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ABSTRACT

This publication contains a variety of ideas and materials for teaching about energy in grades 7-12. Topic areas include: (1) Historical Perspective on Energy; (2) Energy Resources; (3) Energy Conservation; (4) Ideas and Activities; and (5) Appendices. The first three sections provide background information on energy and conservation. The activities include ideas to use in science, social studies, language arts, and multidisciplinary areas. The appendices include a variety of useful tables of data, basic information on energy, a glossary, and a bibliography. (RH)


IDEAS
&
ACTIVITIES
FOR
TEACHING
ENERGY
CONSERVATION
GRADES
7-12

# IDEAS AND ACTIVITIES FOR TEACHING ENERGY CONSERVATION: GRADES 7-12

PREPARED FOR THE
TENNESSEE ENERGY OFFICE
THE TENNESSEE STATE DEPARTMENT OF EDUCATION
THE TENNESSEE STATE AGENCY FOR TITLE I (HEA)



BY
THE UNIVERSITY OF TENNESSEE
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JANUARY 1977

## FOREWORD

*In recent years all of us have become increasingly concerned about the energy situation and its important role in our lives. For years our growing standard of living has required more and more energy. Experts now tell us that unless some immediate steps are taken we will not be able to provide for the energy needs of our people in the future.*

*Oil and natural gas supplies may last another thirty years. Our most abundant energy source, coal, could be sufficient for two hundred years. New research and technology can alleviate part of the problem but an immediate source of relief can be the reduction of energy use. An effective energy conservation program can result in substantial savings in energy consumption and extend the longevity of energy supplies.*

*This energy publication has been developed to increase awareness and understanding of the energy situation and hopefully to encourage each individual to become an energy conservationist. The material has been designed with an interdisciplinary approach and an attempt has been made to provide a flexible document which may be altered to fit your local needs.*

*As you know, our State has long been recognized as a national center for energy development and production. From the early history of the Tennessee Valley Authority to the Energy Research and Development Administration (ERDA) at Oak Ridge, we have been heavily involved in this important task. We hope that our State may continue to be a leader in the energy field by implementing a successful energy conservation program.*

*I hope that you will find this publication useful in your classrooms as a resource for developing a local energy conservation program.*

*---SAM H. INGRAM*
*Commissioner of Education*

## ACKNOWLEDGEMENTS

The preliminary edition of this curriculum guide (entitled "A Teacher's Guide for Energy Conservation") was developed by the Environment Center of The University of Tennessee (UTEC). It was prepared by means of funds from the Tennessee Energy Office (TEO), the State Agency for Title I (HEA), and the Tennessee State Department of Education (SDE). Nearly 100 energy resource specialists and educators evaluated the first edition and 26 teachers field-tested the Guide in their classrooms. This evaluation feedback was used to develop a completely new guide entitled "Ideas and Activities for Teaching Energy Conservation: Grades 7-12." Again, support was received from TEO, Title I (HEA), and SDE, with evaluation again provided by Tennessee educators, including Joe Minor, John Gaines, Jerry Rice, Jack Rhoton, Jerry Warner, Lanny Moore, William Nelson, Doris Head, and Larry Fraley.

Contents of the guide were developed through the cooperation, contributions, and efforts of many UTEC staff members. Jonathan Wert was responsible for developing and writing the activities, with some assistance from John Judy, and for overseeing the initial compilation, by Rose Ellis, of portions of the material included in the background discussions. Nancy Collins prepared the final versions of the background material, critically edited the entire guide, and supervised the typing, layout, and production. John Gibbons, UTEC Director, reviewed the publication for technical accuracy and currency. The Bibliography, Glossary, and Appendices are the result of the combined efforts of Jon Wert, Nancy Collins, Sherry Beard, Rose Ellis, and Joyce Finney. Mary Yoder prepared the illustrations. Pam Stewart typed the drafts and Becky Smith typed the camera-ready copy. The State Department of Education and the Tennessee Energy Office printed and distributed copies of the guide to Tennessee teachers.

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<u>Communications/Language Arts 7-9</u>

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# HISTORICAL PERSPECTIVES ON ENERGY

## World Energy Needs Through the Nineteenth Century

Energy is defined as that commodity which gives men the capability to do work. Early man acquired the metabolic energy necessary to survive by gathering and eating plants. Later, he used his energy to hunt small animals. Because meat contains more concentrated protein than plants, the time spent eating was reduced by two-thirds, leaving time to stalk large animals. Such activity, of course, required greater social interaction and greater communication efforts. One result was that, about 400,000 years ago, man discovered how to use fire. Man's new energy source provided him with heat, light, protection, and increased variety in his diet. More importantly, however, he learned to use fire to extract metals from their ores and forge tools.

At the same time that man first began to use copper (10,000 BC), he began to farm. The harnessing of energy for agricultural purposes made possible the development of stationary rather than nomadic communities. Up to this point, man relied upon the sun for energy. Not only did the sun directly warm his body, but it was indirectly responsible for the production of his food and fuel (wood). Although he was able to use fire to extract metal from ores, his total energy requirement was low. The Egyptians, Greeks, and Romans brought about significant changes in energy by developing waterwheels and mills. It is known that vertical waterwheels were being used even earlier. Although its benefits were understood, water power was not taken advantage of during the early years of the Roman Empire because it was thought that individuals' jobs would be replaced by machines. But as the Empire declined, muscle power was replaced by water power; it was even necessary to ration water to the mills in order to assure everyone an adequate supply. While the Romans had aqueducts to regulate their water supply, most civilizations depended upon the seasonally changing natural flow of rivers for their water power.

