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ABSTRACT

This document is intended to give the elementary school teacher background information and general suggestions for teaching units and correlated learning activities related to energy and energy conservation. Sections are directed to: A Problem Shared by All, Causes, What is Energy?, Energy Sources, Searching for Solutions, Conservation: An Ethic for Everyone, a glossary, and an extensive bibliography. (MH)

ELEMENTARY

ENERGY
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ENERGY

A Teacher's Introduction To Energy and Energy Conservation

EDUCATIONAL
REDESIGN &
RENEWAL

COLUMBUS, OHIO · 1975
OHIO DEPARTMENT OF EDUCATION

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STATE BOARD OF EDUCATION

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FOREWORD

Historically, American education has been responsive to the demands placed upon it by its constituents to resolve human problems. Curriculum—the what of learning—is influenced by both societal advancements and problems

The worldwide energy problem demands that priority be placed upon seeking solutions Hard-hitting shortages have brought general recognition that the sources of energy are exhaustible. Energy to turn the multitudinous wheels of American industry, to transport a highly mobile people, to support the conveniences of homes, and to make possible recreational activities is becoming more and more scarce. A complexity of reasons contribute to this situation. finite energy sources, the demands of life styles resulting from the technological achievement by people throughout the world, comparatively limited support to research, and waste.

The energy problem touches the lives of all people. Hence, schools are involved in efforts affecting our destiny. Students of all ages must be taught the energy conservation ethic, which means using energy more efficiently and with less waste The significant understanding of sharing among nations and world dependency must be acquired. And as a primary goal, schools are called upon to provide creative social and scientific thinking, exploration, and problem-solving experiences. It could well be that some youths now in school may discover untapped sources of energy, find new ways to adapt old sources, and invent new machines capable of contributing to solutions for this complex problem.

To assist teachers in both the elementary and secondary schools, these in-service guidelines on energy and energy conservation have been prepared. It is our hope that teachers will use these materials as a starting point and go far beyond in this necessary instruction. A broad effort is needed to help our society deal with a growing problem which affects all lives and America itself.

Martin W. Essex

Martin W Essex
Superintendent of Public Instruction

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INTRODUCTION

At no other time in the history of our country has there been a greater need for a national commitment to conserving existing energy sources and seeking new ones. A united effort by all Americans is necessary to fulfill this commitment There is no better place or time to begin than in today's schools, with students who will be tomorrow's adults. It is their lives which will be affected by the energy practices and policies of the present.

The teacher's responsibility is a critical one in teaching about the sources and uses of energy, the multi-faceted problem, and the energy conservation ethic Attitudes, along with technology, are important in working toward solutions

The Division of Educational Redesign and Renewal coordinates the Ohio Department of Education's inservice center. One of the division's major responsibilities is the development and dissemination of INDIVIDUALIZED INSERVICE PACKETS, practical resources for independent study or for the use of teacher-leaders working with groups of colleagues. A *Teacher's Introduction to Energy and Energy Conservation* is another of these standfree inservice resources.

This material is intended to give the teacher background information and general suggestions for teaching units and correlated learning activities. Sections are directed to: A Problem Shared by All, Causes, What Is Energy?, Energy Sources, Searching for Solutions, Conservation. An Ethic for Everyone, a glossary, and an extensive bibliography. The background information has been written for all teachers from the kindergarten through the secondary school. Four teaching units provide for the differentiation of instruction. kindergarten-primary, upper elementary, middle school, and high school level.

In addition, a slide pocket is provided for examples of slides related to energy education. Teachers and students are encouraged to build a slide collection by taking pictures which show energy sources, uses, conservation practices and industries in the nearby community.

The major goal of this inservice publication is to give the teacher orientation to energy education and the encouragement to do research and teaching beyond the initial, condensed content. Another goal is that the materials will stimulate school districts to build energy education into the curriculum.

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WHAT IS YOUR E.Q.? (Energy Quotient)

1. Why are our major fuels called *fossil* fuels?

2. What are the three principal fossil fuels?

3. Name three nonfossil sources of energy.

4. Of the nonrenewable fuels, which is most abundant?

5. Give examples of how the study of energy can be related to science, mathematics, social studies, literature, art, music.

6. What are the basic causes of the energy problem?

7. What are positive features of the energy shortage?

8. What two categories combined take over half of the average American family's energy budget?

9. What is the primary use of transportation energy in our country?

10. Why is electricity called *secondary energy*?

11. In what two ways does electrical power waste energy?

12. How were substantial quantities of natural gas reserves wasted?

13. What options do we have to meet energy demand?

14. How is *energy* defined in physics?

15. What are the two states of energy?

16. What two kinds of energy transformations take place in the sun which man has learned how to duplicate?

17. The three types of energy conversion processes are mechanical (physical), chemical, and nuclear (atomic).
    (a) In which of these processes is waste heat generated?
    (b) Which is the primary process responsible for all the energy we have?
    (c) Which process takes place in a storage battery?

18. What unit is used commonly to measure potential or kinetic energy?

19. How is efficiency of the energy process defined?

20. What are the advantages and disadvantages of electricity?

21 When a substance is heated, it increases the movement of atoms, therefore, heat is really what kind of energy?

22 Uranium, green plants, coal, natural gas, sunlight, fuel oil, oil shale, and hydropower are sources of energy.

(a) Which of these sources are renewable or continuous?

(b) Which of these sources are nonrenewable or exhaustible?

23 What generalizations can be made about fossil fuels?

24. Which of the fossil fuels is most abundant in Ohio?

25. What invention gave the impetus to supplant wood with coal?

26 What are some advantages in using oil or gas over coal?

27. Which fossil fuel is the principal one not being completely utilized in the United States?

28 What energy conversion process may ultimately create the biggest new market for coal?

29. What are possible sources of energy for the future?

30 What change took place in November, 1970, that gave us cause to worry about our future oil supply?

31. What is the goal of Project Independence?

32. Name three technology advancements being made in the energy field.

33. What are three advantages of recycling?

34. What are problems in total recycling of throwaway materials?

35. What ways does the concern for natural environment figure in the energy problem?

36 What factors will encourage the development of new energy resources?

37. What is the energy conservation ethic?

38. How can the energy conservation ethic be practiced in schools?

39 What are some conservation measures which may be practiced in the home and community?

40. How can local, state and national government assist in the conservation of energy?

A PROBLEM SHARED BY ALL

As we are gaining a realistic view of the energy problem, we have become aware of the finite nature of fossil fuels. Our students also need a comprehensive appraisal before they can devise ideas for solutions.

QUESTIONS TO GUIDE YOUR READING

At present consumption rates, when do the optimists say we will run out of domestic oil resources in the United States?

When do pessimists say we will run out?

How long will our domestic coal last?

In what ways can the study of energy be related to

science

mathematics

social studies

literature

art

music?

What is the primary cause of the energy problem?

A PROBLEM SHARED BY ALL

We in America are a problem-solving society. We live in the spirit of "Can do!" and, while we no longer believe that every problem has a simple solution, we believe that man, if he looks hard enough and works hard enough, can do much about improving his own living conditions. In this sense, we, like our pioneer forefathers, are pragmatists. Our approaches to recent problems continue to evidence this.

As an example, putting a man on the moon was the result of a clearly defined approach to a specific problem, with implications which reached into classrooms, where the challenge was to improve science education. More recently, our efforts to clean up the environment have had their roots in largely successful ecological programs in the schools. There is no reason to assume that the readjustments required by a new understanding of the value and scarcity of energy sources will not also have their roots in education.

Yet, the "energy crisis" is a most perplexing problem. Daily, the headlines add to the confusion. We must reduce oil imports and cut down on gasoline consumption, yet we depend on the automobile for shopping and getting to work, and in Ohio many of us owe our jobs to the automobile industry. We turn down the thermostats and sometimes shiver in chilly classrooms to conserve natural gas, yet we are told that America has enough coal for many hundreds of years if only someone can find ways of using it properly.

But we have, at least, made some progress toward recognizing the problem. In the 1960's, when the warnings became clear, many of us simply didn't believe them. Then, when we began to feel the pinch, some of us blamed the industrial and political sectors of our society. It seemed inconceivable that America suddenly could go from an abundance to a shortage of fuel. But no longer! We at last are beginning to realize what the economists have been saying since before today's teachers were in school. "As the cheapest energy sources are becoming exhausted, the *real* costs are going up."

While this is a problem shared by all of us, it is not a situation which is all bad. As we recognize, for example, the extent of our dependence upon foreign suppliers, we realize that the United States must move toward self-sufficiency in energy supply. The longer we wait in working towards solutions, the fewer options we will have. The evidence is clear that the era of cheap fuel is ended. It is, however, not a matter alone of fuel becoming more expensive. The greater problem is diminishing availability based on past and present rates of consumption. At issue, therefore, is the question of our nation's whole value system. As readily available domestic supplies of coal, natural gas and petroleum dwindle, earlier values which have led to unrestricted consumption must yield to reality.

Historically, energy sources have been supplanted by newer, more efficient sources. Early man found he could augment his own muscle power with the muscle of animals for a greater power supply. As civilization advanced, wood became a chief source of power. During the Industrial Revolution, coal supplemented and then replaced wood as the fuel to power rapidly growing and expanding industry.

Now, fuel supplies are waning. Our search for alternatives suggests that we could be on the brink of another technological revolution in energy—the discovery of new sources and conversion processes.

The table below strikingly indicates that a number of sources of energy may be depleted within the life spans of students now in school.

But even this does not say enough. As supplies of oil and gas level off and decrease, we obviously will no longer be able to get nearly 80 percent of our power from them. Coal reserves are great, but there may have to be trade-offs between coal availability and environmental factors Strip mining is the only cost-effective way to reach many of our coal reserves Nor is it economically feasible to remove the sulfur in most of our bituminous coal, using presently available technology. Nuclear fuel reserves are far greater than the projected 100-year supply if technological development of advanced nuclear power plants (breeder reactors) is continued. Yet, nuclear power development has been painfully slow and is attended with complex environmental and health concerns Today nuclear power accounts for only about two percent of our total energy budget Shale oil reserves in Wyoming, Colorado, and Utah are great, but here again there are monumental pollution problems. "Cooking" oil shale to release the oil causes the rock to swell and produces alkali compounds which pollute soil and water

The situation is not hopeless. New sources of oil are being discovered New ways are being found to convert coal to gas New research is pointing to more efficient uses of atomic energy And new ways are being found to use old energy sources the energy of the earth, the sun, the winds and the tides.

But all of this will take time, and it will demand the use of our best brain power Today's children need to learn to cope with the situation as it is being presented to them, and they must be prepared so they may do something about it. Providing energy-focused instruction will be an ongoing activity, for it will require us to stay aware of swiftly changing use patterns and priorities The problem is more than a matter of adequate supply, we must decrease our rate of consumption while working toward solutions.

Understandings about the sources and uses of energy and a commitment to energy conservation, require teaching-learning emphasis. And it is not enough simply to come up with lists of "helpful hints" that students can take home to their parents. Certainly, conservation of energy should start in the home. However, if conservation is to be meaningful, there must be an understanding of what energy is, where it comes from, who uses it, why and how it is used.

The role of energy has bearing upon various school subjects. The correlations with science and mathematics are readily noted. However, there are others. The sun, the ultimate energy source, has had a dominant influence in music and art. History chronicles the advancement of societies in relationship with energy use.

Our Fuel Predicament

U.S. Energy Resources	Potential Reserves	Known Reserves	Years Left
Oil	100 billion barrels	35 billion barrels	10-30
Natural Gas.	1000 trillion cu.ft.	250 trillion cu.ft.	10-30
Coal	3.25 trillion tons	1.5 trillion tons	500-1000
Nuclear Fuel (uranium)	1.7 million tons	.7 million tons	100 (~1000 with breeder reactors)
Shale Oil	Unknown	200 billion barrels	Unknown

Note. Figures are *estimates* derived from several sources. Estimates of energy resources vary widely, often depending to some extent on the interests of the estimators.

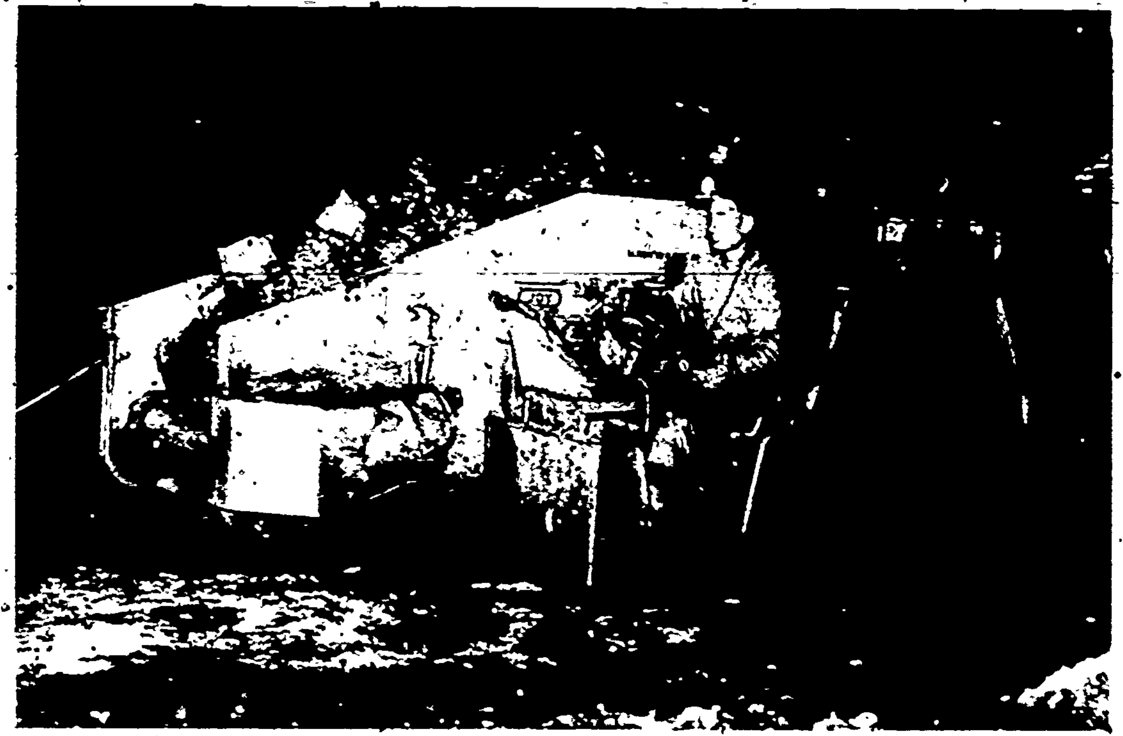
Literature tells of the lives of people involved in the development of energy Examples are novels such as Richard Llewellyn s *How Green Was My Valley* and A J Cronin's *The Stars Look Down* The Molly Maguires (19th century militant Pennsylvania miners) are the subjects of nonfiction works

Although energy use is so much a part of the daily lives of Americans studies indicate a general lack of awareness about sources of energy and how energy is used to generate power The sources of energy used today are simply taken for granted

It is hoped that students will reverse this carefree flip of the switch psychology by becoming fully and well informed about energy uses, consumption and related problems Future responsibility will be upon their shoulders It is not too early, even at the kindergarten level, to begin thinking about new and innovative ways of saving energy and unlocking new resources.

For these exercises, our text can be the real world as it exists and changes. And our school setting itself can become a model energy conservation center. We can maintain lower temperatures, use lights and paper carefully, and then in a mathematics class we can calculate the effects to see what they really mean Or in a driver education class we can study the energy saving (as well as safety) aspects of good driving habits In social studies we can study the energy consumption patterns of children in other countries where fuel is already scarce And we can visit and learn from people in the community whose job it already is to conserve energy people at the electric company, the gas company the school custodian the school bus supervisor and others

The possibilities for learning by doing and seeing for ourselves are limitless!



CAUSES

Man's ability to control and develop energy sources has helped to make civilization possible. To save civilization, he must now buy time for finding new energy sources by conserving the fossil fuels that are left.

QUESTIONS TO GUIDE YOUR READING

What two categories combined take over half of the American family's energy budget?

What fraction of all American workers have jobs associated with the automobile business?

When will nuclear power begin to make major contributions to our electrical supply?

What is called *secondary energy*?

Why is it called *secondary energy*?

How did we waste substantial quantities of our natural gas reserves?

What do we need to get to an era of energy abundance? (one word)

CAUSES

From early man to the present, progress can be recorded in one way as a series of technological jumps—each one directly related to energy use. Man's control of fire with wood as the primary fuel permitted him to cook and preserve food, to live in an otherwise inhospitable environment. With coal, a more concentrated energy source, he could develop manufacturing and expedite trade via steamships and railroads Oil and natural gas gave him added mobility and opened new prospects for chemical technology. Nuclear energy already has permitted significant advances in medical diagnosis and treatment (through X-rays); it has only begun to be realized as a portable source of power capable of making the deserts bloom and powering spacecraft Concepts unheard of only a few years ago—such as fusion, utilizing the almost limitless hydrogen of the oceans as a primary energy source—are now nearly within the realm of technical feasibility.

We may be on the threshold of an era when the ability to use almost limitless energy will be shared by all mankind. But what is needed to cross that threshold is time, and that's what we're running out of. Man is literally in a race with himself. As teachers, we have the opportunity and the responsibility to help make sure that tomorrow's citizens understand the implications of the race.

We are running out of time because we are exhausting our fossil fuels on which we have placed great dependence. It is with these fuels that we heat our homes, cook our food, operate our factories, and turn the wheels for moving people and products These fuels have powered the auto age and the beginnings of the space age.

A noted geologist* has described the situation

When the first settlers landed on the eastern shore of this continent, they were confronted by a forest that came down to the water's edge. Since wood was the basic fuel for both heating and cooking, they must have been encouraged by the seemingly inexhaustible supply of firewood. This could have been the origin of the American attitude toward energy resources—namely—our resources of fuel are so huge as to be virtually inexhaustible.

As the population pushed westward into Pennsylvania and western Virginia, coal was discovered. Exposed on hillsides and in stream valleys, coal seemed to be everywhere.

