thinking of energy that reflects an awareness of our finite assets."

2. "For most of our history, a plentiful supply of energy is something the American people have taken very much for granted. In the past twenty years alone, we have been able to double our consumption of energy without exhausting the supply. But the assumption that sufficient energy will always be readily available has been brought sharply into question with the last year. The brownouts that have affected some areas of our country, the possible shortages of fuel that were threatened last fall, the sharp increases in certain fuel prices and our growing awareness of the environmental consequences of energy production have all demonstrated that we cannot take our energy supply for granted any longer..."

3. "For every problem, there is a solution. For a problem as complex as energy, there are many solutions. We--all of us--hold the key."

4. "Between now and the end of this century man will consume as much energy as he did in all previous time prior to 1850. Let us now restrict our attention to the United States, the most energy ravenous nation in the world. We presently account for over one-third of the world's consumption of energy though we have only about 6 percent of the world's population."

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

6. "The wise use of energy can restore nature and rejuvenate man. It can help us to turn green again much of the desert wasteland that was once natural gardens. It can help us clean up our man-made environment and rebuild, with the same materials we may have misused or wasted, the lives of men and the lands and cities they inhabit. It can help us build the foundation for lasting peace on this planet. And it can give us the means to explore beyond this planet--to open new frontiers to man, physical frontiers and those of the mind and spirit. In short, the future of energy is the future of man. Without it we become nothing. With it we become whatever we wish to be."

7. "Recent history shows a steady growth in transportation energy use at a rate more than double the population growth rate... However, oil scarcities and increasing dependence on petroleum imports, coupled with rising environmental concern, could reverse these historical trends. It is technologically feasible to show transportation energy growth by increasing transportation energy efficiency. Policies to achieve such goals would involve some life-style changes and important institutional decisions, but they do not imply a return to 'cave and candles'."

8. "It is unrealistic to expect utilities management to place orders for stack gas cleaning systems with the performance guarantees that they can get today... We should consider fine tuning the control procedures to permit plants that aren't really contributing to the problem to continue without change for an extended period to reduce the competition for clean fuel or gas cleaning equipment..."

9. "Our segment of business (coal) is harassed, bedeviled, and increasingly kicked around by a mixed-up government that tells us to produce coal and then tries to prevent production, a government that says, 'use more coal,' and at the same time says, 'but don't burn it'."

10. "Today, if we are to maintain our standard of living, we must be far more conscious of the need to use our energy wisely, and to conserve energy wherever possible. The federal government has made great efforts to reduce its consumption of energy. But demand for fuel has increased at such a rate that fuel conservation by government alone is no longer enough. Only a truly national effort will meet this critical challenge to our future."

11. "Amendments to give greater flexibility to the Clean Air Act are needed in order to avoid unemployment and production cutbacks resulting from a conflict between the enforcement of stringent environmental standards and the lack of adequate energy supplies."

12. "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."

Answers:

1-F, 2-H, 3-B, 4-J, 5-K, 6-E, 7-D, 8-I, 9-C, 10-A, 11-L, 12-G

SUGGESTED ENERGY RELATED FIELD TRIPS

Hydro Generating Plants

Boone, Johnson City, Tennessee
Hubert Gilliam, 615-928-4131

Fort Patrick Henry, Kingsport, Tennessee
Public Safety Service, 247-7491

South Holston, Bristol, Tennessee
J. D. Edmondson, 615-764-1311 (Power plant tour Friday only from 9-12)

Watauga, Elizabethton, Tennessee
Public Safety Service, 615-542-2951

Steam Generating Plants

Clinch River Power Plant, Carbo, Virginia
T. W. Abolin, 703-889-1540

John Sevier Steam Plant, Rogersville, Tennessee
Walter Vance, 615-456-7243

Nuclear Power Plant

Watts Bar Nuclear Power Plant, Spring City, Tennessee
615-365-5405

Tri-City Waste Paper Company, Inc., 501 Riverport Road, Kingsport, Tennessee
246-7801

Bumpass Cove Landfill, Route 2, Erwin, Tennessee
Tom King, 615-245-3312

Tennessee Eastman Company, Kingsport, Tennessee
246-2111

Mead Corporation, W. Main Street, Kingsport, Tennessee
247-7111

Kingsport Iron and Metal Company, Riverport Road, Kingsport, Tennessee
245-5124

Waste Water Treatment Plant, W. Industry Drive, Kingsport, Tennessee
245-1671

Purification Pl nt, Sherwood Road, Kingsport, Tennessee
245-4211

ENERGY USE BY SECTOR - 1971
TENNESSEE PERCENTAGES COMPARED TO OTHER SOUTHERN REGIONS

East South Central-Ky, Tenn, Ala, Miss
South Atlantic-Del, Me, DC, Va, W. Va., N.C., S.C., Ga, Fla
West South Central-Ark, La, Ok, Tex

SECTOR		COAL	PETROLEUM	GAS	HYDRO	ELECTRICITY	TOTAL
HOUSEHOLD							
	Tenn	6	25	35	0	34	100
	ESC	3	27	43	0	27	100
	SA	2	42	28	0	28	100
	WSC	0	25	50	0	25	100
INDUSTRIAL							
	Tenn	14	6	43	0	37	100
	ESC	30	8	40	0	22	100
	SA	30	18	35	0	17	100
	WSC	<1	15	80	0	5	100
TRANSPORTATION							
	Tenn	0	91	9	0	0	100
	ESC	0	86	14	0	0	100
	SA	0	98	2	0	0	100
	WSC	0	89	11	0	0	100
ELECTRIC POWER							
	Tenn	79	<1	1	20	-	100
	ESC	76	1	9	14	-	100
	SA	56	24	13	7	-	100
	WSC	0	2	96	2	-	100