Very little energy technology development took place between the Fall of the Roman Empire and the end of the seventeenth century. Some energy-harnessing tools were invented and used; for example, by 1066 there were, according to the Domesday book, 5,000 waterwheels in England. Windmills, appearing first in Persia during the seventh century, did not appear in Europe until the twelfth century but were a common sight 100 years later. Both waterwheels and windmills relieved man from physical labor and provided goods which aided the growth of towns and commerce. Also, during the ninth and tenth centuries, the horse was utilized more efficiently in Europe: the horse collar, the tandem harness, and the iron horseshoe were introduced. The pulling power of the horse, because of these aids, was three to four times greater than it was during Greek and Roman times. But although few technological developments took place, a significant change in energy did occur; in Europe coal became more and more important as a fuel during the sixteenth and seventeenth centuries because wood, which had been the main source of fuel used by the pyrotechnical trades (soap and glassmaking, the metallurgy), had become more and more scarce. Civilization was switching from renewable (replaceable) energy resources to nonrenewable (irreplaceable) resources.

The greater demand for coal meant more coal mines. It also meant deeper mines from which drainage of water became more and more difficult. During the sixteenth and seventeenth centuries waterwheels and windmills had been used to drain mines, but they were not reliable and depended upon a suitable location. A more efficient device was needed. The result was the steam engine. In 1698 Thomas Savery constructed a steam pump, what he called a "fire engine," for mine use. A short time later, Thomas Newcomen developed an atmospheric steam engine, the first engine to convert heat energy into mechanical energy on a large scale. His engine could raise 50 gallons of water per minute from a 156-foot depth. Later improvements were made by James Watt, who increased the engine's efficiency and adapted it to give rotary mechanical motion, necessary in eighteenth century textile mills.

Increased coal production also meant increased iron production. The mid-eighteenth century marked the beginning of a mechanized civilization increasingly dependent on nonrenewable resources (1775 is usually given as the beginning date of the Industrial Revolution). In 1776, Matthew Boulton began his partnership with Watt to build a new steam engine. When James Boswell came to visit Boulton's Soho Foundry in that year, Boulton said to him proudly, "I sell here, sir, what all the world desires to have--power." Power--the product of harnessing energy sources--became a new and important aspect of civilization.

Watt, around 1776, developed his steam engine without much technological knowledge as to how the engine actually worked. During the first half of the nineteenth century James P. Joule, Sadi Carnot, and Rudolf Clausius formulated the laws that define the relationships among energy, work, and heat. These laws are known as the Laws of Thermodynamics and can be summarized as follows:

1. Energy and matter can be neither created nor destroyed.

2. The energy of the universe is constant, but the energy of the universe increases toward a maximum. (Entropy is a measure of the unavailable energy in a thermodynamic system).

The importance of these laws cannot be overstated. Their formulation meant that energy could be understood theoretically for the first time.

After 1850, the theory of thermodynamics provided the theoretical basis for the improvement of the steam engine as well as the basis for the development of other heat engines. The science of thermodynamics was applied in other ways; for example, Beau de Rochas in 1862 formulated a theoretical cycle of operations that would give an efficient internal combustion engine. In 1883 Dainler introduced his petrol engine, and by 1885 Priestman had developed a heavy oil engine.

Man's increased control over energy in the early nineteenth century resulted in the switch from individually produced items to mass production of both goods and machinery. The precision of engineering and the speed of machines were improved at this time. While the energy developments were taking place, the population of Europe increased to 200 million people. Energy support of this population was not possible through domestic means alone; animals, grains, and other food stuffs had to be imported. Heretofore, the energy supply had been sufficient to feed all Europeans and their work animals and at times sufficient to supply a surplus for export. Thus, while one sees in this period a vast increase in power and energy knowledge, one also sees in Europe the beginning of a dependence on other parts of the world for basic energy resources.

## American Energy Perspectives: 1800-1974

Wood, water, and wind were the major inanimate sources of energy in the United States for most of the nineteenth century. Wood, a source of energy (power) and heat, was important to both home and industry and was the principal fuel used by railroads until about 1870. Unfortunately, most wood used during the nineteenth century was not consumed in stoves, but in open fireplaces--an extravagant and inefficient use of an abundant resource.

As wood became more expensive and less readily available, coal began to replace it for home heating and industrial steam generation. By the middle of the nineteenth century, half a ton of coal could replace two tons of wood at half the cost. In 1885, approximately equal amounts of energy were obtained by Americans from wood and coal.

Early coal mines in America were generally small operations. Due to their tremendous need for fuel, the nineteenth century railroad companies purchased large tracts of coal banks. The wholesale price of soft coal increased from $.90/ton in 1890 to $4.88/ton by 1949.

Eventually, efficient and cheap lubricants and illuminants were needed to replace scarce, expensive animal (especially whale) oils. The Pennsylvania Rock Oil Company found the answer when it struck oil in 1859 near Titusville, Pennsylvania. Early American oil wells were extremely wasteful; because oilmen did not understand geology, uncontrollable gushers often wasted oil at a rate of 3,000 barrels a day. By 1869, 4,215,000 barrels of oil (the equivalent in energy content to approximately one million tons of coal) were being produced annually in the U.S.

Another energy source, natural gas, was known to the earliest colonial settlers, who encountered it in swamps and when drilling water and salt wells. But until the 1870's and 1880's, gas was generally considered a nuisance--a waste product. Wood and coal provided necessary heat and kerosene was used for lighting. In 1878, a large gas well was discovered near Murrysville, Pennsylvania, and in 1883 a pipeline running from this well to Pittsburgh was opened. In 1884, serious searches for natural gas resulted in the discovery of large gas reservoirs which were soon tapped in order to supply local industrial plants with cheap fuel.