Then in the mid 1800's, well before the outbreak of the Civil War, oil was discovered in western Pennsylvania. In rapid succession, oil was found in New York, Ohio and West Virginia. In the early 1900's, the search for oil moved to the mid-continent and then southward into Arkansas, Louisiana and Texas. Also, oil seemed to be almost everywhere.

Natural gas, poured from the oil wells in such enormous quantities that there was nothing to do but burn it at the well, the night sky was lit by hundreds of oil-well flares. We didn't know what to do with it, so we wasted it. The bountiful flow of oil and this unusable oversupply of gas added to the American conviction already established—we have vast energy resources. First it was wood, then coal, then natural gas.

But our convictions were based on assumptions, not on facts. We could, and did, cut down the trees faster than they could be grown. We were mining coal as fast as we knew how, until the pace was slowed by the arrival of cheaper (and less polluting) oil and natural gas. Then oil field after oil field was depleted. Not that all the oil had been recovered . . . But enough had been removed to lower the reservoir pressures, and now the oil would not flow into the wells, and the recovery of the remaining oil could cost more than it was worth. We were running out of cheap oil.

Gas fields gradually gave up their reserves, and the search for new gas deposits was pushed (but not energetically) . . .

To make up for the shrinking supplies at home, the oil and natural gas companies increased imports from abroad. And all the time these critical developments were going on, there were few words of warning, or even caution . . . We were on an unprecedented energy outlay . . . Then came the oil embargo of late 1973.

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*Richard J Anderson, Battelle Memorial Institute

Clearly, we are living on an earth which is limited in its capacity to satisfy our enormous demand for energy supplied by fossil fuels. We must stop using energy which is fed from these sources as if they would last forever

Energy is consumed almost equally in the major sectors of our national economy: transportation, residential/commercial, and industrial. Electricity generation accounts for one-fourth of our energy consumption. Electricity is often called secondary energy, for it requires conversion of a primary energy source such as coal, petroleum, nuclear fission, or hydropower for its generation

Americans have more than doubled their total energy consumption in the last 25 years. Demand for energy, per capita, has increased by 50 percent in that time. Clearly, our use of energy extends well beyond our *needs* into the limitless category of *wants*.

How much energy are we really consuming? The following table shows the 1973 energy budget for the average American family, when each family spent about seven percent of its income on energy. Gasoline for the family automobile(s) accounted for over a fourth of the average family's energy outlay, exceeding the expense of home heating. Americans spent almost 17 times as much for energy to operate automobiles as on public transportation

Consider our affair with the ever-present automobile. The roughly 100 million cars in this country—almost 50 percent of the world total—consume more than 75 billion gallons of gasoline in

Energy Use In the United States Today, by Sector (1971)

	Percentage of Total Consumption	Major Source(s)	Examples of End Uses
Transportation	24	Petroleum and petroleum products (95%)	Moving our vehicles—automobiles, trains, planes, ships, trucks.
Residential/ Commercial	20	Natural gas (40%) Petroleum (40%) Electricity (15%)	Space heating and cooling, water heating, cooking, refrigeration, air conditioning, lighting, clothes drying, running appliances (for homes, stores, offices)
Industrial	28	Natural gas (45%) Petroleum (25%) Coal (20%) Electricity (9%)	Operating machines to produce wide array of manufactured goods.
Electricity Generation	28	Coal (55%) Natural gas (20%) Hydropower (10%) Petroleum (10%)	Electric power plants generate electricity for other sectors (less than 50% efficient), electricity generation not an end use.

Source: Dupree and West, *United States Energy Through the Year 2000*, U.S. Department of the Interior, 1972.

Annual Household Energy Budget for Average American Family (Mid-1973)

Energy End Use	Form of Energy	Percent	Equivalent Amount of Gasoline (gallons)
Automobile	Gasoline	28.2	911
Space Heating	Natural Gas, Oil & Electricity	27.8	897
Major Appliances	Electricity	2.7	88
Water Heating	Natural Gas, Oil & Electricity	6.2	201
Air Conditioning	Electricity	1.6	53
Lighting & Other Electrical	Electricity	1.4	46
Cooking	Natural Gas & Electricity	1.9	60
Miscellaneous Household & Recreation	Gasoline	0.6	20
Public Transportation (Intercity, Nonbusiness Trips)	Jet Fuel, Diesel & Electricity	1.7	54
(Intracity Trips)	Diesel & Electricity	0.1	5
Waste Heat, Electricity Power Generation	Coal, Oil, Natural Gas & Nuclear	21.8	704
Refinery Loss in Gasoline Production	Petroleum	5.9	192
	TOTALS	100	3,231

Source. *Citizen Action Guide to Energy Conservation*. Citizens Advisory Committee on Environmental Quality, 1973.

traveling more than a trillion miles a year One out of six working Americans has a job associated with the automobile business The total annual energy used by passenger cars in the United States (including fuel consumed, losses in petroleum refining to make gasoline and oil, energy used in manufacturing, and repairs) is equal to nearly 150 billion gallons of gasoline or one quarter of gross national energy consumption While transportation energy consumption in most other countries is primarily for hauling *goods*, in the United States it is primarily for hauling people In the chart below, originally published in early 1974, the U S. Office of Science and Technology has plotted this dramatic fact

Three decades ago, Ohio, like many other states, was interlaced by a system of interurban railroads These railroads provided cheap, reasonably convenient transportation between population centers. Where are they now?

As the cheaply fueled automobile became America's people mover, our patterns of living, going to work, and shopping changed Attempts to replace the auto with public transportation have not been successful No longer do we walk to the grocery store, we drive to the shopping center There are signs that some of us are rediscovering the bicycle However, many people still would rather take the family car to recreational areas rather than walk or put up with the inconvenience of a bus

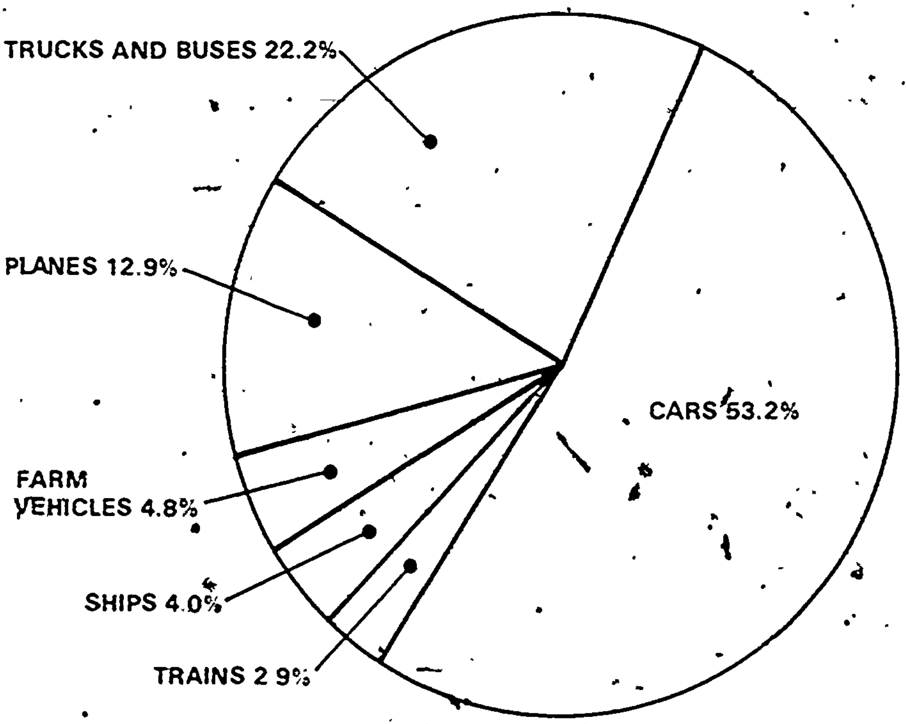
The fact of the matter is that we are so accustomed to using abundant, cheap energy that a sincere national conservation effort will have to be a trying one.

It is true that, with six percent of the world's population, Americans now consume one third of its presently available energy. However, the substitution of mechanical energy for muscle power has traditionally been a source of national pride in a world that acclaimed inventiveness, technology, and a high standard of living.

In the midst of plenty and the exhilaration of discovery, we have come to depend almost exclusively for energy on exhaustible, nonrenewable fossil fuels. The fossil fuels in the earth now are, for practical purposes, all that we will ever have. This dilemma is at the heart of man's current energy problems

Alarmed by the present situation, some of us are taking the attitude that this has been wrong. We lose sight of what can be done to

Transportation Wheel of Energy Consumption in the United States



make the world a better place through the constructive use of technology If new power sources can be developed, there is no reason to believe that we cannot retain the truly meaningful parts of our technology and continue to spread the advantages of mechanical power to other countries But until we have new sources, we must live prudently

Some of today's best science students will be helping design more efficient energy conversion systems Meanwhile, we must make do with machines which are notoriously wasteful in design This waste is illustrated by the average automobile engine, which operates at less than 30 percent efficiency A home oil furnace is 65 percent efficient An industrial gas turbine is only 35 percent efficient. A steam turbine is less than 50 percent efficient in generating electricity, and when that electricity is transmitted long distances, there are substantial losses from the power lines. Prudent operation of mechanical devices can minimize heat losses—whether the heat goes up the chimney, into the cooling water of a power plant, or is lost by friction in the brake linings of the family car

Well worth remembering are these seven thought-provoking energy shortage facts

(1) No single "new" source of energy is going to materialize suddenly and rescue us from today's shortages

(2) It will be 1977 or 1978 before the Alaskan pipelines are finished to bring us oil and natural gas from Prudhoe Bay

(3) It will be 1979 or 1980 before new gas or oil deposits can be found off the Atlantic and Pacific coasts of the United States and brought into production, if indeed they actually exist there, and if they can be recovered without disastrous effects on the environment.

(4) New plants to produce synthetic natural gas or synthetic fuel for motor vehicles will require at least 3 or 4 years to build, even if we could decide *now* what process to employ It could be 1982 or 1985 before significant supplies of synthetic fuel begin to circulate through the national distribution system.

(5) Nuclear reactors, on order or under construction, take years to complete. Major nuclear contributions of electricity to the national supply are not expected before 1985. (Today's nuclear share of the national energy budget is less than two percent.)

(6) Advanced nuclear development, such as commercial breeder reactors, could be 10 to 20 years away. Fusion, despite new and encouraging discoveries, is still a hope for the 21st century, not the 20th.

(7) Important additions to the normal energy budget from solar, geothermal, or tidal sources are not expected for another 10 to 20 years.*

These facts lead to an unavoidable conclusion our only recourse during the next 10 years or more is to increase fuel imports or reduce our consumption It may be uneconomic to seek *total* energy independence in the very short run. Yet, to increase our imports will mean a growing balance of trade deficit and possible further devaluation of the dollar. The other option is to *conserve* wherever energy is used, not by throwing away our electric toothbrushes (which consume a paltry 6/10,000ths of one percent of our electricity) but by careful and intelligent use of dwindling resources

*Richard J Anderson, Battelle Memorial Institute

WHAT IS ENERGY?

We get our ability to perform work from the sun. Much energy is stored as nonrenewable fuel resources. To conserve these resources, we must eliminate waste . . . particularly waste heat.

QUESTIONS TO GUIDE YOUR READING

How is *energy* defined in physics?

What are the two forms of energy?

What two kinds of energy transformations take place in the sun?

The three types of energy conversion processes are mechanical (physical), chemical, and nuclear (atomic).

(a) In which of these processes is waste heat generated?

(b) Which is the process responsible for all the energy we have?

(c) Which process takes place in a storage battery?

What unit is used commonly to measure potential or kinetic energy?

When a substance is heated, it increases the movement of atoms, therefore, heat is really what kind of energy?

WHAT IS ENERGY?

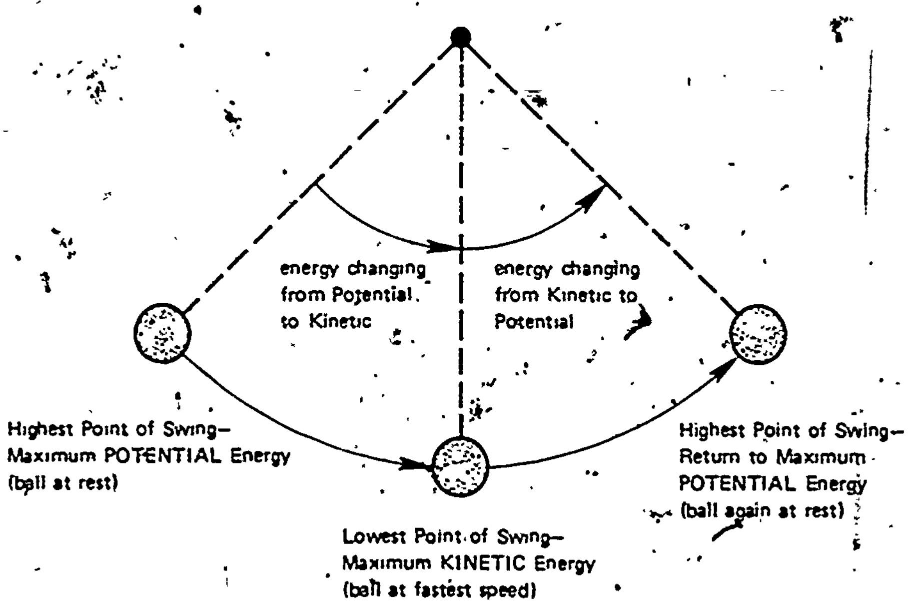
Energy is a word used widely, but often with little thought. There are problems of meaning and problems in scale. *Sheer energy* in a television hosiery commercial may confuse youngsters, nor does it seem meaningful to equate the energy in a popular breakfast food with what the news commentators discuss when they consider new manifestations of the energy crisis (though, of course, food shortages and energy shortages are inexorably related). Frequently, students may be confused and apprehensive, perhaps even turned off. To turn them back on, and provide new awareness, it's practical to introduce energy thinking into other instructional areas, as well as science.*

"How did the Pilgrims use energy? What energy sources did you use this morning in getting up and coming to school? What can you do each day to save energy, and how much can you save? What energy sources are used by the school?" These are some of the questions one can ask.

We all know that energy is the capacity or ability to perform work. What, then, is work? *Work*, in physics, is a push or a pull (called a *force*) on an object which causes that object to move against a resisting force such as friction, gravity, or simple inertia. Since effecting movement is what we mean by work, obviously play is a kind of work, as are all human actions.

Any moving object is capable of performing work, and therefore possesses energy. We call this energy the *energy of movement* or *kinetic energy*. A rock falling from a cliff into a pool of water has kinetic energy due to gravity. Furthermore, any stationary object also possesses the capacity for moving and performing work, for it, too, is acted upon by gravity, which is opposed by a stronger resisting force keeping the object from moving. The stationary object, such as the rock on the cliff before the fall, possesses the *energy of position* or *potential energy*.

Potential and kinetic are the two states of energy. An object at any given moment is either at rest or in motion; its energy is either



Energy Transformations—A Pendulum

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*For illustrative teaching procedures, see the teaching units potential or kinetic Obviously, work is done only after an object passes from the potential state to the kinetic state, when its stored potential energy is released A swinging pendulum illustrates the transformations of energy from potential to kinetic and back again

Several different processes may bring about a change in the energy of an object from potential to kinetic These processes are either mechanical (physical), chemical, or nuclear (atomic) in nature

All of these energy-state transformations set something in motion which then has the capacity for performing work The very first process is a nuclear process The sun is a continuous source of nuclear and thermonuclear energy, it releases energetic nuclear particles and "waves" (photons) which continuously bombard the earth Much of this energy is absorbed by the earth s atmosphere Some of it (sunlight) penetrates the atmosphere, where it strikes green plants which convert it to chemical energy by a natural process, photosynthesis It is this natural process that is responsible for all the fuel we burn Wood comes directly from green plants Coal, oil, and natural gas are the fossilized remains of green plants and of plant and animal organisms which consumed them

When chemical energy is used up, there is no actual loss of matter That is, the combustion products of coal or oil weigh as much as the fuel did in the first place But in the sun, matter is actually transformed into energy And, as we learn from science, the possible energy yield from converting matter is tremendous In the sun there are two processes, fission (the splitting of heavy atoms) and fusion (the combining of light atoms) We are beginning to use the fission process directly to produce heat in nuclear power plants We have produced fusion energy so far only in the hydrogen bomb Man's hope for ultimate plentiful supplies of energy rests on better control of the fission and fusion processes

Except in a few cases, such as storage batteries, heat is always generated as an intermediate step between chemical energy and mechanical energy Heat causes air, steam, or some other gas to expand, and the expanding gas sets something in motion In nature, a cloud may be set in motion In man's environment, the heat can be used to drive a piston or turn a wheel No mechanical device even approaches being a perfect energy converter, some heat always is lost to the surroundings, and there are other losses when heat is generated by friction.

We get most of our electrical power from mechanical energy, requiring another conversion step and more friction losses In a storage battery, chemical energy is converted directly into electrical energy but there still is some heat loss Devices for converting heat energy directly to electricity are being investigated in the laboratory and ultimately may become important assets to energy conservation.

When potential energy is converted to kinetic energy, heat is evolved, plus possibly light and sound. Actually, heat is really a form of kinetic energy due, basically, to the increased movement of atoms in the substance

Processes of Energy Transformation

MECHANICAL (physical) Force pushes or pulls on an object causing it to overcome resistance and move. Origin of force may be man, other animal, plant, wind, water, machine, heat, gravity, magnetism.

Examples: bowling ball strikes pins;
plant pushes up through soil;
tornado uproots tree;
milk is poured on cereal;
toaster pops up toast.

CHEMICAL Two or more substances brought into contact under certain conditions cause reaction which moves something (often expansion due to heat generated).

Examples. effervescent tablet fizzes in water;
cake rises in oven;
match burns when struck.

NUCLEAR (atomic) Tremendous potential energy holding atomic nucleus together is transformed to heat and light and great expansion of air. Some matter is transformed directly to energy. Two processes. (a) fission or splitting of nucleus by bombardment with subatomic particles, (b) fusion or joining of two nuclei under great heat and pressure.