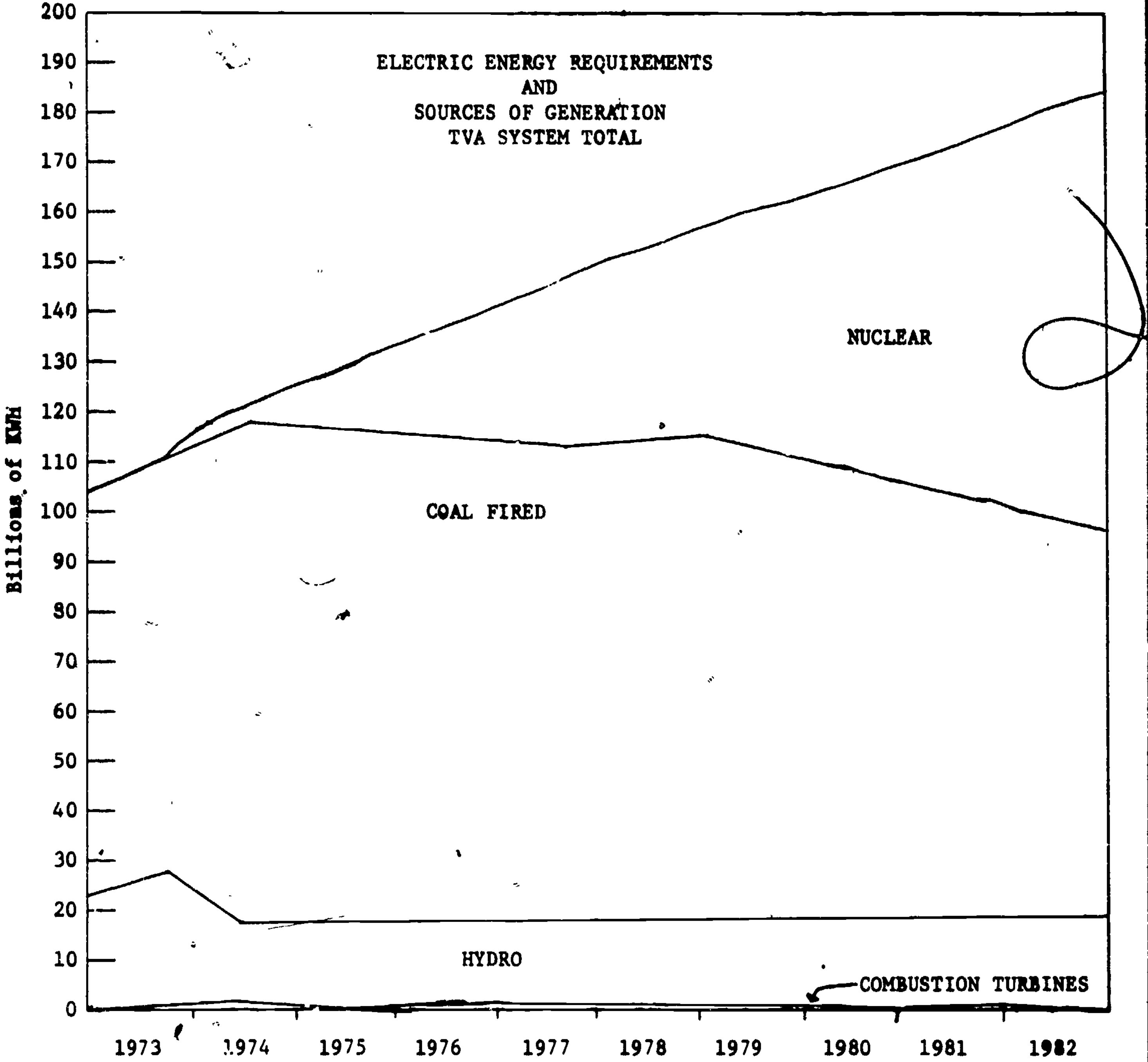
DEMAND AND SUPPLY OF PRIMARY FUELS AND HYDRO FOR TENNESSEE--1950-1970
(trillion of BTU's)

Demand	1950	1960	1970
Coal (Bituminous & Lignite)	290.85	354.50	413.81
Petroleum Products:			
Distillate fuel oil	17.84	30.69	65.56
Residual fuel oil	8.79	1.16	5.80
Kerosene	13.33	14.85	23.80
Gasoline	88.00	146.08	223.63
All petroleum products	127.96	192.78	318.79
Utility Gas	64.55	147.02	249.88
LPG and Ethane	2.74	5.26	14.74
Hydro	25.03	29.60	27.52
Total Demand All Fuels	511.13	729.16	1024.74
Supply			
Coal	123.13	142.19	186.11
Crude Oil	0.02	0.04	1.79
Natural Gas	0.00	0.10	0.07
Hydro	25.03	29.60	27.52
Total Supply All Fuels	148.18	171.93	215.49
Net imports			
Coal	167.72	212.31	227.70
Oil	127.94	192.74	317.00
Natural Gas and LPG	67.29	152.18	254.55

STATE OF TENNESSEE ENERGY DEMAND GROWTH RATES
1960-1970

Item		Average Annual Growth 1960-1970
Residential & Commercial Demand for:	Coal	-0.4%
	Oil	12 %
	Gas	5 %
	Total Fuels	6 %
	Electricity	7 %
Industrial Demand for:	Coal	4 %
	Oil	2 %
	Gas	5 %
	Total Fuels	5 %
	Electricity	2 % *
Transportation Demand for:	Oil	4 %
	Total Fuels	4 %
Electricity Demand for:	Coal	1.1%
	Total Fuels	1.4%

*This is very low because of the large reduction in use by AEC at Oak Ridge.


ELECTRIC ENERGY REQUIREMENTS
AND
SOURCES OF GENERATION
TVA SYSTEM TOTAL
Billions of KWH
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
NUCLEAR
COAL FIRED
HYDRO
COMBUSTION TURBINES
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982

PROJECTED FUEL USE[1/]

TVA SYSTEM TOTAL

	Millions of Tons of Coal	Equivalent Millions of Tons of Coal[2/] Nuclear	Millions of Gallons of Oil[3/]
1973	37.5	-	42.8
1974	43.7	2.0	84.3
1975	42.7	7.6	57.0
1976	43.7	10.9	43.4
1977	43.0	15.0	39.5
1978	43.8	16.3	70.7
1979	43.5	20.5	83.3
1980	42.9	25.1	82.4
1981	40.6	30.8	73.6
1982	37.4	37.4	58.0

1/ From 1973 coal burn estimate.
2/ Assumes 9760 Btu/kWh, 10820 Btu/lb.
3/ Assumes 13650 Btu/kWh, 140,000 Btu/gal. Includes oil for combustion turbines, start-up of coal fired plants, and other equipment use.

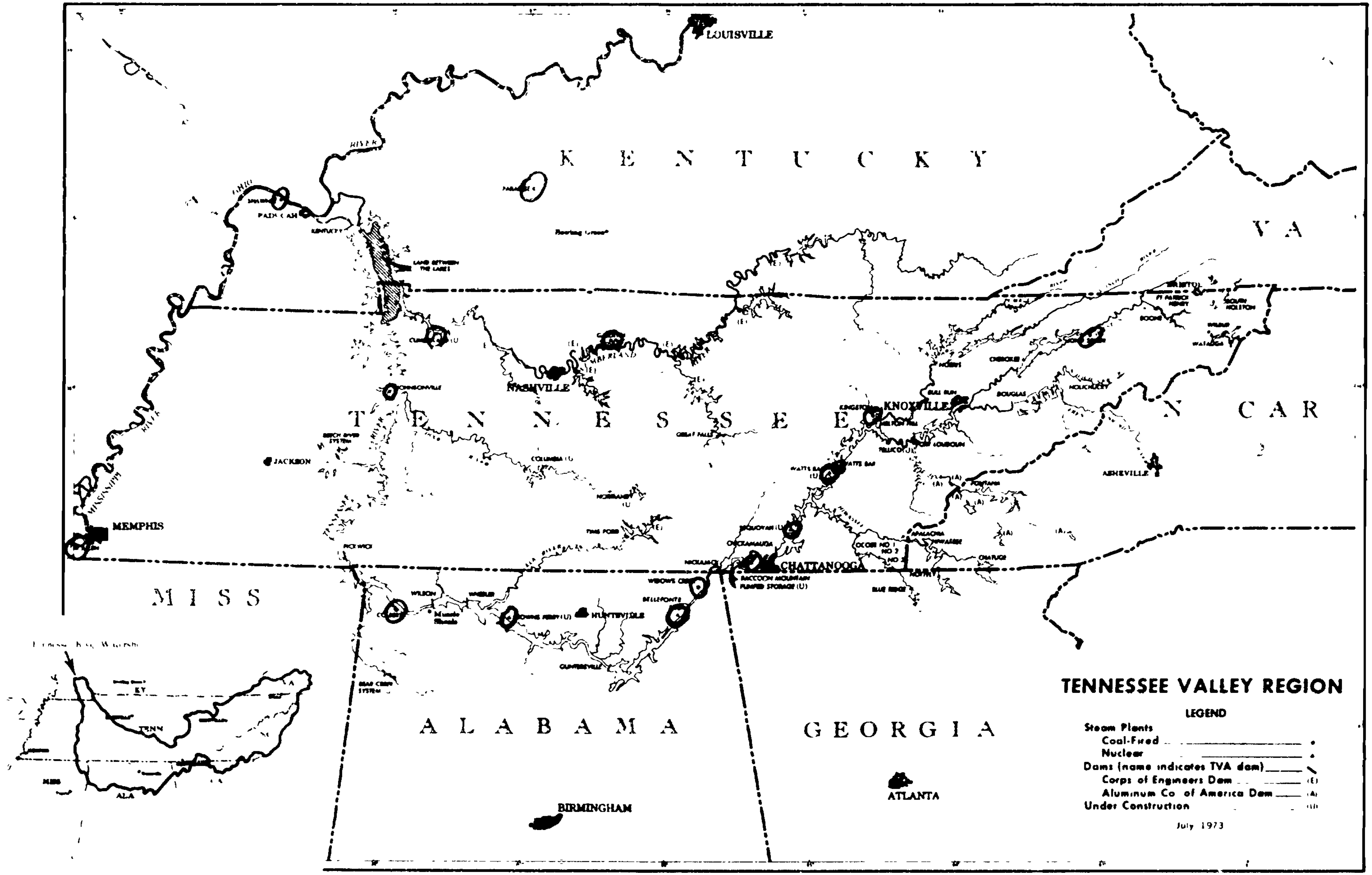
TVA GENERATING PLANTS
Units in Service on June 30, 1973