Even though large reservoirs of natural gas were found during the latter part of the nineteenth century, natural gas could not be used extensively because an adequate way to transport it had not been developed. Efficient, long-distance gas transportation was not perfected until the mid-1930's when seamless, pressurized steel pipes were first manufactured.

Along with the new energy sources came many new energy technologies. For example, in 1879 the electric light was invented; in 1882 the world's first electrical power and generating distribution system was built in New York; in 1882 the first hydroelectric power facility began generating on the Fox River in Appleton, Wisconsin; and in 1896 the plant at Niagara was in operation.

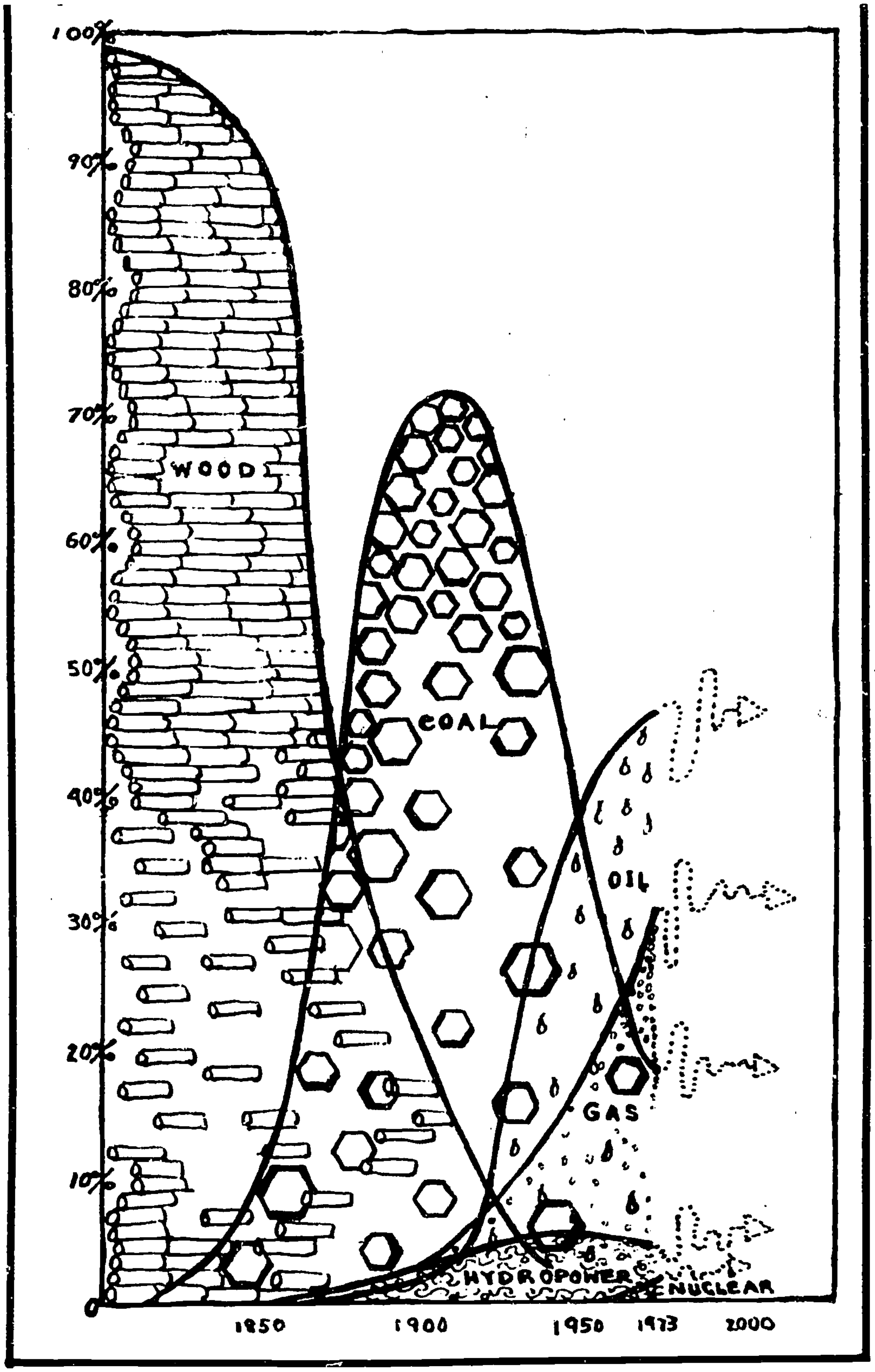
New technologies and discoveries of new energy sources resulted in a redistribution of the traditional sources and uses. The work derived from animals exceeded that obtained from all inanimate sources of energy until well into the second half of the nineteenth century. In 1870, the work output of inanimate energy sources was about equal to that of animals. By 1900, the work output derived from inanimate energy sources was more than three times greater than that derived from animals. During the early twentieth century, the amount of wood used was still substantial, but wood contributed little to the total energy pool. From 1900 to World War II, wood was primarily used for residential heating and cooking.

From 1885 until World War I, coal was the dominant U.S. source of fuel energy. In 1914, the strip-mining technique was introduced to coal mining and became an important mining method in the Midwest which contributed to the wide use of coal as a fuel. Before World War I, six times as much energy was produced by coal as by petroleum; this was reduced to three times as much by 1925, and in five years (1930), the ratio had dropped to approximately two to one.

Petroleum became an increasingly important energy source in the pre-World War II period, as did natural gas. The U.S. demand for fossil fuels--coal, petroleum, and natural gas--became so great that by 1955 the U.S. was a net importer of fossil fuels; in that year, 2.1 percent of all fossil fuels consumed in the U.S. were imported.