Examples nuclear power plants, "atomic" submarines, atom bomb (all fission), sun's surface, hydrogen bomb (fusion).

that is heated Because heat is a result of every energy transformation, and because any energy source can be converted into an equivalent amount of heat, the measurement for heat—the British thermal unit (Btu)—is used commonly to measure potential or kinetic energy One Btu is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit There are about 13,000 Btu in a pound of bituminous coal, 1,032 Btu in a cubic foot of natural gas, 132,000 Btu in a gallon of gasoline, and 145,000 Btu in a gallon of home heating oil.

When one state or form of energy is derived from another, we have *energy-to-energy conversions;* these are happening all the time around us (and even inside of us). The one important thing to remember is that you get only as much out of an energy-to-energy-conversion as you put in; only the forms or states of energy are changed when energy is converted from one form to another. There's no such thing as getting something for nothing.

Of all energy conversions occurring all the time, only a very few will result in work useful to man. We increase the number of conversions that generate useful energy through converters called *machines,* which transform energy of one form, the *fuel,* into energy of another form, the *product.* An automobile engine converts, by burning, the fuel gasoline, a form of stored chemical energy, into the mechanical energy of motion. Our own bodies convert food into movement, heat, and all life processes The excess heat and sound generated by an automobile engine are mostly waste energy, not useful to our purpose of moving from place to place

The term *efficiency* of a conversion process or a machine refers to the ratio of useful product to the total amount of input (or output) As users or converters of vast quantities of energy, we are therefore concerned not only with the supply of energy available to us, but equally with the efficiency of our energy-conversion processes.

Electricity is clean, available instantly, and easily transmitted. Since 1950, generation of electricity in this country has increased by a factor of four. However, both the generation and transmission of electricity involve some waste energy Generation of electricity—the conversion of fuel to electrical energy—is less than 50 percent efficient in even the most modern plants. In many of the older plants as much as two-thirds of the energy generated is lost as waste heat which is exhausted as "thermal pollution" through plant stacks and cooling water. Ten percent of the electricity actually generated is lost during transmission. Newly developed and costly means of transmitting electricity through chilled underground cables have the potential of reducing this loss measurably.

We have seen that all energy conversions—and all our sources of energy—can be traced back to nuclear energy in the sun. Man is only beginning to make use of nuclear energy conversion processes on the earth. The fuel that is presently available for these processes (an uncommon form or isotope of uranium called U-235), is limited in extent and costly to obtain. Other potential fuels for nuclear *fission,* the splitting of heavy atoms, are more plentiful, but they will require many years of technological development. Potentially, the fuel for thermonuclear *fusion* is as abundant as the hydrogen in the oceans, but realistic fusion power may have to wait for the 21st century. This leaves nonrenewable fossil fuels—coal, oil and natural gas—as today's principal energy sources. (Hydroelectric power and other nonfuel sources account for only a small part of our energy budget.) We must simultaneously conserve our remaining fossil fuels and learn how to use them as efficiently as possible.

ENERGY SOURCES

Coal is the only fossil fuel still widely abundant in the United States, but there are problems associated with mining and using it. Ohio is a major producer, but Ohio coal is high in sulfur content.

QUESTIONS TO GUIDE YOUR READING

Uranium, green plants, coal, natural gas, sunlight, fuel oil, oil shale, and hydropower are sources of energy.

(a) Which of these sources are renewable or continuous?

(b) Which of these sources are nonrenewable or exhaustible?

What are the three principal fossil fuels?

Which of the fossil fuels is most abundant in Ohio?

What percent of U.S. energy comes from petroleum and natural gas?

Ohio supplies what percent of the petroleum that is used in the state?

At the beginning of the 20th century, coal supplied about 90 percent of the nonrenewable, inanimate energy in the United States. How much does it supply now?

How many million tons of coal each year (half of U.S. production) come from deep underground mining?

The remaining U.S. coal production each year comes from what type of mining?

What is the principal disadvantage of Ohio coal?

ENERGY SOURCES

Some energy is obtained from sources directly related to the flow of heat and light from the sun. We can term these sources, cautiously, *renewable* or *continuous* energy resources. As long as the sun rises every morning, its energy will be available and constantly replenished.* The amount of solar energy received daily by two square miles of the earth's surface equals the energy released by burning 7,000 tons of coal, or the daily energy output of Hoover Dam. However, we lack the technology to store most of the sun's energy. If we knew how, a year's supply of energy for the world could be gathered from sunlight reaching the earth in three hours and 12 minutes. As a source, solar energy is presently very costly, but extremely valuable. What is needed is an inexpensive means of converting solar radiation to useful energy.

Other energy sources which owe their existence ultimately to energy from the sun and the earth's formation are stored in a kind of potential energy fund. Their supplies have finite limits and, in most cases, are not being replenished. They are *nonrenewable* or *exhaustible* energy resources.

We call these *fossil fuels* because they were formed from animal and vegetable matter that collected at the bottom of ancient seas and in swamps millions of years ago. This debris was buried by inorganic residue and subjected to great heat and pressure as well as bacterial and chemical action. The end products—oil, natural gas, and coal—contain large quantities of stored solar energy in the form of hydrocarbons.

We can make several generalizations about the *fossil fuels* which account for more than 95 percent of the inanimate energy supply in our state.

- All are found primarily within the earth and extracted at great cost. This means expensive exploration to locate them (except for coal) and large investments of capital to extract them (especially in the case of off-shore petroleum and coal).
- All are storable and transportable—petroleum by pipeline, tanker, barge, truck and rail, natural gas by pipeline (liquefied natural gas by special tanker and barge); and coal by rail and slurry pipeline.
- Oil and coal have important nonfuel uses as raw materials in production of plastics, lubricants, and the like. In the future, many experts feel that coal may actually be better suited for (and could be more efficiently used in) such nonfuel capacities (nonfuel use of coal now accounts for about five percent of the total use).
- Because of their location, composition (especially when high in sulfur), and the process by which they are converted, coal, and to a much less extent, petroleum and gas, require an alteration of the landscape in their extraction and can release pollutants into the air and water when produced and used.
- They are all largely burned, releasing heat energy to perform work.
- All are nonrenewable.

Early in his development, man learned to control the release of stored solar energy through fire. By learning how to use this basic chemical reaction, he became the only species capable of controlling its own environment. Later came agriculture, the domestication of animals, and the harnessing of the kinetic energy of winds and falling water, sails, windmills, and water wheels.

For several centuries, two kinds of renewable energy sources—wind and water—and two kinds of nonrenewable sources (which must have seemed *infinitely* renewable to early users)—wood and coal—vied as the major producers of mechanical work output for civilized man. But the scales became weighted toward coal when the steam engine came into being 200 years ago. (Fittingly, two of the first major uses of the steam engine were to pump water from coal mines and to transport trainloads of coal to factories.) Wind power had its last great days in the 19th century, before the completion of the Panama Canal, when clipper ships brought cargos around the tip of South America.

In the United States, as wood was used up and an expanding population began to demand industrial products, the change to fossil fuels—though later than in Europe—occurred at an

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*A total of 13.9 x 10[illegible] Btu reaches the earth daily accelerated rate In 1850, coal accounted for only 10 percent of American fuel consumption, wood for 90 percent. But by 1885, coal passed wood, and, by 1910, the situation of 1850 was reversed coal 90 percent, wood 10 percent After World War I, petroleum was twice as important as wood, though coal was still predominant But, by 1946, the petroleum fuels began to outrank coal

Known for centuries as a product of oil seeps oozing directly from the ground in a few parts of the world, oil was first obtained by drilling in Pennsylvania in 1859 For hundreds of years it had relatively minor use for lighting and heating, but major use in transportation began around 1900 Some 25 years ago, geologists found evidence of large deposits of oil just off the coasts of some lands, under the ocean and under what is called the continental shelf. Offshore oil drilling offers the major hope for finding new oil to replace diminishing supplies today But offshore drilling is costly and subject to the possibilities of leakage which can pollute beach areas. Nor is it easy to extract oil wherever it is found. (The "gushers" so often pictured are the rare exception to the normal recovery process.)

Oil does not occur in large reservoirs underground, but rather it is found in the interstices of sand and rock. It is held there so firmly that often no more than a tenth of it will come to the surface unaided by pressure. Frequently, even pumping is not enough because oil is so viscous and the rock is relatively non-porous. Even with best available technologies, only about a third of the oil in any field may be recovered When water flooding, gas, injections, and underground combustion are used, the recovery may be as high as 70 percent, but such high-cost processes may not be justified The low price of oil has led to waste and has discouraged exploration for new supplies.

Natural gas—previously wasted—began its popularity in the 1940's with the completion of pipelines linking gas fields with user cities. For two decades beginning in 1940, the consumption of natural gas increased at an average rate of 6 6 percent a year, representing nearly two-thirds of the growth in the country's energy production Gas is clean, and it was cheap, with prices held down by Federal regulations. In the early 1970's, natural gas powered 43 percent of industry and heated and/or cooled the homes of 150 million Americans. Recent Federal regulation changes have encouraged the development of natural gas resources by specifying higher rates for gas from "new" wells than from "old" wells, but because consumption is so great, our gas reserves have an even shorter life expectancy than our oil reserves.

Though available since the American continent was settled, coal still presents problems in mining and exploitation. About 300 million tons of coal each year, half of U.S. production, come from deep underground mining. But deep mining is declining because of costs, job hazards, and poor working conditions. The other half of United States production of coal comes from strip mining, and this half must increase if we are to use coal to fill the energy gap. But strip mining has well-known environmental problems. Another difficulty is that our coal reserves which are low in sulfur lie predominantly in the west, away from centers of population. Although companies are working on anti-pollution measures, technology has not yet found an economical way to remove the sulfur from high-sulfur coal before it is burned.

Coal is the only major fossil fuel which could be utilized more completely in the United States. No industry has a greater opportunity to respond to the energy problem. We have 20 percent of the world's supply; in fact, 89 percent of all our fossil fuel reserves are in the form of coal deposits. We also have relatively large deposits of oil shale; but extracting the oil presents major problems of cost and environmental disruption.

At the beginning of the 20th century, coal supplied about 90 percent of the nonrenewable, inanimate energy in the United States Since that time, coal production has remained relatively constant but coal's share of the energy budget has dropped drastically Meanwhile, oil and natural gas have changed places with coal.

Some 77 percent of United States energy now comes from oil and natural gas, and reasons for this are not hard to find. Petroleum fluids are easier to handle and use than coal solids, particularly for cars and other mobile combustion sources. Our massive high-pressure gas pipeline network makes natural gas available in most homes, gas heating units are clean, convenient and inexpensive. Oil is the versatile source of a wide variety of liquid fuels and chemicals, and it is relatively easy to remove polluting sulfur from oil. Even with price increases at the pump, gasoline is still fairly cheap. During the 10 years prior to the time of the Arab oil embargo of 1973, gasoline prices increased considerably less than half as much as prices for other consumer items.

On the horizon are ways of synthesizing gas and liquid fuels from coal, of converting underground coal deposits to gas without mining them first. Twenty years ago gas made from coal was widely used in the United States, and the "gas works" with its huge expanding storage tank was a prominent (though not particularly attractive) feature in the urban landscape. The coal gasifier of 20 years ago, originally developed in Germany, is still the only one on the market. Caught napping because of our apparent abundance of natural gas, we have neglected research in coal gasification. Only recently have we begun to mend our ways. And the potential is there, providing we are willing to pay for it. Gasification may ultimately create the biggest new market for coal

In Ohio, the energy source picture differs somewhat from the national picture. We are fortunate in having abundant coal at a time when petroleum and natural gas are in short supply. But most of Ohio's coal is high in sulfur content, and much of it is economically extractable only by strip mining.

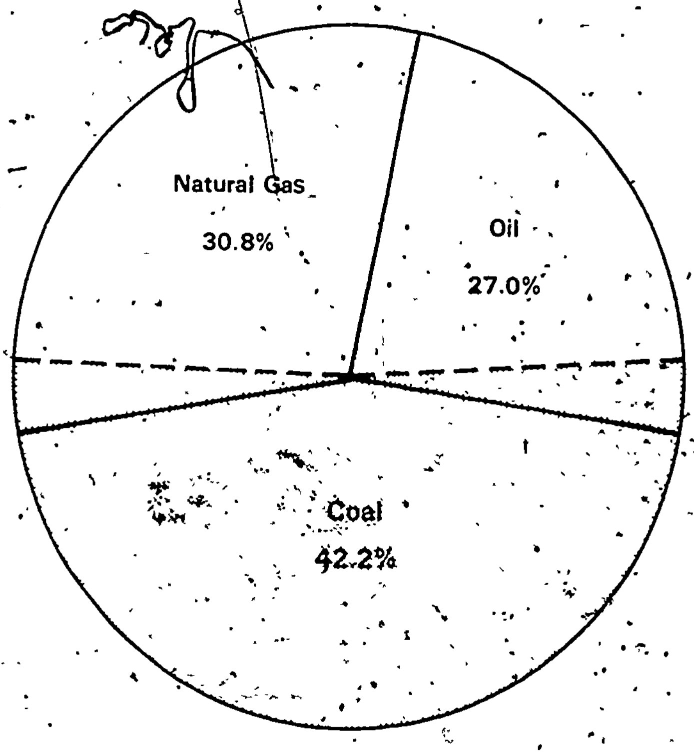
While only two percent of the nation's known recoverable coal reserves are in Ohio, this amounts to more than 20 billion tons of bituminous coal. Ohio supplies roughly 10 percent of the nation's coal and consumes more coal than any other state Coal satisfies more than 40 percent of Ohio's energy needs, far more than the national average, supplying 95 percent of the fuel for generating electricity in the state

Ohio uses about the same percentage of natural gas for its energy needs as do most other states—about 31 percent—but can supply only about seven percent of its needs, importing the remainder from other states. Roughly 60 percent of the natural gas is used for residential purposes and 40 percent for industry.

The remainder of Ohio's energy needs are met with oil, 95 percent of which is imported from other states or supplied by companies which rely heavily on foreign suppliers. Ohio's use of oil, which is considerably below the national average, is mainly for transportation.

Ohio's annual consumption of electricity exceeds 106 billion kilowatt hours, placing the state third in electric power consumption, behind only California and Texas. In residential consumption of electricity, Ohio (with 26 billion kilowatts) ranks sixth, behind California, Texas, Florida, New York and Pennsylvania. In commercial and industrial consumption, Ohio (77 billion kilowatts) ranks third, behind California and Texas.

Consumption of Fuels in Ohio (1971)



Shaded areas indicate portions of Ohio fuel consumption which could be supplied by the state's resources, assuming present levels of production (less than 7 percent each for natural gas and oil, 100 percent for coal).

Source U S Department of the Interior.

Less than 10 percent of this country's energy consumption is presently supplied by three non fossil fuels hydropower—a renewable, continuous source, wood—a questionably renewable one, and nuclear fission—a non renewable, highly controversial one. Such renewable sources as wind power and solar heating are as old as civilization. Their present use is minimal, but their potential is great (They will be dealt with in the next chapter)

Why we have changed from one energy source to another is an interesting topic for discussion and speculation Historically, we owe much of our progress to the transition from animate energy sources (horses, human backs) to nonrenewable inanimate ones Coal replaced wood because it was a more efficient fuel and because wood was becoming scarce Petroleum replaced coal—even though substantial reserves of coal remain—largely because it is easier to use. In these processes, wind and water power were sidetracked. Water power received some emphasis for generating hydroelectricity, but the lack of availability of sites for hydroelectric power stations imposed a realistic limit Man lacked the incentive to develop wind power (considered an unreliable source) beyond its early application to windmills.

What will the trend be at the beginning of the 21st century—when today's students will have been making the decisions about fueling America?

Energy may be obtained from the hot interior of the earth. Geothermal energy is largely untapped and additional research is needed to determine how this source may relieve the shortage.

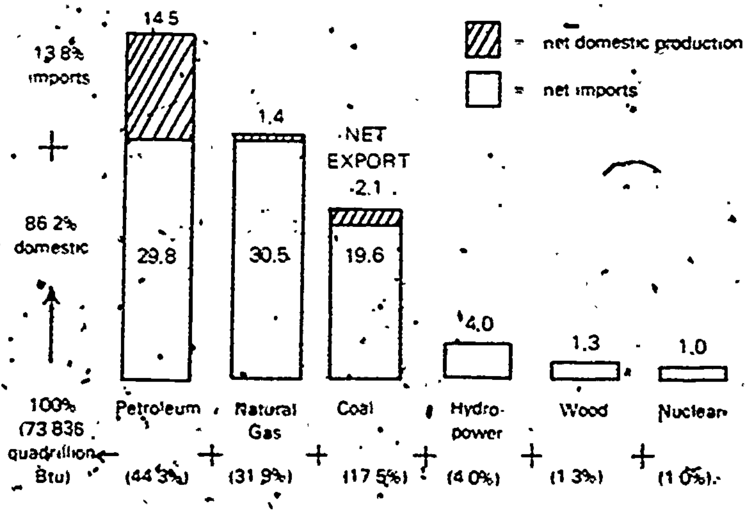
The movement of water has long been a useful energy source Although its use in an earlier day was readily apparent in grist mills located by rivers, it has never provided more than four percent of our needs even as hydropower At some future date, water may be a more useful source Investigations are being conducted to determine the feasibility of extracting large amounts of energy from ocean waves

Shale comprises a resource base for oil extraction Deposits are mostly located in government lands in Colorado and Wyoming, these areas may prove of value in the search for additional oil

The nuclear source of energy is of significance in part because this nation has the greatest low-cost uranium reserve in the free world. Extraction of this source is costly and the by-products of its use create a disposal problem, but its availability in large amounts will compel further investigation of nuclear energy's potential to help alleviate the shortage. Potentially, thermonuclear fusion has an almost limitless fuel supply—hydrogen. But there must be a major scientific breakthrough before fusion power can be considered seriously

For the short term, our reliance would seem to be on oil and gas. For the long term, we will be looking to coal and atomic power With large United States reserves, coal would appear to see us through the first quarter of the next century. For any lasting relief, we must hope that practical means can be found to tap hydropower, solar radiation, winds, tides and geothermal sources on a large scale. In the immediate future, the hope for alleviating shortages lies with reducing demand

United States Energy Consumption by Source—Mid-1973



Source Citizen Action Guide to Energy Conservation 1973

MAJOR ENERGY SOURCES

	PETROLEUM	NATURAL GAS	COAL
Composition/ Origin	Hydrogen and carbon formed from tiny marine organisms and plant matter buried under ancient seas, under great pressure.	Methane, petroleum (natural gas liquids are also formed). May be liquefied at cost for easier transportation by tanker, truck.	Varied composition — mostly carbon, some hydrogen, varying amounts of sulfur; formed from plant remains buried under ancient lakes and bogs under great pressure; three types, of increasing age and hardness, are lignite, bituminous, and anthracite.
Location	Underground "reservoirs", petroleum trapped in interstices of sand and rock, largely Texas, Oklahoma; off-shore under Continental Shelf (Louisiana, Texas, southern California). Large untapped deposits in northern Alaska.	One-half is found wherever petroleum is found and one-half is found in underground rock (especially southwestern and south central states). Forms "cap" on petroleum deposits and provides pressure to aid petroleum extraction.	At varying depths from just under surface to far underground; found in 27 states.
Extraction/ Conversion	Wells drilled up to 25,000 feet depth, 15% of reservoir of petroleum rises to surface because of underground gas and water pressure; pumps remove 15% more; another 20% may be recovered but at a much higher cost. Crude petroleum is refined through separation into fractions at different boiling points. From chemical modifications and blending of the fractions, products are given the desired characteristics.	Removed by wells, rises to surface under pressure, some is found with petroleum, some is found alone. Natural gas is treated to remove heavy hydrocarbons and hydrogen sulfide, which can be used by the petroleum and petrochemical industries.	Underground mines (only half of coal in a deposit is recovered) and strip- and open-pit mining where surface earth is removed and coal cut and shoveled out by machine. Sizing, washing and cleaning for traditional combustion uses. Conversion to synthetic natural gas and liquefaction by treatment with hydrogen are in the demonstration stage.