	Nameplate Capacity-kW					
	Alabama	Georgia	Kentucky	North Carolina	Tennessee	Total
Hydro Plants						
Appalachia	-	-	-	-	78,900	
Blue Ridge	-	20,000	-	-	-	
Boone	-	-	-	-	75,000	
Chatuga	-	-	-	10,000	-	
Cherokee	-	-	-	-	120,000	
Chickamauga	-	-	-	-	108,000	
Douglas	-	-	-	-	115,000	
Fontana	-	-	-	225,000	-	
Fort Loudoun	-	-	-	-	135,590	
Fort Patrick Henry	-	-	-	-	36,000	
Great Falls	-	-	-	-	31,860	
Guntersville	97,200	-	-	-	-	
Hiwassee	-	-	-	-	117,100	
Kentucky	-	-	175,000	-	-	
Melton Hill	-	-	-	-	72,000	
Nickajack	-	-	-	-	97,200	
Norris	-	-	-	-	100,800	
Nottely	-	15,000	-	-	-	
Ocoee #1	-	-	-	-	18,000	
Ocoee #2	-	-	-	-	21,000	
Ocoee #3	-	-	-	-	27,000	
Pickwick	-	-	-	-	220,040	
South Holston	-	-	-	-	35,000	
Tims Ford	-	-	-	-	45,000	
Watauga	-	-	-	-	50,000	
Watts Bar	-	-	-	-	150,000	
Wheeler	-	-	-	-	356,400	
Wilbur	-	-	-	-	10,700	
Wilson	629,840	-	-	-	-	
*Bear Creek	-	-	-	9,000	-	
*Calderwood	-	-	-	-	121,500	
*Cedar Cliff	-	-	-	6,375	-	
*Cheoah	-	-	-	110,000	-	
*Chilhowee	-	-	-	-	50,000	
*Nantahala	-	-	-	43,200	-	
*Santeetlah	-	-	-	45,000	-	
*Tennessee Creek	-	-	-	10,800	-	
*Thorpe	-	-	-	21,600	-	
*Minor Plants	-	-	-	6,240	-	
**Barkley	-	-	130,000	-	-	
**Cedar Hill	-	-	-	-	135,000	
**Cheatham	-	-	-	-	36,000	
**Dale Hollow	-	-	-	-	54,000	
**Old Hickory	-	-	-	-	100,000	
**J. Percy Priest	-	-	-	-	28,000	
**Wolf Creek	-	-	270,000	-	-	
Total	727,040	35,000	575,000	487,215	2,545,090	4,369,345

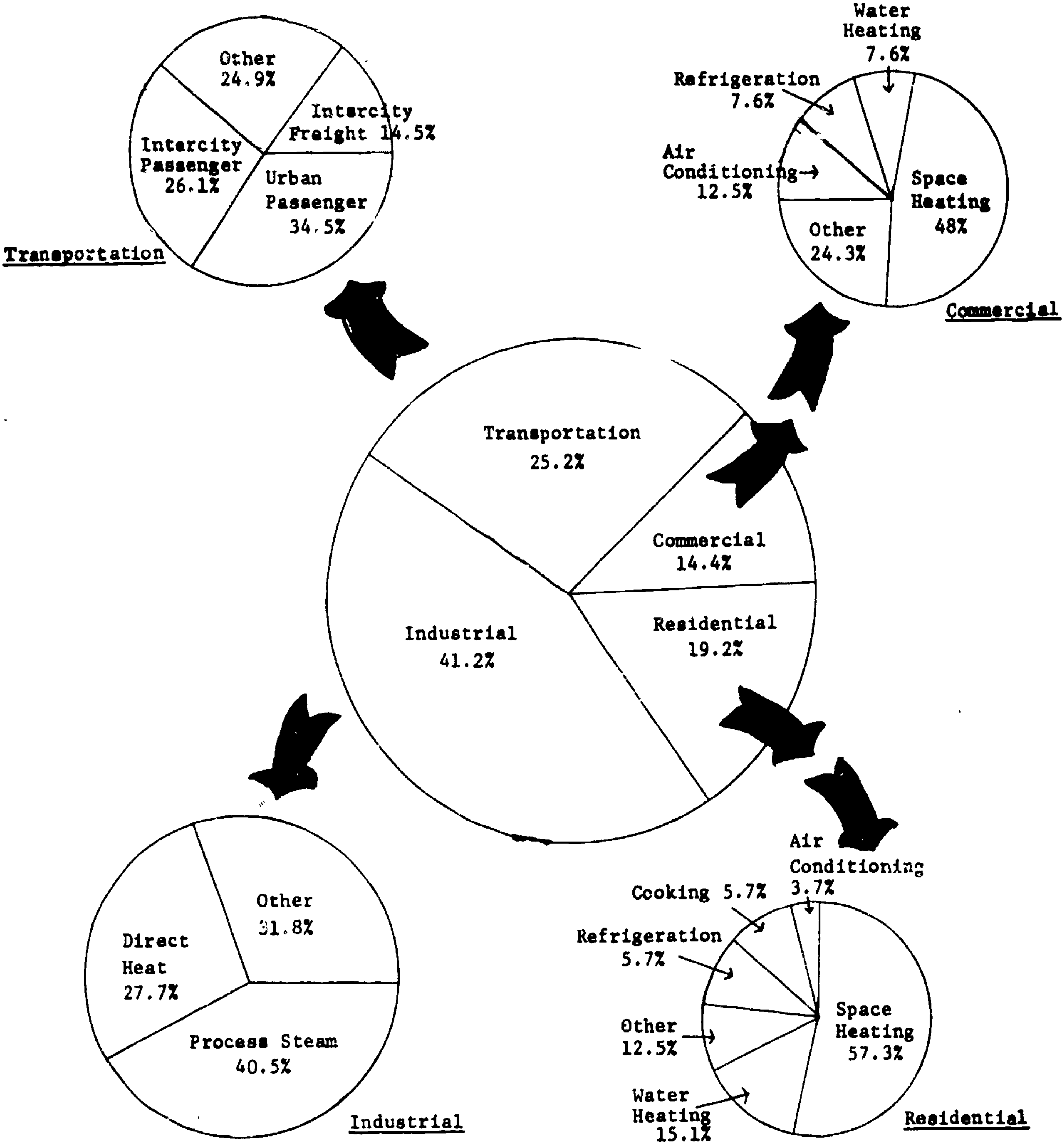
* [illegible] Plants
** Corps of Engineers Plants