In 1900, hydroelectric power accounted for 57 percent of all electricity generated, but by 1950 accounted for only one-third. On the other hand, total electricity generation increased steadily until the end of World War I when it began to accelerate rapidly. Excluding World War II, the annual per capita growth rate of electricity has been seven to nine percent since the mid-1930's.

During World War II, progress was made in harnessing nuclear energy. A nuclear chain reaction was first demonstrated in 1942; the first atomic bomb was exploded in a test in 1945; and in 1951 electricity was first generated from atomic energy. Nuclear energy now provides about one percent of our electricity. Figure 1 summarizes the amounts of fuels used in the U.S. since 1850.




| | | | | |
|---|---|---|---|---|
| Fuel Wood | 90.7% | 21.0% | --- | --- |
| Coal | 9.3 | 71.4 | 38% | 18% |
| Hydropower | 0.0 | 2.6 | 5 | 4 |
| Natural Gas | 0.0 | 2.6 | 18 | 31 |
| Oil | 0.0 | 2.4 | 39 | 46 |
| Nuclear | 0.0 | 0.0 | 0 | 1 |

FIGURE 1. U.S. UTILIZATION OF FUELS, 1850-1973.



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By 1960 oil and gas together accounted for approximately 70 percent of U.S. aggregate fuel demand and electricity production consumed 20.5 percent. The chart on the following page shows that 94 percent of all energy resources consumed in 1974 were fossil fuels (resources that cannot be replaced because they were heated and pressurized in the earth over millions of years as fossilized vegetation). Furthermore, in 1974 the U.S. was importing 35 percent of its oil. We had succumbed to the enticements of cheap, foreign oil, without realizing the high interest rate we were paying in the form of lost energy independence. Our true position became clear in 1973 when the international oil crisis created an unprecedented problem for both developed and undeveloped countries. On October 6, 1973, the Arab-Israeli ("Yom Kippur") war broke out; on October 17, 1973, the Arab oil ministers decided to use their oil as a weapon to support the anti-Israeli Arab cause; and on October 19, 1973, King Faisal decided to impose an oil embargo when he learned that the U.S. government planned to send military aid to Israel. The U.S. "short-fall" was nearly five million barrels of oil per day. The effect of the embargo was not immediately felt in the U.S. because oil tankers at sea were allowed to make final oil deliveries. But by January and February of 1974--the worst months of the American "gas shortage"--American consumers were painfully aware that many goods and services were dependent upon petroleum for transportation. By the end of February, 1974, the cost of gasoline and motor oil in the U.S. was 31 percent above the February 1973 level, and the cost of fuel oil had risen 59 percent.

Electricity bills as well as gasoline prices rose during the embargo. Since electricity is generated by burning either coal or oil, the rise in oil prices meant coal prices also rose. Food prices also rose due to oil-related cost hikes in the cost of fertilizers, the cost of food preparation, and the cost of transportation. American manufacturers and farmers increased the prices of their goods in order to maintain their profit margin, so wholesalers and retailers subsequently increased their prices.

Not only did the embargo raise American fuel prices, it caused public alarm not unlike that associated with the Great Depression of the 1930's. The gasoline shortage in 1973 forced approximately 11,000 gasoline station owners out of business, caused General Motors' production to temporarily drop approximately 80 percent, and induced people to seek smaller, more energy-efficient automobiles. American motorists had to endure waiting in line at service stations. Often, the gas allotments at service stations were depleted before the end of the day. Decreased use of automobiles affected other sections of the economy--especially recreation, restaurants, and motels.

Consumers who heated their homes with oil also experienced a crisis during the winter of 1973. Not only did the cost of oil triple (from $2-3 to $6-$9) within a few short months, but availability became a question of great concern. Many consumers experienced difficulty in having oil delivered or were able to get only partial delivery on orders. Despite skyrocketing electric rates, many homeowners began switching to more dependable electric heating.

The United States was not the only country to suffer during the crisis; other industrialized nations such as Britain, France, and Italy recorded massive deficits in their balance of payments. While the embargo meant a cutback of about 18 percent of all energy for the U.S., it was five times as great as this for others who had little domestic oil production to begin with. Japan, for instance, was brought to the verge of economic collapse by resulting inflation. (See Figure 2 for comparative figures.)

The Organization of Petroleum Exporting Countries (OPEC, established in 1960) had 12 members in 1973--Venezuela, Iran, Saudi Arabia, Iraq, Libya, Indonesia, Nigeria, Kuwait, Abu Dhaki, Qatar, Algeria, and Equador. Their total petroleum output represented 60 percent of all petroleum produced in 1973. The OPEC members took advantage of the Arab embargo by raising and controlling the price of exported oil. On May 17, 1974, OPEC ended the embargo, and OPEC members negotiated agreements with foreign oil companies that gave the members controlling shares in ownership of the oil fields in their respective countries. Today, although the embargo has ended, the cost of petroleum is still increasing and remains at a level far above pre-1973 prices. This new high price of energy requires changing patterns of energy use in both higher efficiency and energy conservation.