MAJOR ENERGY SOURCES (Continued)

	PETROLEUM	NATURAL GAS	COAL
Uses	60% transportation (largely refined as gasoline, diesel fuel), 20% residential/commercial heating, 10% electrical generation.	45% industrial fuel, 35% commercial heating, 10% electrical generation.	65% electrical generation, 30% industrial.
Advantages	Easy to use, store and transport; ideal fuel for transportation industry.	Cheap, clean, easy to transport.	Cheap, large reserve, Appalachian sources close to large markets.
Disadvantages	Domestic supply has declined in recent years; increase in usage requires increased foreign exchange; refining of high sulfur crude can cause pollution.	Difficult to store, increasingly in short supply.	Expensive to transport. Ash disposal and fly ash out of the stack cause pollution. Combustion of high-sulfur coal releases sulfur dioxide. Low sulfur western coal is distant from large markets. Underground mining is a hazardous operation unless elaborate precautions are taken. Surface mining (strip mining) causes environmental problems unless expensive reclamation is undertaken.

MINOR ENERGY SOURCES

	HYDROPOWER	NUCLEAR FISSION	WOOD
Composition/ Origin	Water impounded in dams; tidal water area potential resource.	Uranium and thorium ores.	Trees, wood waste, agricultural waste.
Location	Often in remote and mountainous areas.	Ores are found in Colorado Basin, Canada, South Africa, Zaire, India.	Areas often remote from large population centers.
Extraction/ Conversion	Water turns turbines producing electrical energy. (Virtually all hydropower is converted to electricity.)	Chemical processing concentrates ore, enrichment of desired isotopes by physical means, e.g., gaseous diffusion. In nuclear reaction, nuclei of heavy atoms of "fissionable" isotope are bombarded by neutrons causing nuclei to split, converting the matter to great quantities of heat. Fission of one atom releases neutrons causing a chain reaction, splitting other atoms in a controlled process. Turns water to steam to drive turbines and produce electricity.	Trees are grown, felled and collected at wood or crop processing centers. Burned for heating and cooking in some places.
Uses	100% electrical generation.	100% electrical generation.	50% heating homes 50% industrial (scrap). 34 million cord in 1975

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MINOR ENERGY SOURCES (Continued)

	HYDROPOWER	NUCLEAR FISSION	WOOD
Advantages	Efficient, little waste heat; inexpensive, renewable energy; may be conserved through pump storage; environmental effects generally slight; reservoirs may enhance recreational value of area.	Heat value of one ounce of U235 equal to 388 barrels of petroleum. Very rapidly growing as an energy source — the "energy source of the future."	Availability, wood is renewable, given time to grow new forests.
Disadvantages	High capital construction costs; requires very special location, few good sites remain; may flood land better used for other purposes (agriculture); evaporation rate high in arid lands.	Controversy over harmful effects of radiation leakage into surrounding area from unlikely, but still possible, accident; possible leakage from radioactive wastes; the common "light-water reactor" requires large quantities of water for cooling — recycling water into lakes or rivers may result in thermal pollution. U 235 is scarce — new breeder reactors may alleviate problem.	Low heat value per unit volume; non-fuel uses more important; only practical in certain locations.

ENERGY SOURCES FOR THE FUTURE

SOURCE	HOW CONVERTED	COMMENT
(Fossil Fuels)		
Oil Shale	A sedimentary rock which contains "kerogen", a substance that, when heated, yields shale oil; would likely be used as substitute for oil.	Present in huge quantities in Rocky Mountain states (estimates from 600 billion to 3 trillion barrels of oil). Adverse environmental effects of extraction by open-pit mining. Large quantities of shale required for small yield of oil (one ton of shale yields 30 gallons or less petroleum). Problem of waste disposal.
Tar Sands	Contain extractable petroleum substance.	Large deposits only in remote areas. Major supply in North America in Athabaska, Canada, frozen and difficult to extract and transport.
Coal Gasification	Coal reacted with steam followed by further processing produces synthetic natural gas (SNG).	Coal is plentiful, but the cost of processing plants is great ($500-$800 million). SNG is a clean and desirable fuel. New coal mines are needed.

ENERGY SOURCES FOR THE FUTURE (Continued)

SOURCE	HOW CONVERTED	COMMENT
(Natural Continuous Sources)		
Geothermal	Natural steam underground rises to surface with enough force to drive turbogenerators for electricity.	Clean, inexpensive energy. Used in Italy, Iceland, Japan, New Zealand, in the U. S. at the Geysers near San Francisco and California's Imperial Valley, with potential sites throughout western United States. Little natural steam exists underground. However, much heat in underground rock layers could be tapped by pumping cool water down to the rocks and retrieving heated water. Limited to local use in a few favorable locations. Problem of brine deposits clogging and corroding pipes. Surface pollution problem from New Zealand underground waters.
Solar	Collectors over a vast area focus sun's rays on a liquid which can conduct the heat to an electrical generating plant; or solar cells over vast area convert sunlight directly to electricity. Space heating.	An immense energy source. Little environmental effect except that large amounts of open space would likely have to be devoted to collectors to gather the diffuse energy of sunlight. Location would seem restricted to areas of great sunlight far from population centers in this country (drawback because of extent to which electricity is dissipated during transmission). At present, most important in home heating and water heating in specially designed houses.
Tidal	Same principles as conventional hydropower — rise and fall of tides rotate turbines to generate electricity.	Very efficient. Requires very special locations; few exist in North America, and those that do, such as the coasts of Maine and Alaska, are remote from population centers. Difficult to make energy supply continuous.

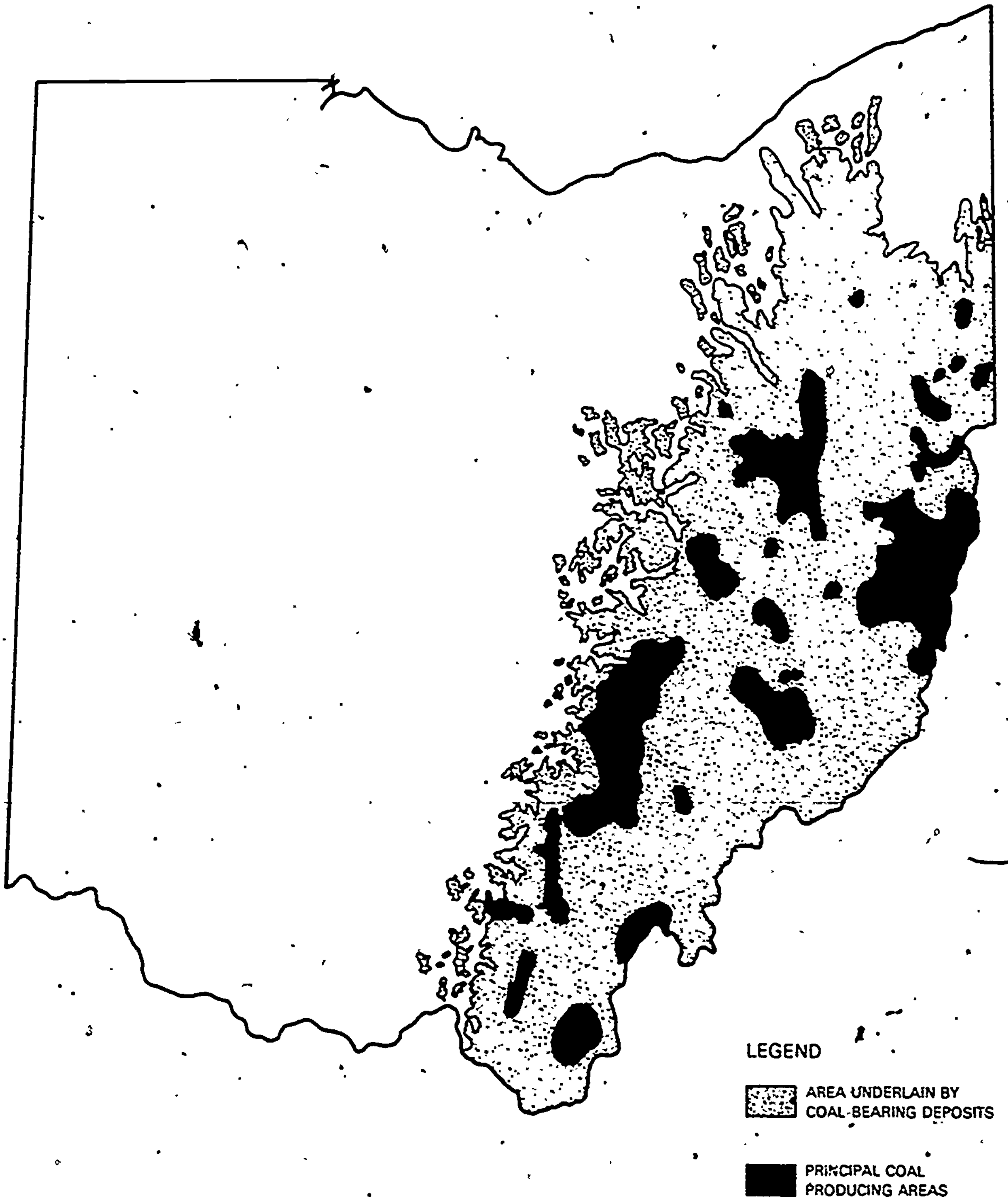
ENERGY SOURCES FOR THE FUTURE (Continued)

SOURCE	HOW CONVERTED	COMMENT
Wind	Same principles as hydropower – running air propels turbine to generate electricity.	Clean, neat, inexpensive. Very efficient. Location important – proposals generally for windmills on platforms in Great Lakes or on Atlantic Ocean. Better as local source in certain conducive areas. Sufficient wind for continuous generation unlikely.
(Other Sources) Hydrogen	Burning hydrogen for heating as with natural gas.	Most abundant element in universe, although extraction of hydrogen from compounds can be costly. Reactions between liquid hydrogen and liquid oxygen powered NASA rockets. Clean – only waste product is water. Drawbacks – dangerous to handle; one-half the energy content per volume of natural gas.
Fuel Cells	Battery-like, portable electric generators produce current from reaction of hydrogen and oxygen.	Little pollution, no noise, much more efficient in generating electricity than conventional generators. Drawback – very costly because of short life. Have been used only in space program.
Magneto-hydrodynamics (MHD)	Converts heat from combustion gases from coal directly to electricity by passing gases through magnetic field. Uses coal as starter fuel. Represents new kind of generator converter.	As an alternative to conventional coal-fueled power plants, MHD eliminates most air pollution, requires less fuel, is 1½ times as efficient (very little waste heat). At present many technical problems and little support for research. More research being done in USSR and Japan than in U. S.

ENERGY SOURCES FOR THE FUTURE (Continued)

SOURCE	HOW CONVERTED	COMMENT
Burning of Trash	Burning combustible trash, in mixture with coal or other fuel, to power electric generator.	Cheap, readily available fuel. Conventional combustible garbage possesses 50% of potential heat of coal. "Solves" garbage disposal problem. Although the air pollution problem remains, the waste disposal problem is alleviated. City of St. Louis currently getting some electricity from power plants fueled by garbage and coal. Trash must be carefully sorted.
Nuclear Fission (breeder reactor)	Uses U235 as "starter" to bombard surrounding atoms of nonfissionable U238 and convert it to Plutonium 239 which is fissionable, "creating" more starter.	Uses less scarce U235 than present light-water reactors. Some plutonium is produced directly in light-water reactors. Is cooled by liquid sodium (difficult to handle). Possibility of accident, especially during transportation of wastes, more of a concern with plutonium than with uranium. Technological difficulties.
Thermonuclear Fusion	Fusion of atoms of hydrogen to form heavier atoms of helium under extremely high temperatures (100 million degrees C) in a controlled reaction (as opposed to the uncontrolled fusion reaction of a hydrogen bomb.)	Hydrogen is very abundant. Ordinary seawater could be used as source of fuel. Very efficient reaction. Releases only small amounts of radioactivity. However, it is technologically very difficult to achieve a controlled reaction at present levels of technology and knowledge.

Ohio Coal Producing Areas



Source Ohio Chamber of Commerce

SEARCHING FOR SOLUTIONS

As America seeks to become energy self-sufficient once again, we develop new sources ranging from better nuclear power generators to huge solar collectors. But the lack of time compels us to conserve and recycle the energy resources that we can use today . . . not in the next century.

QUESTIONS TO GUIDE YOUR READING

What happened in November, 1970, that gave us cause to worry about our future oil supply?

By 1972, what fraction of our U.S. oil heritage of 200 billion barrels was gone?

What percentage of known petroleum reserves is located in the Middle East?

How many million tons of trash, potentially burnable in power plants, do Americans throw away each year?

Newspapers, potentially, are good candidates for recycling. What are two reasons why this isn't done more widely?

What factor will encourage the development of new energy resources?

What is the government program for national energy self-sufficiency called?

SEARCHING FOR SOLUTIONS

In 1972, Representative Chet Holifield of California said, "What this country needs to dramatize our energy crisis is a good 24-hour blackout."

We've come a long way since then, and there are few of us who do not realize that conserving energy and our country's future are inexorably related. Some of us even have stopped complaining about driving 55 mph to save gasoline! But, lest we become panic stricken, this is a time also for concrete solutions rather than desperate measures.

Oil and natural gas became the most widely used fossil fuels in the United States because we drew on our own resources, not those in the Middle East. In fact, we may remember the prophets of doom some years ago, who kept saying that the United States was running out of oil. Yet, new deposits were constantly discovered, and the future somehow was pushed back.

All of this came to a halt in November, 1970, when the *rate* at which we were finding domestic oil reserves failed, for the first time, to exceed the rate at which we were consuming oil. From that time on, the known reserves have declined steadily, we have increased our dependence on oil imports, which have tripled in the last 25 years. By 1972, about half of our known oil heritage of 200 billion barrels was gone, and the rest was becoming increasingly hard to get.

As oil imports increased, we became more dependent on foreign reserves, joining the nations of Western Europe whose petroleum reserves are considerably smaller than ours. We turned to the Middle East, source of 53 percent of known petroleum reserves, as well as to Latin America, which traditionally had made up our oil deficits. The activities of the oil cartel and the effects on our foreign trade and balance of payments are well known. As a result, the government, through Project Independence, has opted for national energy self-sufficiency by 1985. This project is a blueprint outlining the size and shape of our problem and recommending self-sufficiency as a national goal.

It is hoped by 1985 that it will make economic sense to "buy American." By that time, we may have curbed our energy appetite, which by 1970 was doubling every 10 years. We may also have developed new energy sources through research and better utilization of traditional sources such as coal.

Several trends justify a cautious optimism. We have realized that the environment is fragile and in some aspects irreplaceable, and technologies are being developed to harvest energy resources without as high an environmental cost as has been paid in the past. Technology is also advancing in the field of recycling, in order to lengthen the life of dwindling resources. Research is progressing on several fronts to harness the energy of renewable sources such as wind, sun and tides. Higher fuel prices are furnishing incentive to explore and develop new sources and conversion techniques.

Economic incentives, probably in the form of higher prices, will encourage searches for new deposits and promote further development of present ones. Such economic incentives will also spur efforts to improve refining and electricity transmission methods to cut down on energy losses.

However, these efforts will not alleviate the central problem. They will simply help us use our finite fossil fuel supply more efficiently. Increased funding for research and development of alternative sources will be needed to bring about the day when they are viable sources.

Surface mining companies can, and do, make efforts to restore mined lands to their former usefulness. Methods can be found for removing sulfur from coal, the key is to find a method that is economically feasible. Automobiles can be designed with smaller, more efficient engines.

Many things are being done to improve our extraction and conversion of energy sources so as to increase supply and lessen the environmental cost. More could be done. They are technologically possible, and they will be practiced increasingly as there is economic benefit to be gained from them in terms of added profits or penalties avoided.

Recycling is a key to extending our present resources until alternative energy sources can be made workable Recycling includes both the recovery and reuse of natural resources, and extending the life of products Here too, a united effort is required The student must be helped to understand that each of us can make an important contribution if we live conservatively and keep doing so. Meaningful recycling must go far beyond the two-week science project or the occasional paper drive We must start at home in an unglamorous way by using up what we have or wearing it out

Ohioans can be proud of the steps toward recycling already taking place in our state. Many city governments are considering the possibilities for burning wastes to supply power At Franklin, Ohio, there is an experimental *total* waste recycling plant, potentially capable of processing nearly all of the community's wastes for reuse..