	Nameplate Capacity-kW					
	Alabama	Georgia	Kentucky	North Carolina	Tennessee	Total
Steam Plants						
***Allen	-	-	-	-	990,000	
Bull Run	-	-	-	-	950,000	
Colbert	1,396,500	-	-	-	-	
Cumberland	-	-	-	-	1,300,000	
Gallatin	-	-	-	-	1,255,200	
John Sevier	-	-	-	-	823,250	
Johnsonville	-	-	-	-	1,485,200	
Kingston	-	-	-	-	1,700,000	
Paradise	-	-	2,558,200	-	-	
Shawnee	-	-	1,750,000	-	-	
Watts Bar	-	-	-	-	240,000	
Widows Creek	1,977,985	-	-	-	-	
Total	3,374,485	0	4,308,200	0	8,743,650	16,426
Gas Turbine Plants						
Allen	-	-	-	-	620,800	
Colbert	476,000	-	-	-	-	
Total	476,000	0	0	0	620,800	1,096
SYSTEM TOTAL	4,577,525	35,000	4,883,200	487,215	11,909,540	21,892

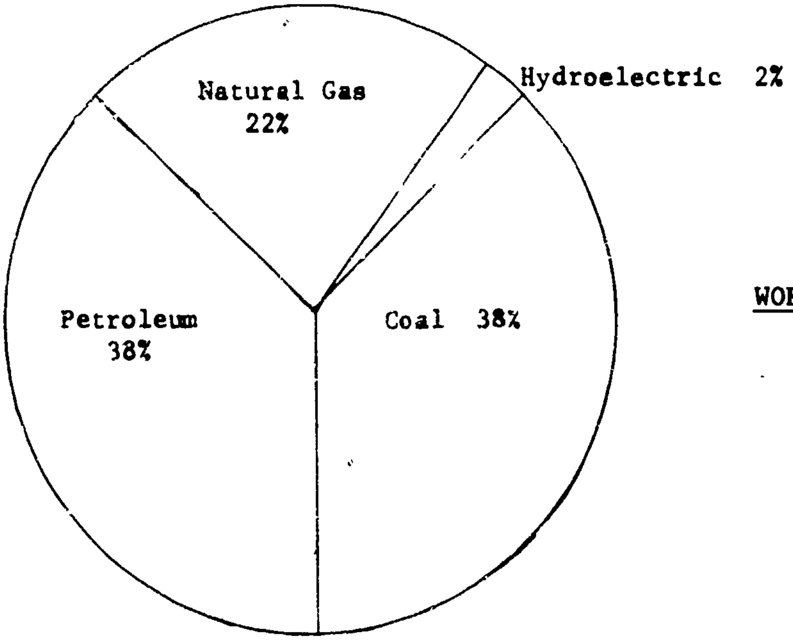
***Leased Plants


TENNESSEE VALLEY REGION
LEGEND
Steam Plants
Coal-Fired
Nuclear
Dams (name indicates TVA dam)
Corps of Engineers Dam (E)
Aluminum Co. of America Dam (A)
Under Construction (U)
July 1973
KENTUCKY
TENNESSEE
VA
N CAR
MISS
ALABAMA
GEORGIA
LOUISVILLE
MEMPHIS
JACKSON
NASHVILLE
KNOXVILLE
CHATTANOOGA
HUNTSVILLE
BIRMINGHAM
ATLANTA
ASHEVILLE
RACCOON MOUNTAIN PUMPED STORAGE (U)
LAND BETWEEN THE LAKES
RIVER
MISSISSIPPI
TENN
KY
ALA

HOW DOES THE U. S. USE ITS ENERGY?

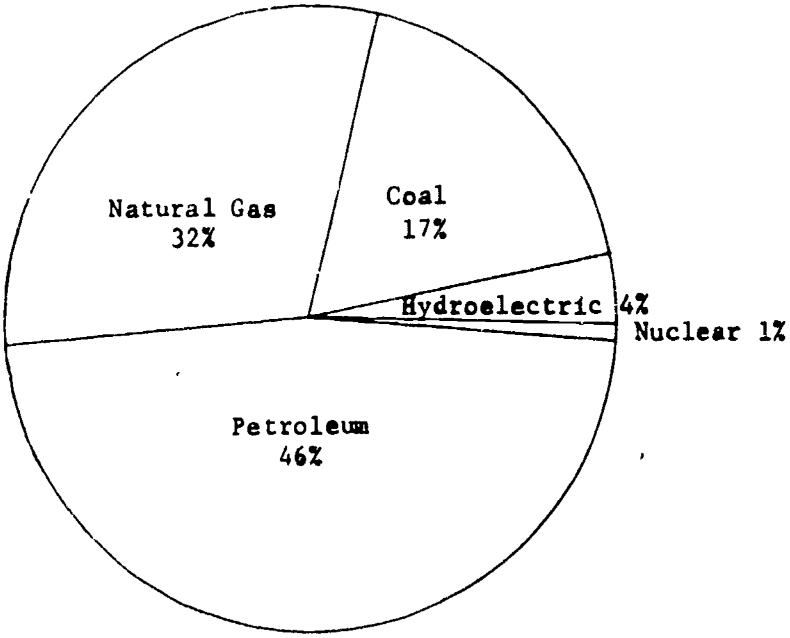


WHERE DO WE GET OUR ENERGY?