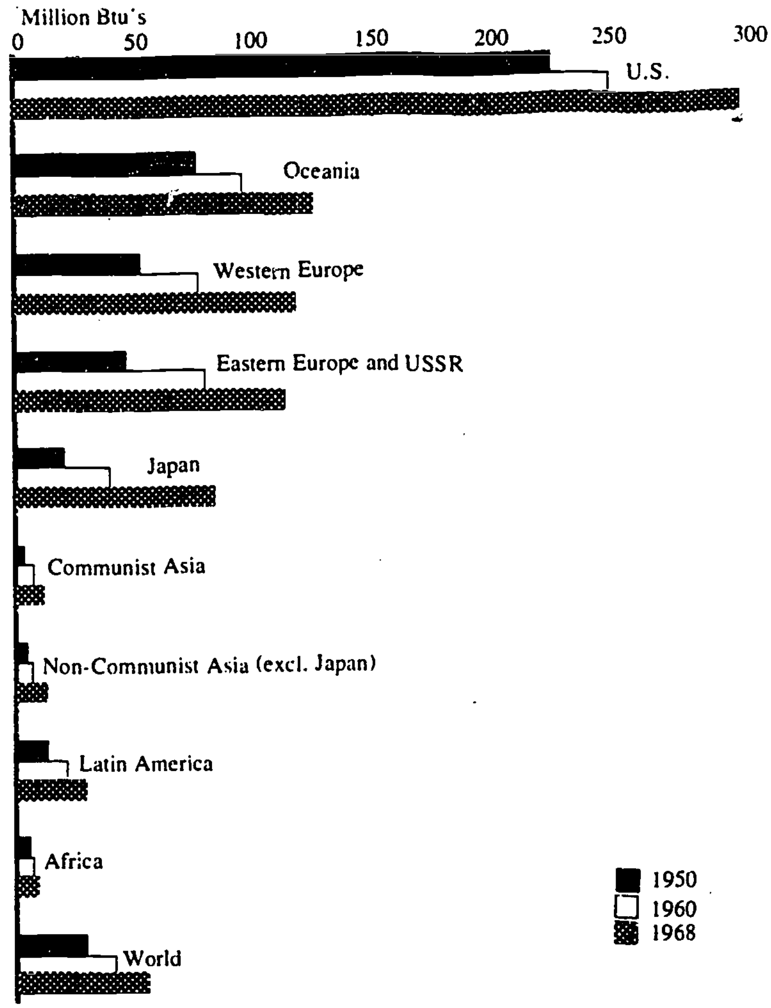
The 1973-1974 international oil crisis showed this country that it has a serious energy problem. Clearly, we must develop long-lived and renewable resources if we do not wish to run out of energy. Of course, such resources cannot be developed overnight. For example, only one percent of this nation's energy needs are provided by nuclear power although research has been going on for over 30 years. Although rates of change are increasing, it typically takes 25 years to develop and introduce new technologies; it often takes twice as long for social attitudes and change to occur in a population.

## The U.S. Energy Problem

The oil crisis did not create the U.S. energy problem--it merely hastened U.S. awareness of a situation that had already existed for many years and was steadily worsening. The U.S. depends heavily on dwindling fossil fuels; furthermore, it depends most heavily on the least abundant fossil fuels--gas and oil--for about 75 percent of all its energy.

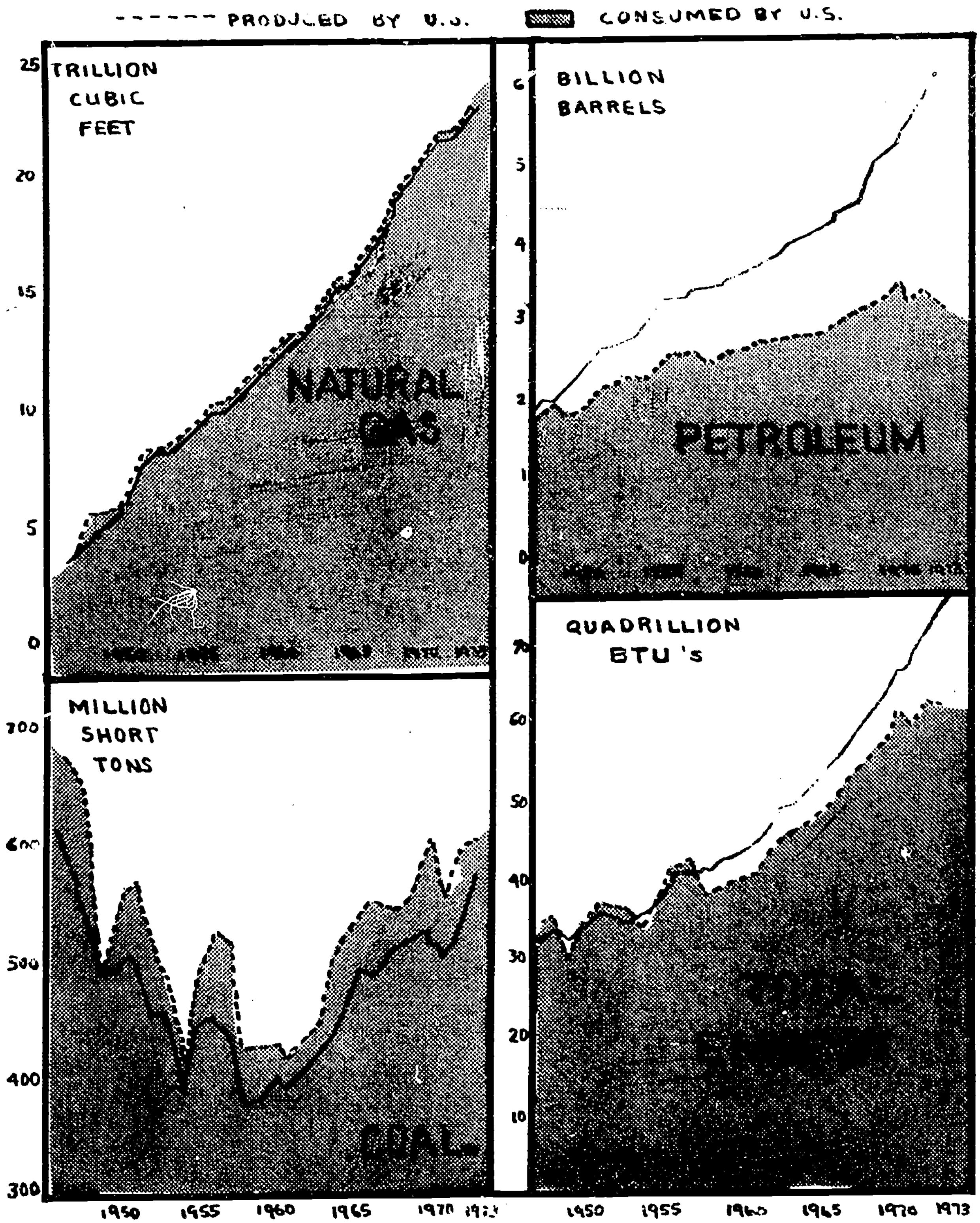
In the twentieth century, as the U.S. energy demand grew, the U.S. energy supply did not keep pace, as shown in the following examples. Coal production peaked in 1947. Crude oil exploration declined until 1971, but picked up considerably in 1974; still, new discoveries are not keeping pace with consumption. Since 1968, natural gas consumption has outpaced the discovery of new supplies, but reserves are dropping and production has begun to decline. At the same time, our energy consumption has been increasing by about four percent a year--we imported 35 percent of our oil in 1973 and between 40 and 45 percent in 1976.