Each year Americans throw away 125 million tons of trash, potentially burnable in power plants. Yet, the plants to burn this trash must be highly sophisticated, capable of removing air pollutants and operating with a variety of fuels. The wastes must be collected and brought to the plants in large enough quantities to make the processes economic.

Many of us save old newspapers for recycling, but here also are constraints. Large quantities of water, which may become polluted, are required for recycling paper pulp. And high freight rates make it costly to bring newsprint to a recycling plant even though it may cost less to make paper from recycled stock than from wood.

In many areas our old automobiles and other metal scrap are being almost totally recycled. Yet there still are problems in getting the scrap into sizes and forms in which it can be utilized. Burning the nonmetal parts of old automobiles is highly polluting; removing the copper wire from junked cars takes time. Big machines can chop steel scrap into bite-sized chunks for reprocessing, but these machines require considerable energy.

There are many approaches to new thinking and better conversion methods for recycling; better ways of handling wastes at home and in industry and at all levels of the recycling process. Has anyone ever thought of designing automobiles which, in addition to using gas more efficiently, can be recycled more easily? Questions like this are good discussion starters for all grade levels. How can "tin" cans be recycled? What provisions does your community have for recycling glass? How can we get more use from books and magazines?

As is true for environmental safeguards, the technology of recycling is, as yet, far ahead of the capacity of most communities to practice it on a significant level. One estimate is that large-scale adoption of municipal resource recovery systems is 10 years away. Most present systems consist of some combination of shredders, grinders, scanners, screens, and electromagnets to break down and sort out ferrous metals, aluminum, glass, combustible and noncombustible garbage. Some demonstration plants are developing the capability to yield fuel oil as well.

The economics of large-scale recycling pose more problems than the technology. In addition to a sizable investment in equipment, recycling centers must find markets for the sorted scrap. The overriding economics, however, may well be the savings in energy as well as raw materials. Recycling paper and steel requires 70 percent less energy than manufacturing with new materials.

Although today s energy situation is serious and the forecast is a challenge for survival, there is another side to our energy problems. Our belated realization that fossil fuels are finite may prompt a reversal in our energy use patterns from spendthrift to more thoughtful use. And the change may come soon enough to give us a margin of time in which to find other sources, other use patterns.

CONSERVATION: AN ETHIC FOR EVERYONE

We know we can work together for a common goal if we believe in it. The challenge is to make energy conservation a common experience that we all can share directly.

QUESTIONS TO GUIDE YOUR READING

What should you look for when your students complain they are cold in a heated classroom?

You and your students are planning a field trip, and you will be away from your classroom for the entire day. Turning out the room lights and turning down the thermostats are two possible energy conservation measures for your class. Can you suggest others for the field trip?

In past history, when a society ran out of energy, what could it do?

Why can't we do this today?

CONSERVATION: AN ETHIC FOR EVERYONE

We've seen the story over and over again in the movies and on television. A group of people in a lifeboat have only a little food and water. They divide up the supply, and each one takes just enough. For days they survive, and just at the last minute they are rescued. This is a simplistic illustration, but time and time again history has demonstrated that people will practice conservation and work together for the common good, providing they realize that they all are in the same boat. It is our job to make this realization meaningful to our students. Conservation is not just what one does somewhere else, out in the forests of the American West.

Some conservation measures are being imposed on us from the outside. We must pay more for luxuries, so we consume less of them and, thereby, we save energy. We must remember that society *also* is responsible for finding new and meaningful work for the people who formerly made these products. Higher prices inevitably will slow down energy demands, but in the long run energy conservation—and our very quality of life—must depend on our practice, together, of an energy conservation ethic. Like the environmental ethic already practiced in our schools, this new energy ethic must be with us constantly, interpreted in a way that makes us understand our needs and wants in the context of the world around us. We must all overcome the attitude that, if we can afford it, we should be able to use it. This attitude does nothing to solve the energy waste and conservation problem. Perhaps viewing conservation as energy insurance would help change attitudes and stimulate positive action.

We practice the energy conservation ethic when we understand that fossil fuels are very important to us, personally. How many children today actually know what a lump of coal looks like? How many know what happens when they plug in an electric toaster? Because children and youth are curious about the world around them, they may be far better prepared to appreciate the personal value of energy resources than their parents are. Creating a learning atmosphere in which they can understand and practice energy conservation is a challenge worthy of the personal commitment of every teacher.

For most of us, the changes will not be fundamental ones. We will be slightly cooler in winter, warmer in summer; make our purchases with a view to efficiency and recyclability, rely less on throwaway packaging, drive smaller cars at slower speeds, use public transportation and walk more, turn off lights we are not using, and learn to think of energy as money. We will not need to return to energy-use patterns of a century ago. But we might well return to the spirit of the slogan that was so popular during World War II. "Use it up, wear it out, make it do, or do without."

Most school systems already have worked out energy conservation plans. Every teacher should be thoroughly familiar with the *Guidelines for the Conservation of Energy in Ohio Schools* published by the State Department of Education. They reflect the development of an awareness of the value of energy as a scarce resource. By carefully observing and practicing these guidelines, we can transmit this awareness to our students.

For example, we know that even when air that is heated to 74 to 78 degrees is moved swiftly through a classroom, we can be uncomfortable because the air removes body heat in an excessive way. If we can eliminate drafts and reduce air flow to required standards, we feel much more comfortable at lower temperatures. But many of today's schools were built when there seemed to be energy to burn, so insulation, tight doors and windows were not always given priority attention. You can help correct this, but you may require professional assistance. Similarly, you as a teacher can watch the thermostat, but your school district must make sure that the automatic temperature regulators are maintained adequately and that heating systems are kept up to date.

You might want to consider (depending on your local situation) setting thermostats as low as 55°F near the close of the school day and for the night ... turning thermostats down to 40°

on weekends unless pockets of uneven temperature may cause damage shutting off all outside air at the end of the school day and on weekends switching from natural gas to an alternative fuel, where possible

At home there are many possible conservation measures (your students can doubtless come up with a much longer list than this one)

- keeping thermostats down
- providing adequate insulation, weather stripping, and storm windows
- operating dishwashers, clothes washers and dryers only once a day
- turning off lights and televisions and replacing incandescent bulbs with fluorescent fixtures
- washing in cold water and taking showers instead of tub baths
- selecting clothing for wear and durability
- closing draperies at night during the winter and keeping them closed during hot summer days
- walking or riding a bicycle instead of driving (but always practicing *safe* riding habits)
- keeping the family car in tune, with tires properly inflated
- buying and using appliances which are most efficient (consumer magazines can tell you which ones to select)
- using an exhaust fan in the summer to supplant or help the air conditioner
- doing without air conditioning if possible
- taking vacations close to home with the entire family together
- organizing car pools
- and so on

Most of these suggestions boil down simply to using good judgment, a quality Americans are traditionally noted for.

Nationally and statewide, many energy-saving steps are being taken. Your students can document them; they also can suggest more steps by writing *directly* to leaders in industry and government. We see moves

- to encourage interest in intermediate technology as compared to placing value on bigness.
- to move toward self-supporting communities with diversified industries to support the needs of the population.
- to stimulate interest in handcrafting and the manual operation of small machines for making products.
- to provide better mass transit through express bus services from suburban parking lots, "dial ride" and pooled taxi services, more convenient transit schedules, renewed interest in trains and interurban lines particularly in high-traffic corridors such as Cincinnati-Columbus-Cleveland.
- to schedule airline flights to 90 percent seat capacity and at times when planes are not "stacked" over airports.
- to cut down on yearly automobile redesign and make it easier to replace fenders, bumpers and other parts.
- to promote nearby tourist attractions.

If these trends are to fulfill their promise, your role as an educator will be crucial. Creative thinking will be at a premium as we seek both short and long range solutions to our energy problems. Both thinking and doing are important, for time spent in teaching conservation is practically useless unless the knowledge is translated into action.

In Ohio classrooms today are the boys and girls who must develop workable ways of protecting and preserving the vital natural environment, if the environment as they know it is to be left for their children. Perhaps one of them also will unlock the technology which will relieve us of our dependence on fossil fuels. Is that student in your classroom today?

Our energy situation is like the status of space exploration less than a generation ago when the Russians surprised us with Sputnik. Suddenly, America needed trained scientific leadership, and it was fortunate that the talents of John Glenn, Neil Armstrong and other leaders were being developed on foundations laid in Ohio schools—foundations in the humanities as well as the sciences.

Since the 1950's, the space program has given us a new opportunity to look at ourselves The implications, to science and mathematics have been obvious, but we also have seen from the perspective of space that the earth has limited resources and that we all are responsible for conserving these resources The world view that we share through the social sciences and literature already is reflecting this interdependence Today's students must be the "energy astronauts" of the future For them, the conservation ethic must become a way of life, reaching into nearly every activity.

Historians would search in vain for a society which has cut back its demands for energy and still flourished Usually, the historical answer to avoiding extinction has been to conquer new lands to find new energy sources. But there are no more new lands. We are confined to a planet where energy is scarce everywhere. Thus, we lack a historical precedent, but we do have at our disposal the technology and the knowledge to find our way out of this apparent dilemma. The challenge is in communicating the energy conservation ethic and its basic foundations to those who will need this knowledge in order to live.

That is why the outcome rests, to a critical extent, with those who would mold the future in the classrooms of the present.

ANSWERS TO E.Q. QUESTIONS

1 Because they are derived from animal and vegetable remains that collected at the bottom of ancient seas and swamps more than three hundred million years ago

2 Petroleum, natural gas, coal

3 Sun, wind, falling water, tides, plants, animals, muscles

4 Coal

5 The correlation of the study of energy to science and mathematics is obvious Social studies trace the advancement of societies in relationship to energy use Literature tells of the lives of people involved in the development of energy. The basic energy source, the sun, is frequently the theme of much music and art.

6 (1) The fossil fuels in the earth now are, for practical purposes, all that we will ever have This dilemma is at the heart of man's current energy problems (2) The demand for energy is ever increasing

7 As a nation, we are realizing the need to move toward self-sufficiency, and technology is being challenged to discover new energy sources and conversion processes.

8 The automobile and space heating

9 Over half of the transportation energy in our country is consumed by automobiles, which are used primarily to carry people rather than goods

10 Because it requires conversion of a primary energy source such as coal, petroleum, nuclear fission, or hydropower for its generation

11 The turbines which generate electricity are less than 50 percent efficient, and a substantial amount is lost through transmission along power lines.

12 By being burned off at the heads of oil wells before it was learned that gas could be used profitably.

13 In meeting our energy demand, we can either import more fuel or reduce our consumption Other options are intensified exploration for new reserves, more efficient ways of recovering fuel resources, and discovery of new sources and conversion processes

14 Energy is the ability to perform work

15 Kinetic and potential

16 Fission and fusion

17 (a) All three

(b) Nuclear

(c) Chemical

18 The British thermal unit (Btu)

19 The ratio of useful product to the total amount of energy input or output

20 Electricity is clean, available instantly, and easily transmitted However, both the generation and transmission of electricity involve some waste energy.

21 Heat is a kind of kinetic energy

22 (a) Sunlight, green plants, and hydropower

(b) Uranium, coal, natural gas, fuel oil and oil shale

23 Fossil fuels are found primarily within the earth and all are storable and transportable. They have nonfuel uses and require altering the landscape for their use All are burned, producing heat to perform work All are nonrenewable

24 Coal

25 Steam engine

26 Oil and gas are cleaner, easier to handle than coal solids, more versatile, and less polluting.

27 Coal

28 Gasification

29 Hydropower, solar radiation, winds, tides and geothermal sources

30 In November, 1970, the rate at which we were finding domestic oil reserves failed, for the first time, to exceed the rate at which we were consuming oil

31 National energy self-sufficiency by 1985

32 Technological advancements are being made in the areas of (1) harvesting energy resources without as high an environmental cost, (2) recycling to prolong the life of dwindling resources, (3) harnessing energy of renewable sources such as wind, sun, and tides

33 Recycling (1) extends the life of products, (2) cuts consumption of natural resources, (3) reduces litter.

34 Problems in total recycling of throwaway materials are finding markets for the sorted scrap, costs of collecting and transporting it, and energy consumption of machines which sort and process it

35 Present major extraction and conversion processes exact environmental cost by releasing pollutants and causing damage to the land and bodies of water.

36 Higher fuel prices to furnish an incentive for exploration and development of new sources of energy and conversion methods

37 An acceptance of the fact that resources, in particular our fossil fuel resources, are finite and therefore precious, to be used wisely.

38 Maintaining lower temperatures and using electricity, paper supplies and other energy consuming materials carefully

39 Turning off lights and appliances when not in use, keeping thermostats down, buying appliances which are efficient, providing adequate insulation.

40 Providing efficient mass transit, promoting nearby recreational attractions, enforcing lower speed limits, encouraging community planning to decrease commuting distances, enacting standards for more energy efficient cars and appliances, stimulating technological advances in the discovery and development of new sources of energy and means of conversion.

GLOSSARY

British Thermal Unit (Btu)—The amount of heat required to raise the temperature of one pound of water one degree Fahrenheit. Because all energy may be converted to heat energy, the Btu is often used as a standard measurement for the "energy content" of many energy sources As the following table of equivalents shows, the Btu is a very small unit of measurement

Fuel	Common Measure	Btu Content
Crude Oil	Barrel (bbl)	5,800,000
Natural Gas	Cubic Foot (cf)	1,032
Coal	Ton	24–28,000,000
Electricity	Kilowatt Hour (kwh)	3,412

(Unfortunately, direct comparisons of energy content of different fuels cannot be made accurately because of the difficulties of measuring them in the same units.)

Coal Gasification—A process by which coal, in contact with steam, can be made to produce a substitute for natural gas.

Conservation—Preservation from loss or waste. With regard to our consumption of energy, the message of conservation means finding the wisest possible use of nonrenewable, exhaustible energy sources and improving conversion processes so as to increase efficiency.

Cycles of Energy Substitution—A way of picturing the history of energy sources in the United States Wood and coal had completely replaced wind and water as major energy sources around 1870, coal replaced wood as the major energy source around 1885, and petroleum replaced coal as the major energy source about 1940.

Efficiency—The amount of *useful work* we get out of a machine or conversion process divided by the total energy output. Efficiency, expressed as a percentage, also measures the amount of useful energy we get out, divided by the amount of energy we put *into* a machine We can speak of the relative efficiencies of various fuels or energy sources in a particular conversion process, and we can speak of the relative efficiencies of various conversion processes using a particular fuel. No machine is 100% efficient.

Energy—The capacity or ability to perform work.

Energy to Energy Conversions—Changes in states or forms of energy. Most energy is derived from another state or form—kinetic from potential, heat from mechanical, and the like.

Environmental Cost—All forms of energy extraction, conversion, and use exact a toll of our environment The advantages of a particular energy use must be weighed against its effects on the environment.

Extraction—Retrieval of fossil fuels from the earth

Fission—A "splitting," specifically the splitting of certain heavy atomic nuclei into two atoms of much lower atomic weight. The loss of mass appears as energy in an amount equal to the difference in mass times the speed of light squared (186,000 miles per second^2), or $e = mc^2$ The process begins with the bombardment of a "fissionable" atom by a neutron of another atomic nucleus which releases neutrons from the "target nucleus." This release enables the process to be self perpetuating, and *chain reactions* are possible. Controlled, they generate useful energy, uncontrolled, they are an atomic bomb like those of World War II

Flow or Fund—A useful way of classifying energy sources. Some energy is derived from the continuous, renewable flow of energy from the sun. Other sources are stored from times long past in a nonrenewable, exhaustible energy fund.

Fossil Fuel—An energy source, such as coal, oil, and natural gas, derived from the action of tremendous heat and pressure on animal (chiefly marine) and plant fossils buried under the earth's surface more than three hundred million years ago. Fossil fuels contain the stored chemical energy of plants and animals that were once alive.

Friction—Resistance to motion of two adjacent surfaces.

Fuel—Anything converted from one form to another with "release" of energy to perform useful work, as when coal is burned to produce heat to produce steam to run a turbine to produce electricity to light a lamp to help you read a book at night.

Fuel Cells—Battery like, portable electric generators producing current from the reaction of hydrogen and oxygen.

Fusion—A joining, in particular, the combination of two atomic nuclei to yield one larger nucleus whose mass is less than the sum of the masses of the original nuclei. The lost mass appears as energy as in fission (see above). Because electrical charges within the nucleus make it very difficult to bring two nuclei close enough for fusion, the reaction requires extremely high temperatures and pressure (hence the synonym "thermonuclear reaction"). To generate useful energy, the reaction must be controlled, the hydrogen bomb represents an uncontrolled fusion reaction.

Geothermal—An energy source relying on natural steam rising from underground with enough force to drive turbogenerators.

Horsepower (hp)—A standard unit of measurement of power, equal to 33,000 foot-pounds of work per minute or the force required to do that much work. (A *foot-pound* is the force required to raise a one-pound object one foot straight up in the air, or its equivalent. In other words, one foot-pound of work may be done by lifting a one-pound object one foot, or a two-pound object one half foot, or a half-pound object two feet.) A horsepower is more power than a real horse possesses over long periods, but less than it possesses in a short period of work. One horsepower equals 745.7 *watts*, where the watt is another measurement of power.

Hydropower—The energy of falling water harnessed to turn turbines to generate electricity.

Inertia—The resistance of an object to a change of state regarding its motion. Inertia is the condition reflected by the law of physics that an object at rest tends to stay at rest and an object in motion tends to stay in motion. It is a force which resists the transformation of an object's energy state from potential to kinetic or vice versa.

Kinetic Energy—The energy stored in a moving object. By moving, an object can perform work or move other objects to perform work. Kinetic energy of an object equals one-half the product of its mass and its velocity squared ($E_k = 1/2\ mv^2$).