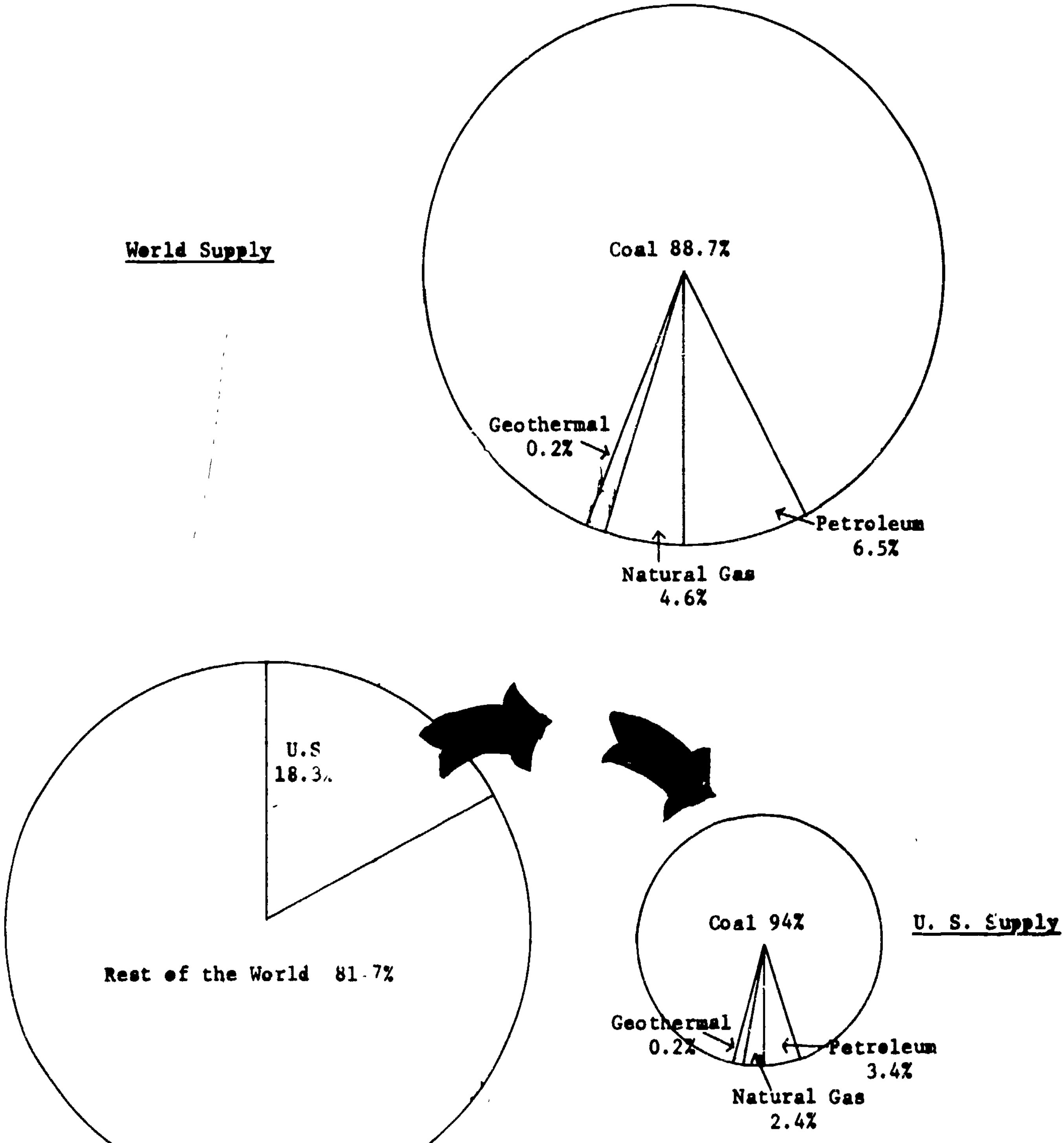
WORLD (1968)

U. S (1972)



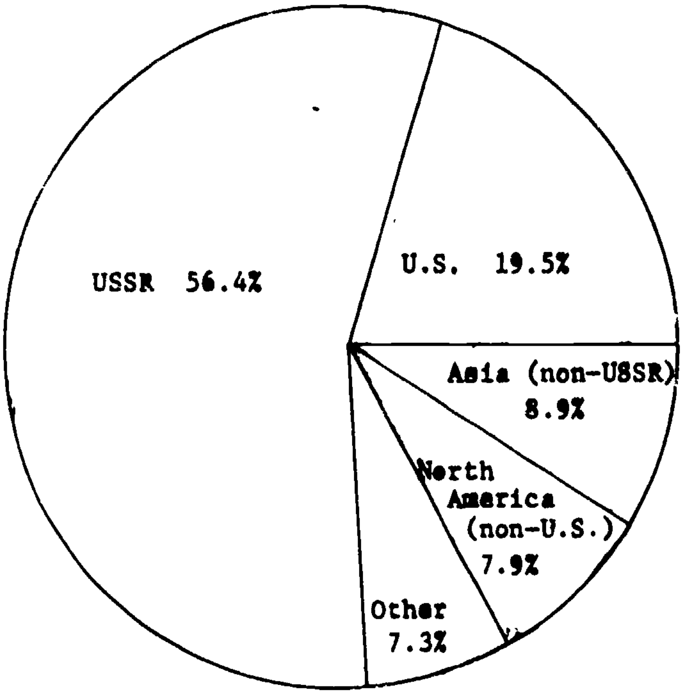
ENERGY-ENVIRONMENT FACTS

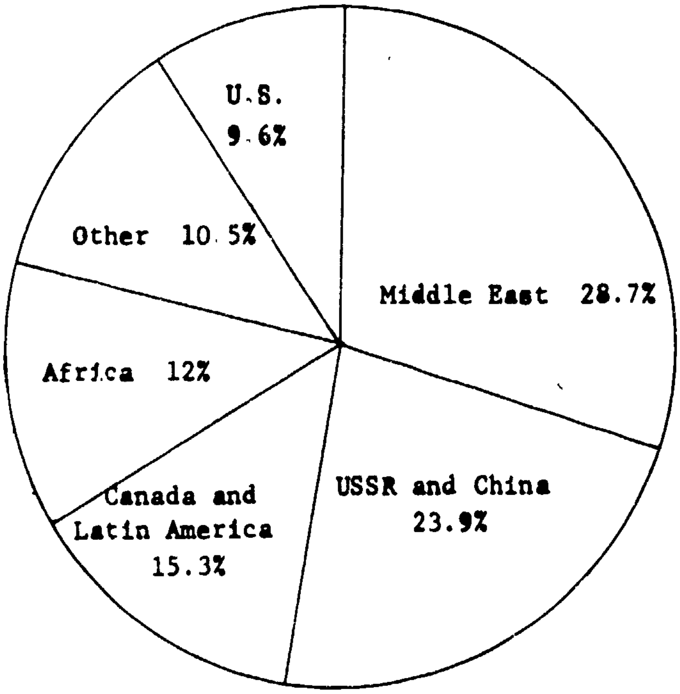
What Are the Forms of Our Non-Nuclear Energy Supply?