Another more specific cause of the current energy problem is the gap between consumption and production for major fuels, as shown in Figure 3.




SOURCE: Energy Policy Project of the Ford Foundation, *Exploring Energy Choices: A Preliminary Report* (Washington, D.C.: The Ford Foundation, 1974, p. 128.

FIGURE 2. ENERGY USE PER CAPITA, U.S. AND THE WORLD, 1950-1968.




*Source: Adapted from* Energy Policy Project of the Ford Foundation, *Exploring Energy Choices: A Preliminary Report* (Washington, D.C.: The Ford Foundation, 1974), p. 71.

FIGURE 3. ENERGY PRODUCED AND CONSUMED BY THE U.S., 1947-1973.

In general, this was because, from the end of World War II until 1970-1972, the "real" price of energy (corrected for inflation) steadily fell. Low prices encouraged steadily less efficient use of energy. More specifically, *Exploring Energy Choices*, a publication by the Energy Policy Project of the Ford Foundation, listed seven reasons to account for this gap:

*a. Rate structures for natural gas and electricity promoted more consumption by offering large-volume users a significantly lower price per Btu than small users.*

*b. Promotional advertising encouraged the use of energy-consuming goods such as autos, air conditioners, home appliances, electric heating systems, color televisions, and petrochemical products.*

*c. Construction of the interstate highway system with the billions of dollars from the Highway Trust Fund brought a rapid increase in inter-city high-speed auto travel.*

*d. Subsidies to truck and air transportation encouraged a shift in freight away from rail transport. Public expenditures for road and airport construction plus military development of aircraft later used for freight and passenger travel were among these subsidies.*

*e. Passenger air fares dropped in comparison with bus and rail fares, and stimulated air traffic. While air fares increased 8 percent between 1950 and 1970, bus and rail fares increased 90 percent and 47 percent respectively.*

*f. Investment tax incentives and steadily rising wage rates encouraged industry to expand with energy-intensive capital equipment.*

*g. The growth in suburbia, encouraged by federal income tax breaks and federally guaranteed loans for homeowners, has resulted in the soaring use of gasoline for commuting and other energy for the single-family homes that were built.*

*Exploring Energy Choices* also listed seven ways in which federal government policies curbed growth in domestic energy production:

*a. The foreign tax credit, which permits oil companies to subtract the payments to host governments from their U.S. income taxes, became a greater incentive to oil production abroad--rather than at home--during the 1950's and 1960's. Ironically, while the import quota system was trying to boost domestic oil production, the foreign tax credit was effectively stimulating oil production abroad by U.S. oil companies.*

*b. FPC regulation of natural gas prices and reductions in the oil and gas depletion allowances in 1969 from 27½ percent to 22 percent were also viewed by industry and others as a deterrent to development.*

*c. Price controls imposed in 1971 on fuels (as well as on other goods and services) distorted normal marketplace actions to balance supply and demand.*

*d. Offshore oil and gas lease sales were virtually halted after 1969 for a year-and-a-half.*

*e. Implementation of the Coal Mine Health and Safety Act of 1969 resulted in lower productivity in underground coal mines.*

*f. The National Environment Policy Act of 1969, requiring detailed environmental impact assessments of major federal projects, caused delays in the Trans-Alaska Pipeline, offshore lease sales, and nuclear power plants, while government agencies learned to comply adequately with its requirements.*

*g. The Clean Air Act of 1970 caused industrial and power plant operators to turn away from coal to natural gas and oil to meet the sulfur oxide standards as well as automobile manufacturers to build cars with reduced fuel economy to meet emission requirements.*

Of course, these production inhibitors must also be viewed in terms of their positive environmental impacts. If energy costs had been considered as a line item in the national budget, effective policies might have been able to handle both the environmental and energy problems without the accompanying economic crises. In some respects the energy situation has worsened while in other respects it has improved. Forecasting future supplies and consumption is difficult, but one thing is certain: unless the nation weighs the impacts of alternate policy assumptions, it cannot balance economic, environmental, and social objectives. This goal cannot be accomplished without both government and citizens regarding energy as a top priority.

Several alternate energy strategies can be considered for the U.S.:

1: Conduct business as usual.
2: Achieve U.S. energy independence by 1985.
3: Develop "successor sources" to replace oil and gas over the next several years.
4: Develop a nonfossil fuel energy economy.
5: Increase efficiency of energy generation and use.
6: Change from a "disposable" to a "durable" society.