Law of Conservation of Energy—The law of physics stating that the total amount of energy in a "system" (such as the Universe) is constant. Energy is neither created nor destroyed, but merely is constantly changing forms and states. Particular energy sources or fuels *do* disappear, however. This "law" has been revised in the light of findings that in nuclear reactions, matter is directly converted to energy. The reverse process is also true, and the law has been renamed the *Law of Conservation of Energy and Matter*.

Machine—Any system or object which, through any of a number of processes (burning, chemical reaction, atomic reactions) converts energy in one form (the fuel) into energy in another, more useful form (the product or output) plus some energy converted to a "waste" form.

Magnetohydrodynamics—A process of converting heat from combustion gases directly to electricity by passing gases through a magnetic field.

Oil Shale—Sedimentary rock which contains a substance yielding oil when heated.

Open Pit Mining—Strip mining.

Potential Energy—The energy stored in a non-moving object because of its position or inherent qualities. The force of gravity may act on any object as resisting forces are removed. Furthermore, some things, such as coal or wood, contain stored or potential energy which may be converted to heat energy through the process of burning.

Power—The rate at which work is done, expressed in units of work, such as foot-pounds, per unit of time. Energy is a capacity for doing something (work), whereas power is the rate at which the something is actually done.

Project Independence—Our government's goal of national self-sufficiency in energy.

Secondary Energy—Electricity may be thought of as secondary energy, for it requires conversion of a primary energy source such as coal, petroleum, or nuclear fission for its generation.

Short Ton—2000 lbs., the customary "ton" of coal, as distinguished from the "long ton," 2,240 lbs.

Solar—The sun as an energy source, harnessed by systems of collectors or solar cells over vast surfaces.

Tar Sands—Deposits containing an extractable petroleum substance.

Tidal—The tides as an energy source, converted by the same processes as hydropower.

Transformations of Energy—Changes in energy state from potential to kinetic or kinetic to potential. Energy transformations are brought about by three types of processes: mechanical (physical), chemical, or nuclear.

Transmission—Transportation of electrical energy from the point of generation to the point of use. Some energy loss is inevitable in transmission. Ten percent of the electricity actually generated is lost in transmission through power lines and cables.

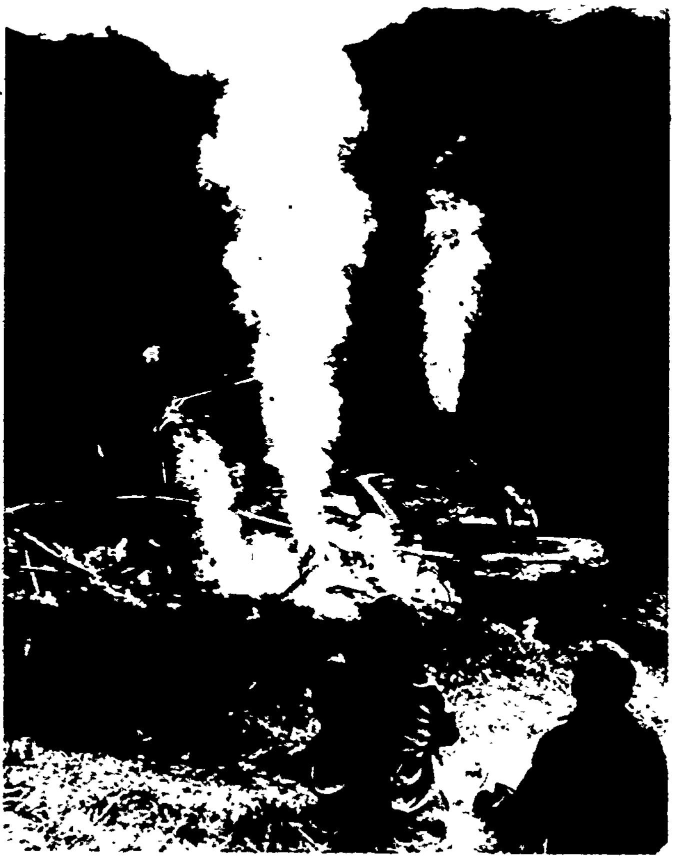
Waste—That which is not useful to one's purposes. In certain energy conversion reactions, a resultant form of energy may perform no useful work for us, as for example, the sound generated by many machines. However, that sound may be useful energy in another process at another time, depending on our purposes, as when a whistling teakettle tells us the water is boiling.

Watt (w)—A common unit of measurement of power, especially electrical power. Named after James Watt, the famous Scottish engineer of the 18th century. One thousand watts, or one kilowatt (kw), is equal to 1.34 horsepower. Electrical power generation, or consumption, is commonly measured in kilowatt-hours (kw hrs), where one kilowatt-hour is equal to the energy of one kilowatt of power acting for one hour.

Work—The conversion of energy which results in the movement of an object from one place to another in response to forces (mechanical, chemical, nuclear). The measurements for work have to do with heat generated (the calorie, Btu) or movement produced (the joule, electron volt, erg, foot-pound); any of these measurements may also be used to measure energy, the potential for work.

SUGGESTED TEACHING UNITS

Primary



Energy Conservation Teaching Resource Units

UNIT I: ENERGY AND HOW IT CAN HELP US

UNIT PURPOSE:

To help children understand what energy is and where it comes from.

ENABLING CONCEPTS:

A. Work: What it is

B. Energy for our bodies and where it comes from

C. Energy all around us

D. Energy for machines and where it comes from

Concept A. Work: What It Is

INSTRUCTIONAL OBJECTIVE:

To help children understand that *work* happens when something moves or changes in some way.

POINTS FOR EMPHASIS:

- Scientists use the word *work* differently than we do. They say that work happens when something moves or changes in some way.
- The word *work* is used many ways. Discuss hard work, work as a job, task, play which is work.

LEARNING ACTIVITIES:

The children may:

- Draw pictures of the kinds of work they do and the kinds of work (jobs) mothers and fathers do. Each picture should be analyzed for its scientific definition of *work*.
- Pantomime a type of work. The children try to guess what the work is.
- Write cooperative stories about "The Work I Do," "The Work Mothers Do," "The Work Fathers Do" and "Neighbors—People in the School and Community."
- Bring in or paint pictures which show work being done for a bulletin board display. The children tell about the work being done in their pictures.
- Select pictures from a collection of those on the bulletin board. (Some show work being done and some not.) Place the word *work* beneath each picture which shows something moving or changing in some way. Describe what could be done to move or change the items in the pictures where work is not happening.
- Make a scrapbook of original or commercial pictures of work being done. Children could write rebus and creative stories or captions for the pictures telling what is being moved or changed.
- Hear resource people, see films and go on field trips as learning experiences about work. The understandings that work occurs when something is moved or changed are emphasized.

- Illustrate the work animals do by observing, either firsthand or through visuals, birds building nests and feeding their young, wasps or bees building their homes, ants (use an ant farm) at work.

Concept B. Energy for Our Bodies and Where It Comes From

INSTRUCTIONAL OBJECTIVE:

To help children understand why our bodies need energy and where that energy comes from.

POINTS FOR EMPHASIS:

- Our bodies need energy in order to move or change in any way.
- *Energy* is being able to do work.
- The energy our bodies need comes from the food we eat.
- Our bodies work in the sense that parts of our bodies move and change.

LEARNING ACTIVITIES:

The children may:

- Do a short series of physical exercises. walk, hop, skip, jog and run a measured distance. Ask the children to determine which method of movement required the most work and to tell why.
- Find pictures of different types of food and try to classify the foods as primarily plant or primarily animal.
- Discuss the parts of plants which we eat: stems, roots, leaves, seeds.
- Discuss which animals give us beef, pork and other meats. What, in turn, are the foods for these animals?
- Make a cooperatively developed bulletin board entitled "Where We Get Our Energy."
- Identify the plant and animal components of such foods as bread, pizza, a milkshake, a hamburger.
- Discuss why it is important to eat three well-balanced meals per day and draw pictures of well-balanced meals.
- Discover and discuss the chain of life-cycle.

Concept C. Energy All Around Us

INSTRUCTIONAL OBJECTIVE:

To expand the children's concept of energy from themselves to the world around them.

POINTS FOR EMPHASIS:

- Energy is all around us.
- We cannot see energy.

- People have energy.
- Animals have energy.
- The wind has energy.
- Water has energy.
- The sun has energy.
- *Energy* is being able to do work.
- Work happens when something moves or changes.

LEARNING ACTIVITIES:

Children can and do gather new information much as scientists do. by observing, asking people, visiting places, experimenting and reading. Children can be scientists in finding out about sources of energy.

They may:

- Draw pictures showing animals, the wind and water moving or changing in some way.
- Stand a safe distance in front of a fan to feel the force of the air. Face one fan against another (two feet apart). Turn on one. The other will be driven by the wind. (Energy transfer).
- Observe the energy of the wind through the use of pinwheels, kite, bubbles, sailing leaf or paper boats, running against the wind, observing the wind bending tree branches and moving objects on the playground.
- Observe wind at work by making and watching a weather vane or windsock and by seeing the effect of a fan on a roller skate.
- Make an energy bulletin board—use pictures of animals, pinwheels, windmills, boats or water as headings. Children paint pictures of how these energy sources work.
- Make up riddles about sources of energy. Example. No one can see me. I blow and push. Who am I?
- Observe an animal to see the many different ways the animal moves or changes things (tadpoles, ant farm, fish, hamster, gerbil). Changes are most dramatic with amphibians or mealworms or chrysalis (cocoon).
- Put their hands under running water from a faucet to feel the force of the water. With a plastic coffee can top, make a water/wind wheel.
- Observe the movement of the water in a nearby body of water.
- Have a tug of war or bounce balls on the playground to observe the energy used by children.

Concept D. Energy for Machines and Where It Comes From

INSTRUCTIONAL OBJECTIVE:

To help children understand what machines are and how they change energy into useful work.

POINTS FOR EMPHASIS:

- Machines can do useful work.
- Machines are made by people.
- Machines change energy into useful work.
- Different machines change different kinds of energy into useful work.

LEARNING ACTIVITIES:

The children may:

- Experiment with a flat sled and a roller skate. Bakery twine is attached to sled and to skate Books or other weights are put on each. Students pull sled and skate. Which is easier? Which can do most work? Load them both until string snaps. With which machine is more energy used?
- Draw pictures of at least five machines found at home.
- Each bring in an example of a machine and show how it moves or changes something.
- Name machines in a bulletin board display and tell what work each does.
- Make and demonstrate the use of an inclined plane, wheel, lever, and pulley. Bring to class toys which have one or more of these parts.
- Do demonstrations using simple machines and explain how they work.
- Identify and analyze items in classroom according to definition of *machine*. Is the light switch a machine? Pencil sharpener?
- Divide up into small "detective agencies" and have a contest to see which group can come up with the largest number of magazine pictures of different types of machines.
- Talk about why people and animals are like machines.

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UNIT 2: ENERGY FOR TODAY AND TOMORROW

UNIT PURPOSE:

To help children learn about the major sources of energy which we use.

ENABLING CONCEPTS:

A. Today's energy sources and why we use them
B. The major energy sources used today are nonrenewable
C. New energy sources for the future

Concept A. Today's Energy Sources and Why We Use Them

INSTRUCTIONAL OBJECTIVE:

To make the children aware of the major energy sources used today and why we use these sources.

POINTS FOR EMPHASIS:

- The major energy sources we use today are oil, natural gas and coal.
- These sources of energy are stored in the earth.
- The major reasons we use oil, natural gas and coal as energy sources are that they are relatively easy to obtain and to transport.

LEARNING ACTIVITIES:

The children may:

- Examine samples of oil and coal.
- Make a display of examples of fossil fuels and label them.
- Examine a fossil, explore the meaning of the word *fossil*, and discuss the ways and the long time it takes fossil fuels to be formed.
- Make leaf prints in plaster of Paris or clay to develop the understanding of fossils.
- Build oil derricks with straws.
- Collect pictures of coal mines, oil derricks, gasoline pumps.
- Take field trip to a coal mine or oil field.
- Learn about static electricity by rubbing a comb with a woolen cloth.
- Watch demonstration by the teacher using a Bunsen burner to show the heat and light qualities of natural gas.
- Learn that coal and water energy are needed to make electricity.
- Learn how electricity works by inviting children from the middle school to demonstrate a buzzer, bell or light being activated by an electric switch.
- Categorize the machines they have in their homes by the energy source they use. oil, natural gas, coal or electricity.

- Read stories about coal miners and oil drillers.
- Discuss and write cooperative chart stories about how coal, oil, natural gas and electricity are transported

Concept B. The Major Energy Sources Used Today Are Nonrenewable

INSTRUCTIONAL OBJECTIVE:

To make the children aware of the fact that the energy sources we use today will not last forever When they grow up, there may not be these sources of energy.

POINTS FOR EMPHASIS:

- Our energy sources are being used up rapidly because more people are using more energy.
- The major energy sources we use today are nonrenewable.

LEARNING ACTIVITIES:

- The teacher brings to class a half dozen new boxes of crayons (balls, jumping ropes or other selected objects). The children count them. The teacher states these are all there are. Two children are invited to come to take crayon boxes. The teacher asks if there are enough left Three more children are invited to take crayon boxes. The children are asked about what is happening to the supply and are reminded that there are no more With the one box remaining, all of the children in the class are invited to come to get crayons. The teacher asks why all of the children can't have them. *(The children are led to realize that 1) there are no more, 2) that larger numbers of children needed the smaller amount of boxes, 3) that great care should be taken of the crayons which they have; and 4) that the crayons will need to be shared).*
- Learn the meaning of the word *nonrenewable* by tearing apart the leaves, stems and roots of a plant and trying to put the plant together in order that it will grow again. (Humpty Dumpty may be another example).
- The children recall the fossil fuels (coal, oil, natural gas) and the teacher compares them with the destroyed plant in that they are nonrenewable. They can be used up.
- Group discussions develop the understanding of what it would be like if we didn't have oil and natural gas or if we had very little coal. These ideas could be summarized in chart stories

  Example WITHOUT OIL

  — cars could not run
  — trucks could not carry food and clothing
  — some homes would be cold
  — people would be out of work
  — we could not go on vacations
- Illustrate the chart *WITHOUT COAL—We Would Not Have*—The children draw pictures of the work and products supplied by coal which would not exist.
- Children pretend that there is no more electricity and describe all of the things they couldn't do or have if there were no electricity They might tell and draw pictures of the things they would miss the most

Concept C. New Energy Sources for the Future

INSTRUCTIONAL OBJECTIVE:

To make children aware that other energy sources may be available in the future but that time will be needed to develop them.

POINTS FOR EMPHASIS:

- Finding ways to make new energy sources work for us is going to be more difficult than it was to make oil, natural gas and coal work for us.
- Energy from the sun is called *solar energy*. Solar energy is one of the biggest sources of energy for the future It is renewable because the sun is shining every day, even when the clouds cover it.
- Some other renewable sources are wind, water, the ocean tides, muscles, and using the things we throw away.

LEARNING ACTIVITIES:

The children may:

- Make a cooperative list of indications of the sun's heat. Examples—1. Comparing how it feels to sit in the sun and in the shade. 2. Noting the melting of snow. 3. Taking temperatures in sunny and shady rooms in the building. 4. Observing that the sun dries materials.
- Make "sun" mobiles with drawing attached of the work the sun does.
- Discuss and list what work the sun's energy can do.
- Make a simple windmill (four or five popsicle sticks with cardboard fan paddler glued to the stick). Drive the windmill with a fan. Discuss what work the wind may do for us that it is not being used to do today.
- Demonstrate a radiometer—put in sun, then in shade. Make it move with flashlight, burning match, flash bulb.
- Make shoebox gardens. Put some in the shade and others in the sun. Photograph or draw pictures of the various stages of plant growth to compare the two gardens and the sun's role in their growth.
- Make a sundial by using one child as the dial and the other children to draw the shadow. What does this tell us about the sun?
- Use a garden hose to move objects on the playground. Discuss the work water power may do for us today.
- View motion pictures showing the ocean tides. Discuss the force of the tides and how this energy may be used to perform work.
- Empty the wastebasket and discuss what materials in it could be used to make energy Introduce the word *conversion* by talking about how these materials would have to be changed to be a source of energy. Make lists of what we have lots of at home and in the community which are thrown away but could be used to convert to energy. (Example: leaves, food cartons).
- Make *My Energy Books*. Children draw pictures and write sentence stories about how they can use their own energy to move or change things. Examples. Walking to school. Having vacation close to home.

UNIT 3: ENERGY CONSERVATION

UNIT PURPOSE:

To make the children aware of what they can do to conserve energy as well as the importance of everyone's helping to save energy

ENABLING CONCEPTS:

A. The importance of conserving energy.
B. What we can do to conserve energy.
C. The importance of everyone's conserving energy.

Concept A. The Importance of Conserving Energy

INSTRUCTIONAL OBJECTIVE:

To make children aware of the importance of saving energy.

POINT FOR EMPHASIS:

- The understandings of limited supply and the need to share and to save are discussed by means of a ream of paper which must last the entire class for a certain period of time. The children are asked what they could do to make the paper last longer for the use of all of the children in the group. The understanding of the word *conservation* is the desired result. The conservation understanding is applied to energy use both at home and at school.

LEARNING ACTIVITIES:

The children may:

- Make up their own stories telling why it is important to save energy. They might illustrate these stories on shelf lining paper and present them in a simulated television set.
- Play the "Refrigerator Game." Ten items (eggs, milk, lettuce, and so forth) must be put into the refrigerator. Time the duration the refrigerator is open. Then prepare a dinner—opening refrigerator every time you need an item. Again time the seconds. By planning and organizing, one can cut the time the door is open, thereby saving energy. Transfer this to letting water run while brushing teeth and other routine activities.

Concept B. What We Can Do To Conserve Energy

INSTRUCTIONAL OBJECTIVE:

To make children aware of the ways in which they can help save energy.