WORLD DISTRIBUTION OF COAL AND PETROLEUM

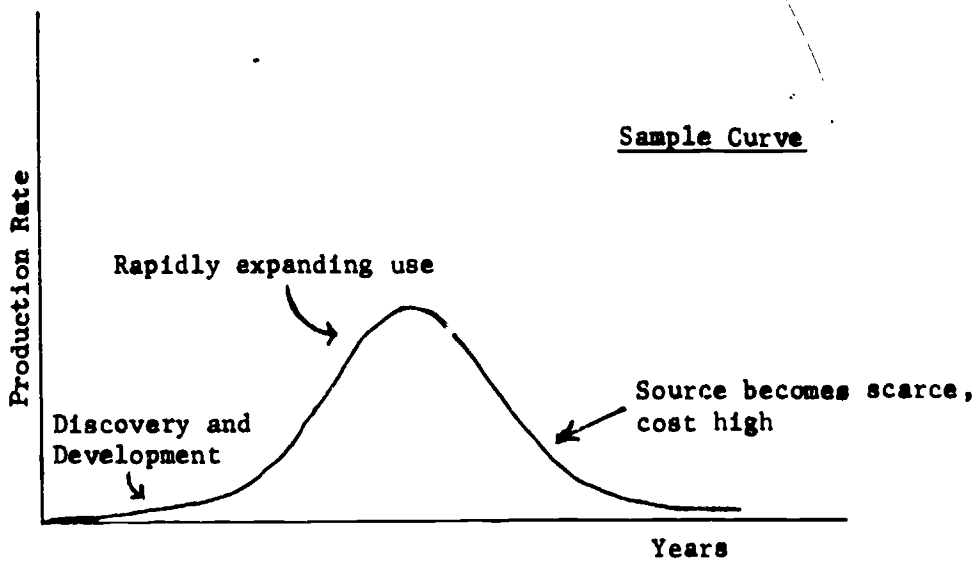
COAL





PETROLEUM

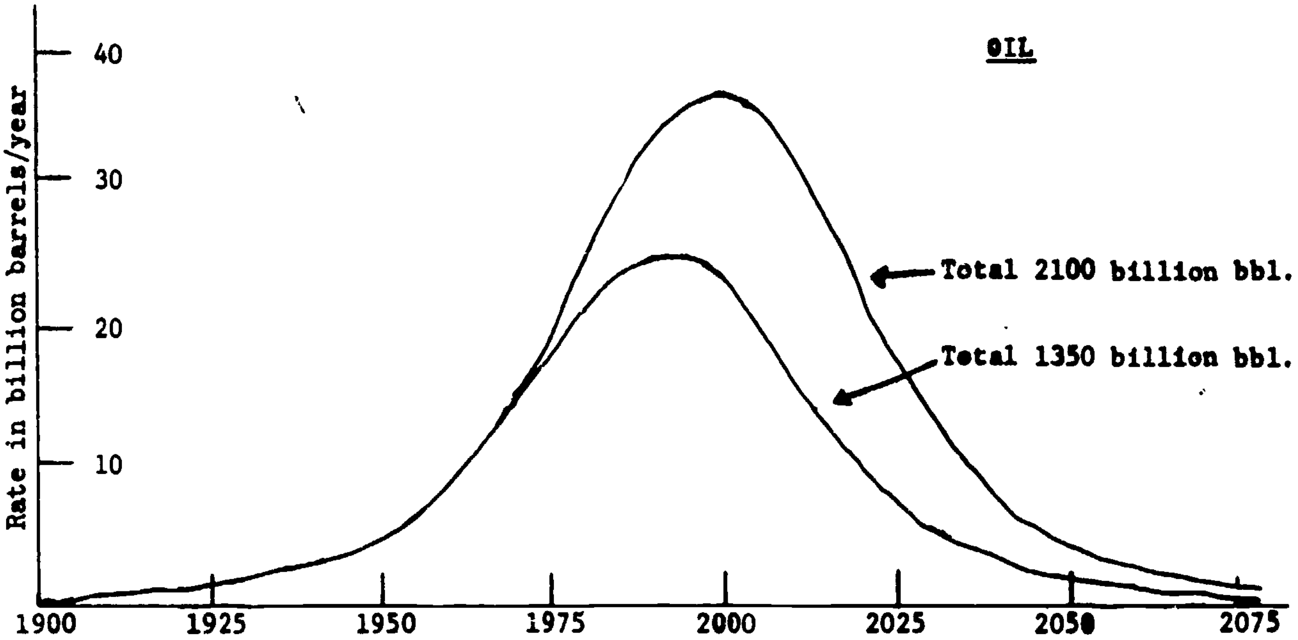
LIFE SPAN OF A DEPLETABLE RESOURCE

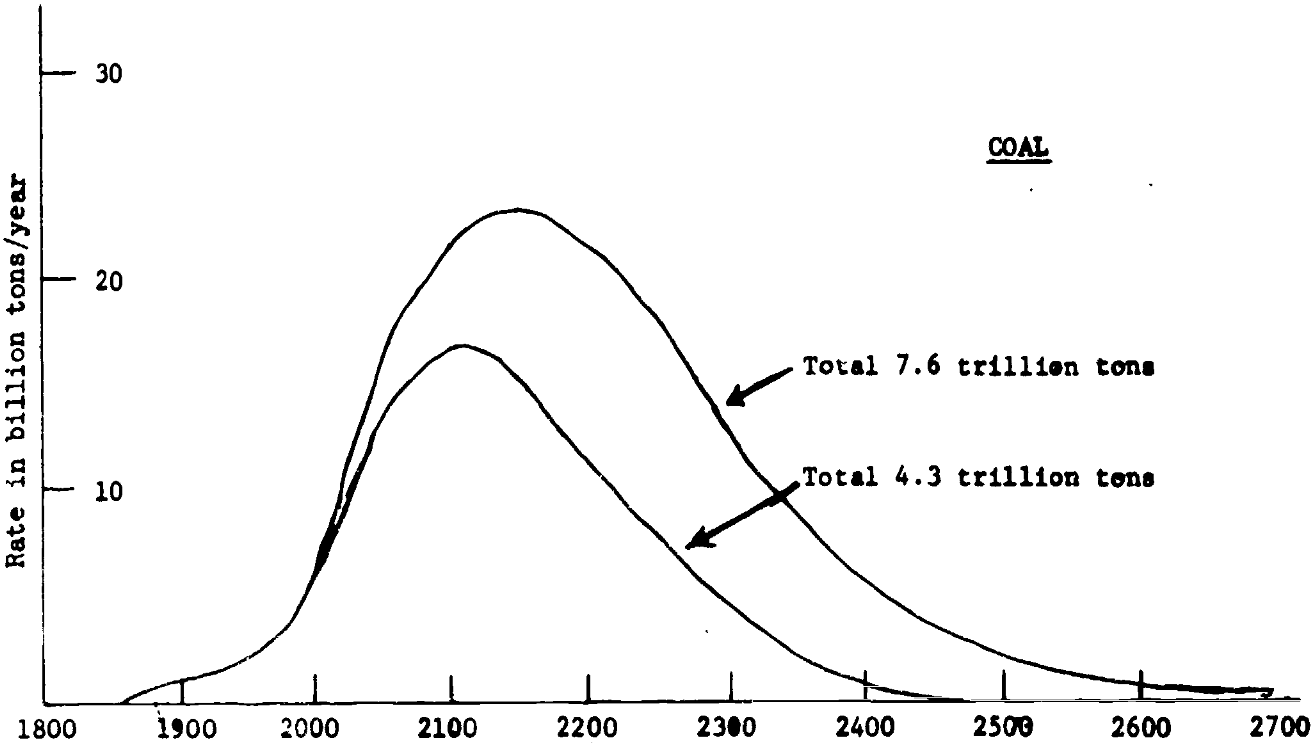


The area under the curve represents the total amount of the rexource at the outset.

The curves on the following page represent petroleum and coal resources of the world. Note that for each resource, two curves are given, based on different estimates of the total amount of the resource available.

LIFE SPAN OF WORLD'S PETROLEUM AND COAL RESOURCES





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BOOKS RELATED TO ENERGY

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ATOMIC ENERGY	
621.48	The Useful Atom, Anderson, William R
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500	Science for Better Living, Brandwein, Paul F.
541.2	Atomic Energy in the Coming Era, Dietz, David
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DAMS	
627	Captive Rivers, Faber, Doris
Fic	Crack of Doom, Holmvik, Qyvind
917.68	God's Valley; People and Power Along the Tennessee River, Whitman, William

Number	Title and Author
ELECTRICITY	
530	Physics: A Descriptive Interpretation, Bachman, C. H.
537	Lightning in Harness, Basford, Leslie
621.319	Traveling Waves on Transmission Systems, ewley, L. V.
530	Exploring Physics, Brincherhoff, Richard E.
537	Fundamentals of Electricity, Carnegie-Illinois Steel Corporation
507	Harvard Case Histories in Experimental Science, Conant, James
537	Electricity and Electromagnetic Fields, Dart, Francis E.
920	Giants of Electricity, Dunsheath, Percy
530	The Feynman Lectures on Physics, Feynman, Richard P.
500	How and Why Explorations, Frasier, George
621	Exploring Power Mechanics, Glenn, Harold T.
541.2	Understanding Electronics, Lewellen, John
621.3	Industrial-Arts Electricity, Lush, Clifford K.
537	First Electrical Book for Boys, Morgan, Alfred Powell
530	Introductory Physics, Priestley, Herbert
537	A Boy and A Battery, Yates, Raymond Francis
530	College Physics, S-ars, Francis
507	700 Science Experiments for Everyone
530.9	Bright Design, Shippen, Katherine Binney
500	Science for Every Day Use, Smith, Victor
537	Electricity and Electronics Basic, Steinberg, William
500.2	Investigations in Physical Science, Strickland, Warren L.
530	Physics: The Pioneer Science, Taylor, Lloyd W.
608	Age of Invention, Thompson, Holland
537	Electricity Today, Vinycomb, T. B.
500	Our Environment, Wood, George C.