"Strategy 1" may be eliminated for five reasons: (1) energy prices have increased; (2) energy demand has slowed somewhat due to a lower population growth rate; (3) there is a national need to lessen our dependence on energy imports; (4) domestic oil and natural gas supplies are dwindling; and (5) world oil and natural gas resources will decline within a decade.

"Strategy 2" (energy independence by 1985) would require that we make changes so fast that we would have to waste resources; for example, recently manufactured cars would have to be discarded for new non-petroleum-using cars. Interdependence between the U.S. and other countries is a natural part of our lives, but we must not become overly dependent.

"Strategy 3" (developing successor resources to replace oil and gas) is reasonable since, over the next several decades, coal, nuclear (fission), geothermal, and other energy resources can be developed to replace oil and gas. Of course, these developments present technical challenges, and time and capital will be required. At the present time, "Strategy 3" is receiving the overwhelming attention and commitment of government and industry.

"Strategy 4" is similar to "Strategy 3." Both require a commitment by governmental and private sectors. But "Strategy 4" (developing a non-fossil fuel energy economy) forecloses the use of coal because it pollutes, and the use of oil and natural gas because they are rapidly dwindling. This strategy emphasizes the development of fission and fusion as well as solar energy resources. A long lead time is needed for this strategy.

"Strategy 5" (increasing efficiency) can "trim the fat" off current energy generation and uses over the short run, while saving money. Over the long run, efficiency can be increased by perhaps 50 percent, saving even more money and fuel.

"Strategy 6" concentrates on the overall patterns of energy use rather than the specific methods. It suggests that the disposable, high-energy American society can change to a more durable, less energy-intensive society. Some changes in behavior would have to come about under this strategy, possibly requiring rationing or taxing of resources in order to lower the rate of consumption of materials and energy.

While the technologists implement "Strategies 3, 4, and 5" through research and development, citizens can implement "Strategies 5 and 6"--both of which depend upon wise use of energy. Conservation is the only viable solution for the immediate future. In the long run, conservation methods can enable our society to maintain its standard of living with about half its present energy use.

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# ENERGY RESOURCES

## Renewable and Nonrenewable Energy Resources

All energy resources belong to one of two groups--renewable or nonrenewable resources. Nondepletable energy resources are *renewable*; for example, the sun is a renewable resource, as is water. In 1974, only six percent of all energy resources consumed were renewable.

Depletable energy resources are *nonrenewable*. Fossil fuels--coal, oil, and gas--are nonrenewable because they were produced over millions of years by vegetation under pressure in the earth's crust and heated by the sun. Uranium, another important energy resource, is also renewable. In 1974, 94 percent of all energy resources consumed were nonrenewable; in other words, America's high-energy society is based upon a finite, dwindling supply of energy.

### *Nonrenewable Resources*

*Coal.* Coal is the only nonrenewable energy resource which still exists in any abundance. Proved U.S. reserves are estimated to be 400 billion tons; possible resources are estimated as high as 3200 billion tons. This adds up to as much as 200 years' supply of coal at the current energy use rate. In 1974, we consumed 558 million tons of coal and exported 60 million tons.

Coal is most often used to convert water to electricity or to make steam for industry, but more and more it is being converted directly to gas or oil which reduces the number of years coal will last. Coal's greatest disadvantage is that it creates many environmental problems. Because it is a "dirty" fuel, it causes air pollution (the higher the sulphur content, the more pollution; western coal has less sulphur, but more ash, than eastern coal). Strip-mining--the easiest and least dangerous method of coal mining--causes erosion and leaches wastes into streams and watersheds. Companies which strip-mine for coal (about half of all U.S. coal is strip-mined) are being pressured to reclaim stripped land at high cost.

*Natural gas.* At the present time, natural gas is our least expensive fossil fuel because of price controls that make it artifically cheap. In the near future, however, the price of natural gas will become much higher, necessitating many current users to switch to some other fuel. There will undoubtedly be opposition to such a switch since natural gas is the cleanest of the three fossil fuels and is in great demand for space heating.

The proved U.S. reserves of natural gas (including Alaska) amount to 237 trillion cubic feet (Tcf); "inferred" reserves total 202 Tcf; and undiscovered recoverable resources are estimated by the U.S. Geological Survey (USGS) to range from 338 to 722 Tcf. U.S. production of natural gas has been steadily declining since 1973--in 1975, production (20.1 Tcf) barely kept pace with consumption (about 19.1 Tcf). This situation presents the very real threat of curtailments, which could have severe consequences for the growing number of industries which have come to rely on natural gas.

*Oil.* The total amount of oil available in the U.S. and offshore is unknown, though proven reserves (including Alaska) are estimated by the USGS (in the Federal Energy Administration's *1976 Energy Outlook*) to be 34 to 38 billion barrels (Bbl), estimates of undiscovered recoverable resources average 89 Bbl, and nearly 200 Bbl might become economically recoverable in the future. As with natural gas, the price of extracting petroleum from U.S. oil fields may become so high that we will change our present use patterns (6.19 Bbl in 1973). Costs will increase because most of the easy-to-get oil has been consumed and new, harder-to-get sources requiring more complicated technologies will have to be tapped. Exploration for additional oil reserves centers on sites under as much as 800 feet of ocean water or as far as 25,000 feet underground. Other large reserves of oil are trapped in fine-grained rock called shale. Useful fuel can be extracted from oil shale, but the net energy produced may be small, the process expensive (perhaps twice the present cost), and the environmental problems significant (large amounts of water are needed for extracting processes).