POINTS FOR EMPHASIS:

- People can save energy by not wasting things. Every time something is wasted, the energy that went into producing it is wasted. The waste of food, pencils, paper, paper towels or anything else is a waste of energy

- People can save energy by not misusing it. For example, many things in every house use energy Some things that can be done to save energy at home and in school are
  - — lowering the heat in the winter
  - — wearing heavier clothing indoors in the winter
  - — keeping the doors and windows closed in cold weather to keep the warm air in
  - — turning off the radio or TV when they are not being used
  - — turning off lights that are not being used
  - — not using machines to do work that people could do just as well by themselves
  - — walking short distances rather than going in the car
  - — using public transportation
  - — riding in car pools
  - — reminding parents to drive at slower speeds
  - — having fun at home rather than asking to go distant places.

LEARNING ACTIVITIES:

The children may

- Make a list of all the things they intend to do in order to save energy in school. These may be incorporated in a progress chart to be kept in a prominent place in the classroom. At the end of each day, the group's progress could be recorded on the chart This progress may be reported to other groups over the public address system or in energy conservation assemblies.
- Make a growing list of how energy is saved each day by the class.
- Write individual or cooperative stories about how energy may be saved at home.
- Paint pictures of ways energy can be saved in homes.
- Report each day on one way in which energy was saved at home.
- Have a puppet show about how to save energy.
- Make individual energy conservation report cards which are marked by the child or family each week.

Concept C. The Importance of Everyone's Conserving Energy

INSTRUCTIONAL OBJECTIVE:

To make children aware of why it is so important for everyone to conserve energy.

POINT FOR EMPHASIS:

- It is important for everyone not to waste but to save energy in order that everyone may share in its use.

LEARNING ACTIVITIES:

The children may

- Draw "what they think energy looks like." Have a group discussion in which children can talk about their pictures.
- Have a play about "how energy is used in my home."
- Draw or write about ways to conserve energy and discuss these ways.

- Help other people save energy by
  - — setting a good example and
  - — by letting other people know . . .
    - — how important it is to save energy and
    - — how they can go about saving energy.
- Paint poster pictures showing how to save energy and display these around the school (Do Not Waste Paper, Wear Warm Clothes, Turn Off Lights When You Leave the Room).
- Through creative dramatics, act out ways to save energy in the school.
- Write individual or cooperative stories about saving energy.
- Form an energy-saving club with the children conducting the meeting.
- Compete with another classroom on energy-saving games.
- Devise a plan to celebrate everybody's birthday *but* use only one box of birthday candles (Generally there are 24 or 36 candles to a box.) Candles can be reused or only one used for each celebration. Get students to plan conservative measures so each celebration will be equally nice.
- Make *Save Energy* badges (safety pins and carton tops).
- Prepare a program and displays about energy and energy conservation to show parents at open house

MY ENERGY CONSERVATION CHECKLIST

I. Some Ways to Save Energy in School

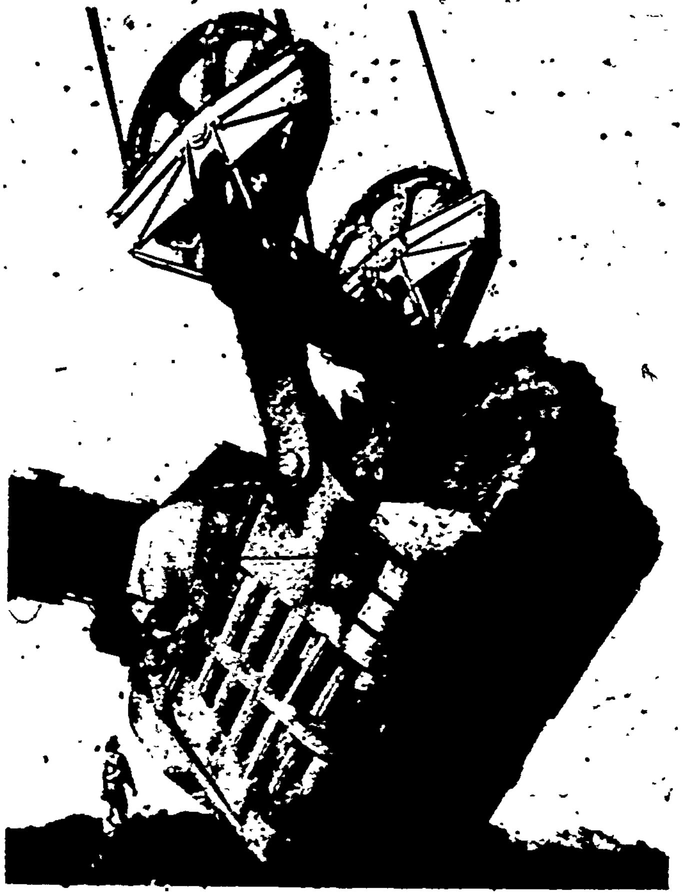
	Need No Improvement	Need a Little Improvement	Need Lots of Improvement
● Conserve paper.			
● Conserve crayons			
● Conserve __________ (Fill in any additional items which the students tend to waste in school.)			
● Turn the lights off if they are not being used.			
● Other __________ __________			

II. Some Ways to Save Energy at Home

● Conserve food.			
● Conserve water.			
● Conserve __________ (Fill in any additional items which the students tend to waste at home.)			
● Turn off lights when they are not being used.			
● Turn off the radio and TV when they are not in use.			
● Keep the doors and windows closed in cool or cold weather.			
● Wear warmer clothes in cold weather so the temperature does not have to be so high.			
● Other __________ __________			

SUGGESTED TEACHING UNITS

Upper Elementary



Energy Conservation Teaching Resource Units

UNIT 1: WHY ENERGY IS IMPORTANT TO US

UNIT PURPOSE:

To help students become aware of what energy is and the vital role it plays in our lives.

ENABLING CONCEPTS:

A. Work: What it is

B. Energy's relationship to work

C. Using machines to change energy into useful work

Concept A. Work: What It Is

INSTRUCTIONAL OBJECTIVE:

To help students define *work* related to the concept of energy.

POINTS FOR EMPHASIS:

- The scientific definition of *work* Scientists define *work* as a push or pull (a force) that causes an object or substance to move or change in some way. (Example Writing with chalk, pencil or pen.)
- Some work is not controlled by man. Work can be done without man having anything to do with it. (Examples. Plants growing, sun drying clothes, waterfalls moving rocks.)
- Man does work. Some of this work is useful, some is wasteful and some is harmful. (Examples. Useful—construction, wasteful—leaving lights on when not in use, harmful—exploding bombs.)

LEARNING ACTIVITIES:

Students may:

- Write the definitions of the various types of work with an extended list of examples in energy notebooks.
- Each pantomime a type of *work* and have the other students try to guess what type of work it is.
- Play a game by having a student give a verb meaning some type of work and the others in the class make up a complete sentence using the verb. The verbs can be written on cards which are drawn for making up sentences about work.
- Have a "Tug of War" in which *no* work is done—that means no movement—on equilibrium of cancelling vector forces.
- Try to push the wall down, lift a book, push one hand against the other. When something moves, work was done in scientific sense.
- In small groups, prepare simple demonstrations of work and present them to the class. (Sample task. constructing a papier mache head using a balloon as a base.) The other students may record how many objects or substances were moved or changed in the course of the demonstration.

- Visit the playground and make a list of the different ways in which *play* is actually work.
- Construct lists of work done by man, animals, wind, water.
- Construct a bulletin board showing by classification types of work which are useful, wasteful or harmful.

Concept B. Energy's Relationship to Work

INSTRUCTIONAL OBJECTIVE:

To help students understand the relationship between work and energy.

POINTS FOR EMPHASIS:

- Everything has energy.
- Energy actually does work when it is an active state. A match has the ability to do work, but not until it is struck is it actually working.
- Energy is either at rest or active. The nail's energy is at rest until it is struck with a hammer The energy of the hammer is inactive until it is used by a person. Energy is the ability to do work.
- Energy must be used to start or stop an object.

LEARNING ACTIVITIES:

Students may:

- Write the definition of *energy* in their energy notebooks.
- Collect pictures which show different types of work being performed and use the pictures to set up a bulletin board display. The display may have a caption such as ... "It Takes Energy To Do Work."
- In small groups, design demonstrations showing energy being changed from the state of rest to an active state, and then describe the work that was performed as proof that the energy was actually changed into an active state. Demonstration example. Drive two identical nails into a two-by-four-inch pine block. Use a heavy hammer for the first Use a tiny tack hammer for the second. Count number of blows. Let hammers fall—don't drive nail. Which was easiest? How much energy was used to accomplish same task?
- Give examples of the force of water, wind, chemical action, magnetism, electricity.
- Make dioramas showing some type of energy causing work to occur. (Example. The sun drying fish.)

Concept C. Using Machines to Change Energy Into Useful Work

INSTRUCTIONAL OBJECTIVE:

To help students understand how energy and work relate to machines.

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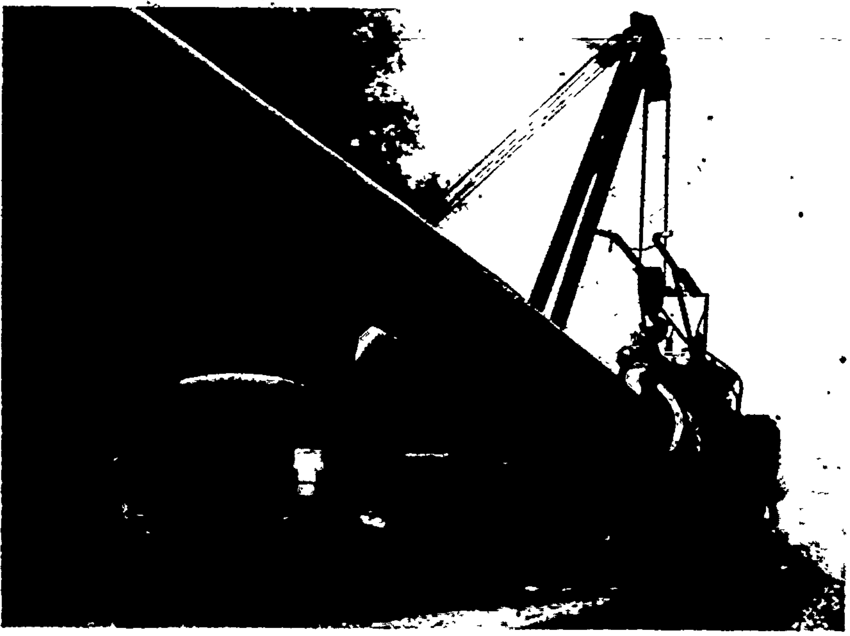
POINTS FOR EMPHASIS:

- Machines are devices that change energy into useful work. Machines come in all sizes and all shapes Some machines are very simple, and some are very complicated.
- The type of machine used to change energy into useful work depends upon the type of energy source being used (mechanical, chemical, nuclear).
- Machines increase speed, force and change direction.

LEARNING ACTIVITIES:

Students may

- Write the definition of *machine* in energy notebooks. Include illustrations of simple and complex machines.
- Study, construct and demonstrate the use of a lever, pulley, wheel and axle, inclined plane, wedge. windlass, and gears. Compare these to such items as scrapers, hammers, scissors, bicycles and doorknobs.
- Bring in actual samples of machines to demonstrate to the class.
- Make lists or sketches of the machines used in homes, schools, farming and a selected industry such as construction
- Assume the role of detectives to find out where electricity comes from.
- Classify electrical appliances by the type of work they do (heat, light, make something move).
- Bring in pictures of machines and arrange them in a bulletin board display. The pictures may be classified by the type of energy source they convert into useful work (mechanical, chemical, nuclear).
- Collect catalogue pictures for a scrapbook and write what each machine pictured does.
- Make charts to classify machines by the type of energy they use—electricity, wind, water, animal, people.



UNIT 2: ENERGY SOURCES

UNIT PURPOSE:

To provide students with an awareness of the many energy sources available to us.

ENABLING CONCEPTS:

A. The energy sources available on our planet

B. The basic energy sources of today

C. Energy sources for the future

Concept A. The Energy Sources Available on Our Planet

INSTRUCTIONAL OBJECTIVE:

To provide students with an overall picture of the available energy sources, with emphasis upon renewable-nonrenewable dichotomy.

POINTS FOR EMPHASIS:

- Concept—The earth has three kinds of resources inexhaustible, renewable, and nonrenewable.

Inexhaustible	Renewable	Nonrenewable
air	wood	gas
*sun		oil
water		coal

*The sun will continue to be our powerhouse.

- Solar, nuclear and geothermal sources of energy will power energy needs in the future.
- Finding new sources depends upon:
  - —seeking new materials
  - —minimizing waste
  - —learning how to use fuel more efficiently.
- Some energy sources are renewable. Solar energy, the earth's heat and tidal power will last as long as our planet and sun last. These are called *renewable* energy sources.
- Some of our earth's energy sources are limited. If we keep using these energy sources, eventually the supply will run out. These are called *exhaustible* or *nonrenewable* energy sources The major exhaustible or nonrenewable energy sources on earth are fossil fuels (coal, oil and natural gas).

- The basic energy sources used in the United States today are ...
  - —oil (44%)
  - —natural gas (32.0%)
  - —coal (17.5%)
  - —hydropower (4%)
  - —nuclear power (1.0%)
  - —wood (1.4%)
- The major uses of energy in our society today are industrial, transportation, residential, and commercial. Much energy is lost in electricity generation.

LEARNING ACTIVITIES:

Students may:

- Prepare summaries in energy notebooks that itemize the major renewable energy sources and the major nonrenewable energy sources.
- Prepare committee reports on why the various types of fossil fuels are nonrenewable.
- Obtain samples of the major energy sources—coal, oil—for a display. Coke, charcoal might be included.
- Research the different forms of oil and natural gas and their uses.
- Research the different forms of coal and their uses.
- Make a large scale mural showing energy sources. (Mining, oil derricks, hydropower, geothermal.)
- Find out more about how nuclear reactors work and the types of fuel they use.
- Take a field trip to a local coal mine, oil field or nuclear reactor facility. (Students take photographs and slides.)
- Construct a bulletin board display showing the uses of energy by industrial, transportation, residential and commercial categories.
- Make an anemometer or wind gauge and demonstrate its use in determining the force of speed of wind and its direction.
- Demonstrate jet propulsion through the use of a balloon.
- Visit stream or river sites to discover and discuss the power of water which causes erosion and subsequent silt deposits which form deltas.
- Research and discuss the force of freezing water such as in the glacial plains.

Concept B. The Basic Energy Sources of Today

INSTRUCTIONAL OBJECTIVE:

To make students aware of the major energy sources utilized today and to emphasize the fact that these are nonrenewable.

POINTS FOR EMPHASIS:

- Oil, natural gas and coal are the major energy sources in use today. All are fossil fuels.
- Fossil fuels make up more than 90% of the energy sources used in the United States today. These fossil fuels all . .
  - — are found primarily within the earth, which often means elaborate extraction techniques are required
  - — are storable and transportable
  - — are largely burned, performing useful work with heat energy
  - — have important nonfuel uses
  - — alter the landscape in their extraction
  - — release pollutants into the air when used

LEARNING ACTIVITIES:

Students may.

- Make various types of graphs showing the relative percentages of use of both the major and minor energy sources in the United States today. This may become a part of their energy notebook.
- Bring to class examples of fossils and discuss how they were formed and how they might relate to fossil fuels.
- Make "fossils" such as plaster of Paris leaf prints.
- Visit a highway cut to observe layers of various deposits in order to discuss how fossils and fossil fuels were formed.
- Construct a chart showing the types of energy used by the family.
- Make maps showing the location of the major energy sources used in the United States today.
- Obtain maps of the location of both the major and minor energy sources in Ohio.
- Prepare reports on energy supply and demand.
- Prepare reports which tell the advantages and disadvantages of each of the fossil fuels.
- Make a time line showing the growth in the use of fossil fuels.
- Report on the major energy sources utilized in the community. Local resource people may discuss these energy sources.
- Construct a bulletin board classifying fossil fuels and their related uses.
- Have a panel discussion in which they debate the pros and cons of using fossil fuels.

Concept C. Energy Sources for the Future

INSTRUCTIONAL OBJECTIVE:

To make students aware of possible alternative energy sources for the future.

POINTS FOR EMPHASIS:

- Future energy sources should have high energy potential, be retrievable, easily obtainable, efficient for conversion, safe, healthful, and environmentally noncontaminating
- New energy sources are being studied for future use. Research is now being done to harness the following energy sources for the future
  - a fossil fuel sources oil shale, tar sands and coal gasification
  - b natural or continuous sources geothermal, solar, tidal and wind.
  - c other sources hydrogen, fuel cells, magnets, hydrodynamics, burning of trash, nuclear fission (breeder reactors) and thermonuclear fusion
- Several of these sources seem to have significant potential for future use

LEARNING ACTIVITIES:

Students may

- Study to learn the meaning of *coal gasification, geothermal, hydrodynamics, thermonuclear fusion*
- Compare the relative benefits of energy sources on the basis of the characteristics of good energy sources. Small groups may each research one or two of the energy sources, recording data on each of the desirable characteristics for each energy source. With the group data compiled on the chalkboard, students may meet in committees to study the data and recommend which of the energy sources would be the better choices for future use.
- Prepare oral or written reports about the characteristics of energy sources. (High energy potential, obtainable, easily converted, safe and healthful, noncontaminating to the environment.)
- Research and report on current developments in explorations for new energy sources and in methods for harnessing these new energy sources to perform useful work.
- Collect magazine and newspaper articles dealing with energy sources for the future. The summary of these activities may be included in a class or individual energy notebook.
- Invite a resource person to discuss current developments in the search for energy sources for the future.
- Study the careers which are related to the development of energy sources and the uses of energy.
- Sort representative samples of school trash to determine potential utility of sorted trash as a fuel. (Cafeteria, classrooms, library, office, shop, gym.)
- Analyze domestic trash as a possible fuel source.
- Ask for permission to analyze commercial/industrial waste from a nearby plant for possible recycling.
- Write about some untapped source which could be converted into a new energy source (Example: Throw-away trash.)

UNIT 3. THE ENERGY SITUATION AND WHAT WE CAN DO TO IMPROVE IT

UNIT PURPOSE:

To help students understand what the energy situation is and what must be done to improve the situation today and in the future.