Number	Title and Author
ENERGY	
525	Man and His Physical World, Gray, Walter
530	Energy, Life (periodical)
500	The Search for Order, Schneer, Cecil
PETROLEUM	
976.3	John Law Wasn't So Wrong, Carter, Hodding
500	Prometheus, Greenwood, Ernest
333	My Country 'Tis of Thee; The Use and Abuse of Natural Resources, Mitchell, Mrs. Lucy (Sprague)
551	Treasurer of the Earth, Reinfield, Fred
665.5	Oil for the World, Schackne, Stewart
POWER	
621	The World of Power and Energy, Ross, Frank
SOLAR ENERGY	
523.7	Solar Energy, Branley, Franklyn
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WATER POWER	
333.9	Water: Riches or Ruin, Bauer, Helen
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333	Federal and State Control of Water Power, Johnsen, Julia
333.9	The Water Crisis, Moss, Frank E.
333.9	The Water Crisis, Nikolaieff, George A.
627.12	The Water and the Power, Williams, Albert N.
333.9	The Coming Water Famine, Wright, Jim

PAMPHLETS IN VERTICAL FILE

ATOMIC ENERGY

Accelerators

Atomic Energy

Atomic Energy and Your World

Atomic Fuel

Atomic Power Safety

Atoms at the Science Fair

Atoms in Agriculture

Atoms in Motion

Atoms, Nature, and Man

Controlled Nuclear Fusion

Cryogenics

Direct Conversion of Energy

An Explanatory Statement on Elementary Particle Physics

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Laws of Matter Up-to-Date

Microstructure of Matter

Neutron Activation Analysis

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Our Atomic World

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Power from Isotopes

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Radioisotopes

Rare Earths: The Fraternal Fifteen

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Amber and Amperes

Highways of Wire

The Incandescent Light

The Romance of Electricity

FUEL

Coal, Heat Petroleum

NUCLEAR ENERGY (See Atomic Energy)

PETROLEUM

American Petroleum Institute Quarterly--Centennial Issue

Chemistry and Petroleum

The Chemistry of Petroleum

The Civilizing Molecules

Conservation--Making the Most of Our Oil

The Conservation of Petroleum

Energy Crisis

Environmental Education Center Newsletter

Facts About Oil--A Handbook for Teachers

Industrial Commentator

Oil For Today...And For Tomorrow

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Petroleum

Petroleum From the Ground to You

Petroleum--Discovery and Production

Petroleum In Our Age of Science

Petroleum In Our Modern Society

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Physics and Petroleum

The Physics of Petroleum

The Prospects for Petroleum

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Science in the Petroleum Industry--Teacher's Guide

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What Makes This Nation

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World of Oil--Offshore Drilling

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There's Plenty of Coal--What's Behind the Holdup?

To Create an Energy Shortage

What U.S. Can Do to Tap Energy Sources Closer Home

What's Holding Up Nuclear Power?

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fs 541	Atomic Theory
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ELECTRICITY	
fs 537	Electricity
fs 537	Safe and Sure With Electricity
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Kit fs 530 4	Matter and Energy; Concepts of Science
f 333.7	The Energy Challenge; An Exclusive Environmental Report
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f 621 48	Man and the Atom; The Challenge of Our Time
PETROLEUM	
fs 553.2	Oil Hunters

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333.9	River of Life, U. S. Department of Interior
333.9	The Third Wave, U. S. Department of Interior
333.9	Whole Earth Energy Crisis, Woodburn, J. H.
530	From Calileo to the Nuclear Age, Lemon, H. B.
531	Energy and Power, Irving, R.
531	Your World in Motion, Barrow, G. (2)
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531	Energy, Wilson, M
537	First Book of Electricity, Epstein, S.
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620.69	The Boy Engineer, Throm, E. L

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621 48	The Useful Atom, Anderson, W. R.
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Ref 503	Van Nostrand's Scientific Encyclopedia, 4th ed.
Ref 537	Basic Electronics, Grob, B
Ref 537	History of Electricity and Magnetism, Meyer, H. W.
Ref 539	Atoms, Energy and Machines, McCormick, J.
Ref 530	Physics, Physical Science Study Commission
Ref 539.7	Sourcebook on Atomic Energy, Glasstone, S.
Ref 539 76	Atomic Energy. Jaworski, I. D.

PAMPHLETS

Understanding the Atom Series, U S Atomic Energy Commission, Division of Technical Information (Abbreviation Listing by Title)

Accelerators	ACC
Animals in Atomic Research	AAR
The Atom and the Ocean	AAO
Atomic Fuel	ATF

Atoms at the Science Fair, Exhibiting Nuclear Projects	ASF
Atoms in Agriculture	AIA
Atoms, Nature, and Man	ANM
Books on Atomic Energy for Adults and Children	BAE
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The Chemistry of the Noble Gases	CNG
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The Elusive Neutrino	ELN
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Our Atomic World, The Story of Atomic Energy	OAW

Plowshare	PSH
Plutonium	PLU
Power From Radioisotopes	PFR
Power Reactors in Small Packages	PRP
Radioactive Wastes	RAW
Radioisotopes in Industry	RII
Radioisotopes and Life Processes	RLP
Radioisotopes in Medicine	RIM
Rare Earths, The Fraternal Fifteen	REA
Research Reactors	RER
Snap: Nuclear Space Reactors	SNP
Sources of Nuclear Fuel	SNF
Space Radiation	SPR
Spectroscopy	SPC
Synthetic Transuranium Elements	STE
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A World of the Atom Series

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Preserving Food With Atomic Energy, Pizer, V.

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Breeder Reactors, Mitchell III, Walter

Nuclear Reactors for Space Power, Corliss, William R.

Atomic Particle Detection, Hellman, Hal

Tennessee Valley Authority (Info File)

River Traffic and Industrial Growth

Tennessee Valley Region (2 maps)

TVA Tames the River

TVA Dams and Steam Plants (leaflet)

A Short History of the TVA

A Quality Environment in the Tennessee Valley

TVA Today 1972

TVA Power 1970

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Theodore Roosevelt Dam (Dams--Info File)

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Facts About Oil, American Petroleum Industry (2) (Oil--Info File)

Map of Major Oil and Gas Producing Areas (Oil--Info File)

Career Info--Going Places in Oil (Oil--Info File)

21 Various Other Pamphlets on Oil and Petroleum (Oil--Info File)

FILMSTRIPS

Atomic and Molecular Weights, Encyclopedia Britannica Education Corporation 1972

Atoms and Molecules, Harper and Row

The Compsotion of Atoms, Encyclopedia Britannica Education Corporation

Molecules, Atoms and Simple Reactions, Encyclopedia Britannica Education Corporation

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623.8	How Atomic Submarines Are Made, Cooke, D. C.
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539.76	Story of Atomic Energy, Fermi, L.
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539.76	Sourcebook of Atomic Energy, Glasstone, S.
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623	Best-Kept Secret: Story of Atomic Bomb
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537	All About Electricity, Freeman, I M
537	Electricity, Gerrish, H
Ref 537.03	Electricity--Electronics Dictionary, Gerrish, H.
551.5	Light and Electricity, Hellman, H.
537	General Electricity, Jones, E. W.
537	30 Instructional Units in Basic Electricity, Matson, C. E.
621.3	Boy Electrician, Morgan, A P.
537	First Electrical Book for Boys, Morgan, A. P.
537.072	Safe and Simple Projects With Electricity, Neal, C. D.
600	General Shop for Everyone, Newkirk, L. V.
537	Wonder of Electricity, Ruchlis, H
621.3	Bright Design, Shippen, K

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920	Stepping Stones to Light (History Biography), Bishop, R. W.