ENABLING CONCEPTS:

A. How energy affects our lives

B. What we can learn from the energy crisis

C. The energy situation today and how we can improve it

D. What we can do to prepare for the future

Concept A. How Energy Affects Our Lives

INSTRUCTIONAL OBJECTIVE:

To make students aware of the tremendous part energy plays in our lives

POINTS FOR EMPHASIS:

- Earliest man relied on his own energy (muscle power) to do the work required to meet his basic needs. He had to make everything without using nonhuman energy sources or machines of any kind.
- Today energy performs work through machines. There has been a rapid growth in the use of energy.

LEARNING ACTIVITIES:

Students may:

- List the energy sources available to earliest man as well as those not available. For example: fire, animals, moving water, wind, fossil fuels, electricity.
- Divide into small groups, each group to make three lists, one indicating ways in which energy is used in the school, one indicating ways in which energy is used in the home, and one indicating ways in which the students themselves use energy. The students should include the type of work, type of energy, and machine used for each way listed.
- Research the ways in which nonhuman energy sources affect

  —transportation capabilities

  —the roles and interaction of family members

  —food supply

  —location of homes

  —recreation

  Students may present their research findings in the form of a panel discussion, a bulletin board display, or written or oral reports.
- Plan a diary for a weekend during which little "outside" energy would be used—i.e., no bus, car transportation—no heating/air conditioning, TV, phone.

- Make and caption a page for their energy notebooks which consists of a collage of magazine pictures illustrating the many uses of energy in the United States today
- Prepare reports on the causes of the rapid growth in the uses of energy
- Write creative stories which tell about what life would be like without a certain kind of energy. (Example electricity)
- Write creative stories about using some new type of energy to produce materials.

Concept B. What We Can Learn From the Energy Crisis

INSTRUCTIONAL OBJECTIVE:

To provide students with a rationale for the need to conserve our fossil fuels

POINTS FOR EMPHASIS:

- People have differing views on the nature of the energy crisis
- Insufficient product and rapidly rising demand are the basic causes of the energy crisis The energy shortages basically occurred when our steadily increasing demands for energy were not met because industries did not extract and refine fossil fuels (our major energy sources) fast enough. Legislation can encourage energy industries to increase the supply of fossil fuels to meet rising demands But that is only a temporary solution Our reserve supplies of fossil fuels will not last forever. They have been used as if they were inexhaustible
- The energy crisis has given us a warning of what will eventually happen if we
  - — continue to use fossil fuels at the present rate,
  - — do not identify new and renewable energy sources, and
  - — do not develop the technology to utilize these new sources.
- The careful conservation of fossil fuels will give us more time to develop technology to utilize new energy sources It takes a long time to develop the technology to utilize new energy sources We must start now in order to prepare for the future.

LEARNING ACTIVITIES:

Students may

- Collect and report on newspaper articles dealing with evidences of local energy shortages
- Write an editorial on "What's Good About the Energy Crisis."
- Interview a variety of community members to find what energy shortages they have experienced
- Form an energy saving committee to warn others of energy misuse and waste.

Concept C. The Energy Shortage Today and What We Can Do About It

INSTRUCTIONAL OBJECTIVE:

To make students aware of what they can do to help ease the energy shortage today

POINTS FOR EMPHASIS:

- Over the past 25 years there has been a tremendous increase in the demand for energy
- To a large extent, the increased energy demand is caused by the population increase and its energy demands as well as industry's use of machines
- Inefficient machines unnecessarily demand more energy More machines are being built that do not use energy efficiently.
  - — While providing the same amount of cooling, some air conditioners use up to two and one-half times as much electricity as others
  - — Frost-free refrigerators use 50 percent more electricity than standard models
- Learn to look for energy efficiency We can reduce the loss of energy by inefficient machines It is important that everyone be concerned about buying machines that use energy efficiently. By using energy-efficient machines ..
  - — more energy can be saved on a nationwide level, and
  - — manufacturers will be encouraged to make products that are energy-efficient
- List simple actions that can conserve energy. Our wasting of energy has added unnecessarily to the increase in the demand for energy. We tend to waste energy in many ways by wasting
  - — products such as food, paper and pencils and the energy that went into making them
  - — using nonhuman energy to do things that we could do just as well by ourselves
  - — doing such things as leaving the lights on when we are not using them
- There are things we can do to help conserve energy

LEARNING ACTIVITIES:

Students may

- Develop the Energy Conservation checklist, discussing each of the items in the checklist in order to answer any questions why a particular activity does in fact save energy
- Develop and use inventories to determine how energy is wasted at home and in public places
- Make up mathematical problems related to energy conservation. Sample problem. It costs about $367 a year for the average family to operate a medium-sized car. It costs about $235 a year for an average family to operate a compact car. How much money can the average family save by using a compact car?

  These can be exchanged by students
- Examine a weekly grocery bag. Bring the unnecessary packaging to school (Examples polyshrink wrap on meat, cartons for toothpaste, aspirin, plastic bags for carrots, double wrap on frozen food)
- Write and produce a puppet show to tell about energy conservation measures.
- Draw cartoons to illustrate current energy waste and methods of correcting it
- Role-play what it would be like if we had no electricity, gasoline, or oil.
- Present a debate Energy Needs versus Saving the Environment.

Concept D. What We Can Do to Prepare for the Future

INSTRUCTIONAL OBJECTIVE:

To make students aware of what needs to be done and how they can help to insure the availability of energy sources in the future

POINTS FOR EMPHASIS:

- We must prepare now to insure adequate usable energy sources for the future. We have seen the need for conserving energy to help ease the energy shortage today, but what about the future? Regardless of how well we conserve our nonrenewable energy sources, eventually they will run out. We need to start now to prepare for the future. We need to research and develop renewable energy sources. This is a big job and will take time.
- It is important to conserve the energy sources currently in use to give us more time to prepare for the future If we conserve our present energy sources, we can increase the time that we have to develop new energy sources. In order to conserve a significant amount of energy, EVERYONE has to help.
- Everyone can help to insure the availability of energy sources in the future by
  - — conserving today's energy sources, and
  - — supporting research to develop new energy sources for the future.

LEARNING ACTIVITIES:

Students may

- Research and report on careers directly related to energy conservation.
- Read periodicals to learn about legislation which is being proposed or adopted regarding the energy situation.
- Design posters or write newspaper editorials to convince people of the importance of planning ahead to insure adequate, usable energy sources for the future.
- Hold an energy education fair where student-prepared models and charts are displayed.
- List all the ways in which they personally can save energy both at home and in school.
- Organize an energy club to be a "Clearinghouse" for recycling information—i.e., newspapers, magazines, aluminum cans, glass, Christmas cards, egg cartons, and other throwaways. Challenge students to find another (perhaps creative) use for our disposable trash items.
- Hold class and student council meetings to propose and adopt through student vote ways that energy may be conserved in the school.
- Have a media show made up of slides of energy sources and types of work, taken and described by students
- Prepare and publish a school newspaper about energy and energy conservation.
- Maintain a collection of library books and periodicals to be researched as a basis for oral and written reports.

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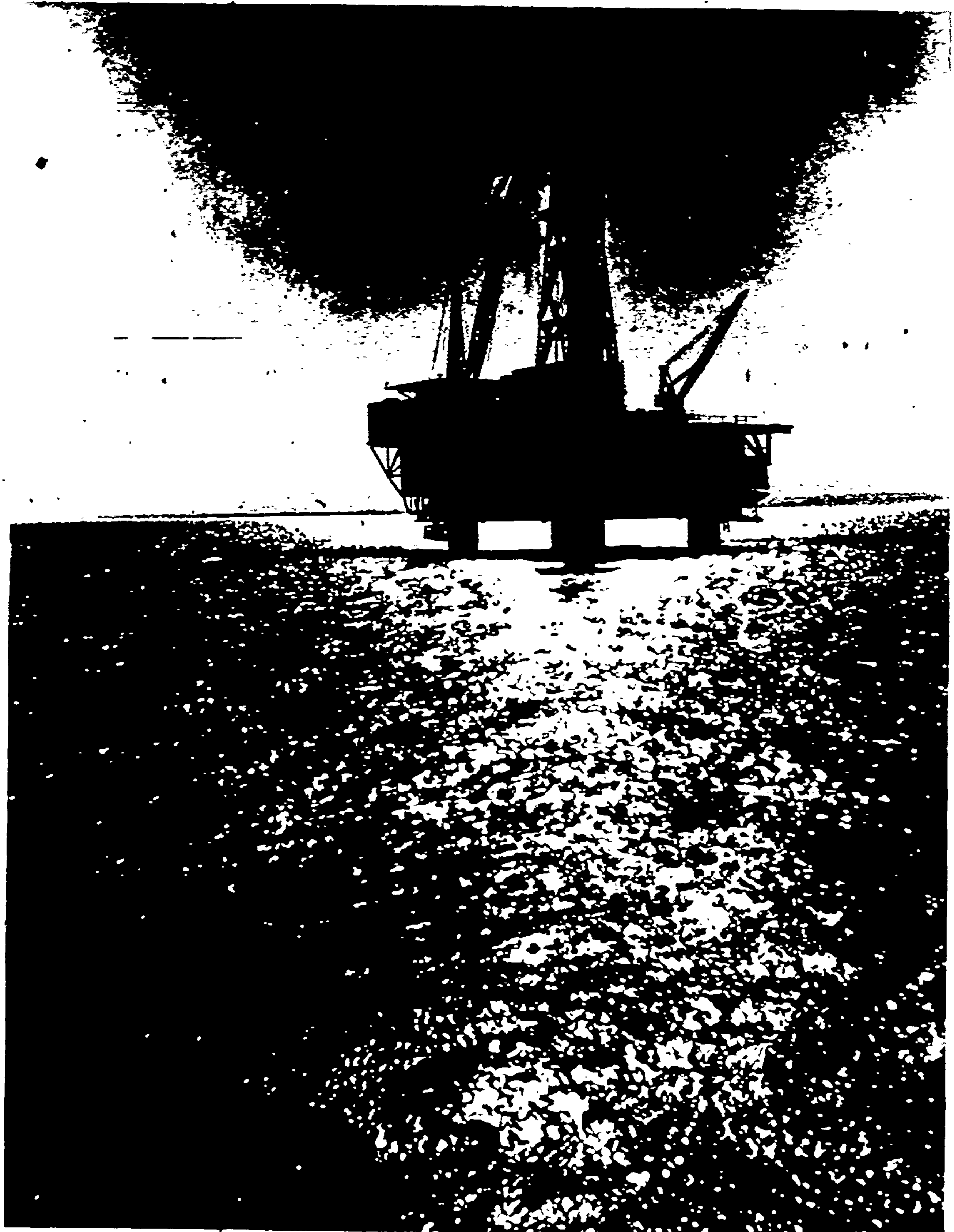


State Board of Education

John R. Meckstroth, President
William H. Cossler, Vice-President

65 South Front Street
Columbus, Ohio 43215

Martin W. Essex, Secretary
Superintendent of Public Instruction

RESOLUTION CONCERNING ENERGY USE CRISIS

WHEREAS, this Board views with great alarm the prospect that many schools may have to close or programs may have to be eliminated due to the energy crisis, and

WHEREAS, understanding this magnitude of the operation of the schools and their far-reaching impact should be made known and fully considered in any action which may be taken, such as, contracts with employees, including teachers, administrators, secretaries, custodians, bus drivers, cooks, and others; contracts with various suppliers of services and materials; difficulties associated with conflicts of summer commitments of teachers and pupils, plans of students related to graduation schedules and entrance to higher education institutions; and

WHEREAS, a majority of Ohio citizens are directly affected by the attendance of pupils in elementary and secondary schools, including work schedules of many parents which depend on children being in school; and

WHEREAS, the transportation of more than 1,250,000 pupils each day to public and nonpublic school would cause additional use of school buses if schools were closed unevenly; and

WHEREAS, the closing of schools would have little effect on the total national fuel supply if such action were taken unilaterally; and

WHEREAS, the anticipated energy crisis is national and international in scope and policies on fuel usage by the schools of Ohio are related to national and state policies yet to be formulated by the President, the U.S. Congress, the Governor of Ohio, and the Ohio General Assembly; and

WHEREAS, a definite national or state policy has not yet been formulated due to uncertainties regarding fuel supplies and other factors; and

WHEREAS, this Board is without legal authority to close the schools of Ohio, to approve a four-day week, or to order other changes in scheduled days of instruction; and

WHEREAS, the months of January and February are usually the coldest months of the winter, and as such appear to be the most logical times for curtailing school schedules if such becomes necessary, and

WHEREAS, conservation measures, if adopted uniformly by all Americans, combined with a mild winter, might result in maintenance of scheduled school days throughout the winter; and

WHEREAS, action of this Board in September and October of this year has resulted in a statewide survey of need and the formulation of "Guidelines for the Conservation of Energy in Ohio Schools".

BE IT FURTHER RESOLVED, That the "Guidelines for the Conservation of Energy in Ohio Schools" be, and they hereby are, adopted; and

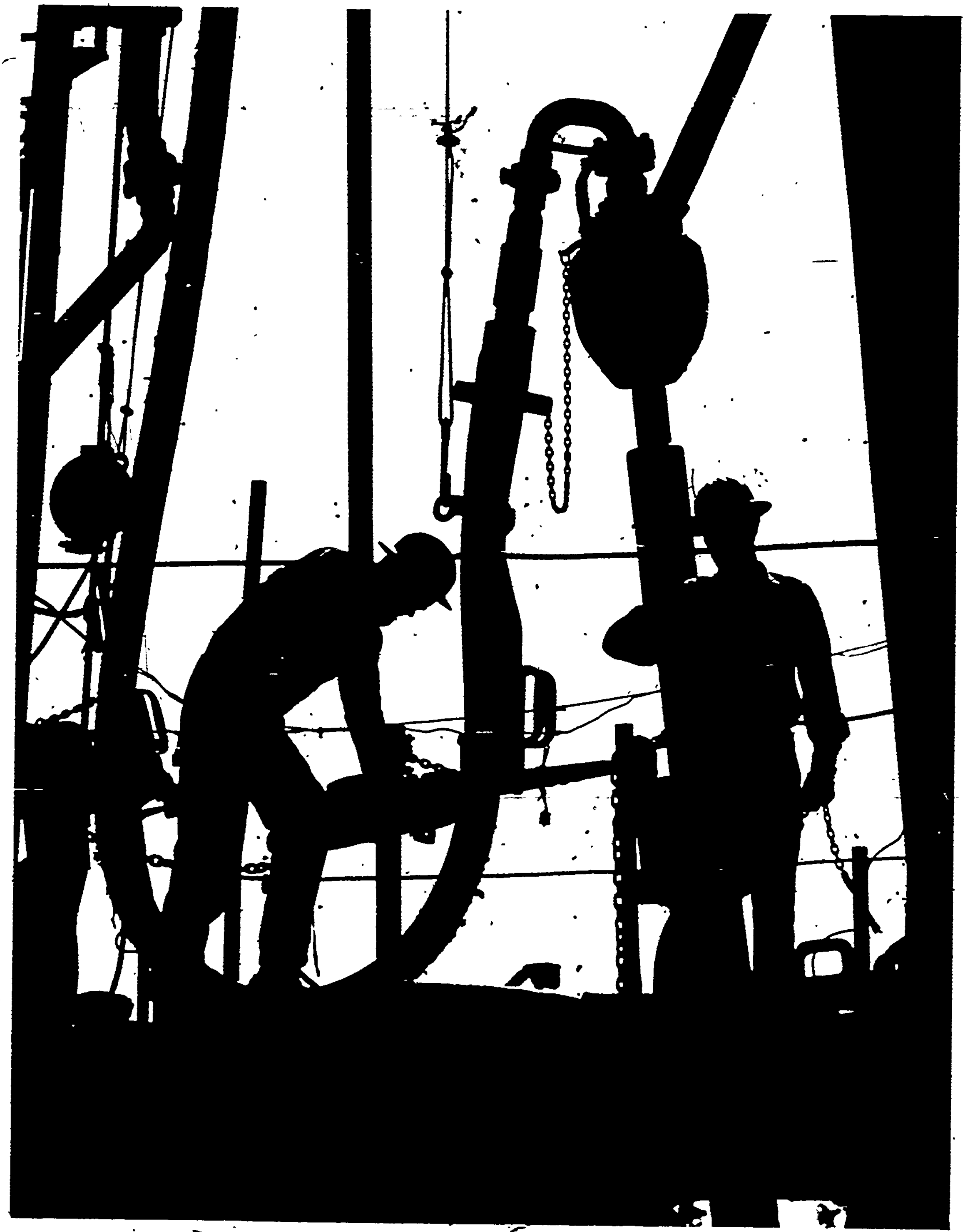
BE IT FURTHER RESOLVED, That this Board invokes the following five-fold program in meeting the anticipated fuel emergency crisis:

1. Continue to process emergency needs of schools.
2 Distribute Guidelines for the Conservation of Energy in Ohio Schools.
3. Assist local school management in development of plans for the contingencies associated with the disruption of school calendars.
4. Develop guidelines for securing buildings in the event of shutdowns during the period of low winter temperatures.
5. Develop suitable instructional materials for teachers and students about the long-range energy crisis; and

BE IT FURTHER RESOLVED, That the Superintendent of Public Instruction be, and hereby is, directed to act in concert with national authorities, the Governor and members of the Ohio General Assembly in the formulation of policy regarding energy usage by schools and the development of action programs which may be indicated when national and state policy is formulated, such programs to be developed cooperatively with school boards, superintendents, parents, and representatives of school employee organizations.

John R. Meckstroth
John R. Meckstroth
President, State Board of Education
November 12, 1973

Martin W. Essex
Martin W. Essex
Superintendent of Public Instruction



7 rules to help conserve fuel in schools

1 Lower thermostat settings to "sweater comfort" heating.

2 Avoid blocking heating vents or air return grills with furniture or drapes.

3 Control room temperatures with thermostats, not by opening windows.

4 Use limited number of outside doors—keep doors closed when not in use.

5 Reduce fresh air ventilation to the minimum required by state and local codes.

6 Turn off unused lights and electrical equipment

7 Establish a program of preventive maintenance for heating, water heating and food service equipment.

COOPERATION CONSERVES ENERGY!