GEOTHERMAL ENERGY

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531	Energy, Wilson, M

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333.82	The Energy Crisis, Rocks, Lawrence
333.8	The Whole Earth Energy Crisis; Our Dwindling Sources of Energy, Woodburn, John H.

NEWSPAPER AND MAGAZINE ARTICLES

Start a collection of articles and reports on energy related activities from your local newspapers. Keep abreast of any new developments associated with TVA's tentative proposal for the construction of a nuclear power plant in Hawkins County. Also, keep yourself informed on the possibility of TVA utilizing waste (Trash Power) to make electricity in the Tri-Cities area and the state of Tennessee.

An avalanche of energy related articles have appeared in the media for the past several months. These articles are too numerous to mention individually. However, the following list of periodicals will serve as an excellent resource for pulling together material on energy.

- Atlantic
- Audobon
- Bulletin of The Atomic Scientists
- Business Week
- Environment
- Fortune
- Harpers
- Intellectual Digest
- Local Newspapers
- National Geographic
- National Review
- National Wildlife Magazine
- Newsweek
- Physics Teacher
- Physics Today
- Science
- Scientific American
- Sierra Club Bulletin
- The Nation
- The Plain Truth
- The Science Teacher
- Time
- U. S. News and World Report
- Weekly Reader

Can you name others?

SOME ENERGY RELATED TERMS

BREEDER REACTOR--A nuclear reactor that 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 heat necessary to raise the temperature of one pound of water $1^{o}F$.

CALORIE--The amount of heat required to raise the temperature of one gram of water through 1^{o} Centigrade

COAL GASIFICATION--A chemical process to change coal into a fuel similar to natural gas; the biggest advantage is that sulfur and other pollutants in coal can be removed before it is burned.

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

DEEP MINING--Mining that must be performed by digging underground shafts and tunnels.

DIRECT ENERGY CONVERSION--The process of changing any other form of energy into electricity without machinery that has moving parts. For example, a battery changes chemical energy into electricity by direct energy conversion.

EFFICIENCY, THERMAL--A measurement of how efficiently any device changes heat into another energy form. For example, a modern coal-burning electric plant has about 38 percent thermal efficiency because just under 4/10 of the heat from burning the coal is actually changed into electricity.

ENERGY--The ability to do work or to make things move.

FISSION--The splitting of the nucleus (or center) of one atom into two or more smaller atoms; fission often releases large quantities of energy.

FISSION PRODUCTS--The smaller atoms formed when atoms fission or split.

FLY ASH--Tiny particles of solid ash in the smoke when fuels such as coal are burned.

FOSSIL FUELS--Coal, petroleum, and natural gas; this term applies to any fuels formed from the fossils of plants and animals that lived eons ago.

FUEL--Anything that can be burned or fissioned to produce heat energy.

FUEL CELL--A device similar to a battery in which fuels such as hydrogen gas or methane can be directly combined with oxygen to produce electricity and very little heat; the principal by-products of the process are water or carbon dioxide.

FUSION--The process of combining the nuclei or centers of two light atoms to form a heavier atom; fusion can release great quantities of energy. The sun produces its energy by fusion.

GAS COOLED REACTOR--A nuclear reactor that is cooled by a gas like air or helium, rather than by water or other liquid.

GASEOUS DIFFUSION--A process by which natural uranium is enriched and becomes a better nuclear fuel.

GEOTHERMAL ENERGY--Heat energy produced deep within the earth largely by radioactive materials that occur there naturally.

GEOTHERMAL STEAM--Steam formed by underground water seeping through hot rocks deep beneath the earth's surface.

HORSEPOWER--A unit that measures the rate at which energy is produced or used. A man doing heavy manual labor produces energy at a rate of about .08 horsepower.

KILOWATT--A unit that measures the rate at which energy is produced or used. Ten 100-watt lightbulbs use energy at the rate of one kilowatt (equal to 1000 watts). A rate of one kilowatt maintained for one hour produces or uses one kilowatt-hour of energy (equal to 1000 watt-hours)

MAGNETOHYDRODYNAMICS (MHD)--Process that uses a magnetic field to produce electricity directly from the hot smoke and gases we get from burning fuels like coal and oil.

MEGAWATT--Unit to measure the rate at which energy is produced or used; it is equal to 1000 kilowatts (see kilowatt).

MODERATOR--Material, such as water and graphite, used in a nuclear reactor to slow the speed of neutrons produced when atoms split.

NATURAL GAS--Gaseous fuel formed from the fossils of ancient plants and animals; often found with crude oil.

NATURAL URANIUM--Uranium as it is found in the ground; a mixture of two types of uranium atoms. Less than one per cent of the atoms in natural uranium are the kind that will produce energy in a nuclear reactor.

NEUTRON--A tiny particle, extremely heavy for its size, often found in the nucleus of an atom. Neutrons have no electrical charge, and are released when atoms split (fission).

NUCLEAR POWER--The energy produced by splitting atoms (such as uranium) in a nuclear reactor.

OIL SHALE--Rock formed by silt and mud settling to the bottom of ancient seas that contains a substance similar to crude oil. So-called shale oil can be removed from the rock by heating and then used to make gasoline, kerosene, etc.

PETROCHEMICALS--Chemicals removed from crude oil at the refinery and used to make a wide range of products such as plastics, synthetic fibers, detergents, and drugs.

PETROLEUM--See crude oil.

PHOTOSYNTHESIS--The process by which green plants convert sunshine into chemicals.

PLUTONIUM--A heavy, man-made, radioactive metal that can be used for fuel in a nuclear reactor.

RADIOACTIVITY--A spontaneous change in the nucleus or center of an atom, accompanied by the release of energy called nuclear radiation.

SOLAR ENERGY--The energy received from the sun. Nuclear and geothermal energy are the only presently available energy forms not derived from the sun.

SOLAR POWER--Electricity, heat, or other useful energy produced from sunshine.

STEAM ELECTRIC PLANT--An electric power plant (either nuclear or one that burns coal or other fuel) in which heat boils water into steam, the steam is used to turn a turbine, and the turbine turns a generator to produce electricity.

STRIP MINING--Mining for coal or useful ores by removing the soil and rock found above them, rather than by tunneling underground

SURFACE MINING--A synonym for strip mining.

THERMAL POLLUTION--Harmful effects to the environment that may be produced by the warm water released by electric power plants into nearby lakes, rivers, or oceans.

WASTES, RADIOACTIVE--A by-product of producing power by splitting atoms in a nuclear power plant; some of these materials are highly radioactive and stay radioactive for long periods of time