*Uranium.* Uranium, as a fuel for nuclear reactors, is a controversial energy source. It is highly favored by some because the potential energy of a given quantity of uranium is several million times greater than the energy available from an equal quantity of any one of the three fossil fuels. Mining uranium is a great deal more difficult than fossil fuels, however. Even the richest uranium ore may contain only a fraction of one percent of uranium. Because uranium ore is not pure and the costs of extraction vary, the amount of current reserves are hard to estimate. It has been suggested, though, that we only have 30 years worth left of $U^{235}$--the uranium necessary to produce fission reactions in conventional nuclear power plants. The drawbacks to fission as it is presently used to produce electricity are the radioactive wastes and safety concerns. These objections may be overcome with the possible future development of the breeder reactor. At the present time, breeder technology is not well-established, costs of development will be high, and it is known that the waste product is extremely toxic. If breeders can be successfully developed and these obstacles overcome, the effective amount of fissionable material (the plentiful $U^{238}$ after being converted to $Pu^{239}$) is tremendously increased, which means that our current energy reserves of uranium can fulfill our energy needs for thousands of years.

*Renewable Energy Resources*

*Solar.* By 1973 only a few dozen U.S. homes had been constructed with solar heating systems; but by the year 2000 solar heating and cooling could satisfy perhaps half the needs of all new residential and commercial buildings. Presently there are some very promising approaches to using solar energy for low temperature needs such as space and water heating, but the cost is still relatively high ($10 to $12 per square foot for solar panels) and functional storage systems must be developed to operate in conjunction with the solar devices. If solar equipment (lenses, mirrors, panels, and other devices used to concentrate the energy of the sun) can be manufactured cheaply enough, we could produce electricity either by a thermal cycle (making steam and driving a turbine) or by direct conversion using solar cells. The thermal cycle alternative is much closer to practical implementation, but is still several times as expensive as present methods of energy generation. The high popularity of solar power is closely related to individuals who strongly believe in alternate lifestyles and *individual* energy independence. These attitudes are also reflected by the large number of non-federal research and development activities taking place in all parts of the country (and world).

*Geothermal*. Large amounts of geothermal energy (heat in the form of steam, such as that found in geysers) are present in the earth's crust, but it is possible to tap these resources only in limited locations. Thus far, development and exploration in the U.S. has been conducted mainly in the West (California) because the most promising sites are found there. Geothermal energy is also being used in Japan, the USSR, New Zealand, Iceland, and Hungary for air conditioning and heating houses, heating greenhouses, processing paper, drying timber, and refrigeration.

Experts estimate that over the next 25 years as much as 25,000 megawatts (MW) will be provided by geothermal plants, where steam from the earth is used to drive turbines which generate electricity. There are, however, a number of disadvantages to using geothermal energy in this manner. Equipment used in the plants tends to corrode quickly because of minerals which dissolve in the hot water. These same minerals can create some environmental problems in the form of ground water contamination, waste salts, and air pollution (including escaping hydrogen sulfide which smells like rotten eggs). Finally, geothermal steam is not very hot, and so is an inefficient means of producing electricity (it also produces a lot of "waste heat").

*Wind*. Like geothermal energy, practical wind energy is found only in certain locations, mostly in the Midwest and Northeast. Even there, it is variable and must be accompanied by storage devices or used only for special purposes, such as pumping water for stock ponds. At present, however, wind power generators are being tested in Northern Europe, Russia, and the U.S. A 100-kilowatt (KW) wind turbine generator has gone into operation recently at NASA's Plumb Brook Station at Sundusky, Ohio, sponsored by ERDA, with several additional projects under way. Unless research designers prove otherwise, many windmills will be needed to obtain a reasonable quantity of energy (thousands would be needed to equal the output of a single modern electric generating plant). Other difficulties to be faced by technologists are intermittent winds, lack of efficient storage units (e.g., batteries), and few favorable sites.

*Tidal*. Although suggestions have been made to harness the energy in tides, the total amount of tidal energy potential (20 million MW) would make a negligible impact on the world's energy supply. Furthermore, suitable locations are not where the demand is and severe environmental problems could be caused by massive movements of water in and out of coastal areas. Other disadvantages are visual pollution if the generating facilities were in a resort area, corrosion of equipment by salt water, and high capital costs.

*Hydro (Water).* Most hydroelectric potential in the United States is already being used and environmental problems will probably prevent the development of additional sites. At the end of 1970, the installed hydroelectric capacity (both conventional and pumped) was 56,000MW. By the year 2000, it is estimated that it will provide 125,000MW of power, but only 10 percent of the nation's electricity demand. Much of the capacity in 2000 will be used for pumped storage systems which will use the spare capacity of "base load" electric plants (for example, in the middle of the night) to provide power during periods of peak demand the next day. Water will be pumped uphill for storage, and power will be produced later when it is released downhill. Thus, a pumped storage system is not a power source, but a means to avoid wasting unused power produced by any type of electricity generating facility (nuclear, hydro, coal-fired, etc.).

*Wood.* Wood is still an important energy source in "third world" nations and can provide a great deal of power for short periods. Wood could continue to be used as a renewable fuel if it were grown on "plantations" and then burned to produce electricity. The obvious disadvantage, however, is the competition for land use by the agricultural sector.

*Refuse.* Using our solid wastes to supply part of our electrical demand is an idea which appeals to many people and, indeed, some small plants are already in operation or under construction which can produce electricity from solid wastes. One such plant in St. Louis burns approximately 300 tons of municipal waste per day to generate 12.5MW of electricity. Other possibilities being considered for refuse are converting it to methane and wood alcohol. But even if we took full advantage of the energy contained in *all* refuse, less than 10 percent of our energy needs would be met. Despite this small impact and regardless of its cost, we may be forced to use municipal wastes in these manners in order to avoid a serious environmental crisis in the near future.

*Fusion.* Although the key concepts and technologies which will unlock the intricacies of fusion are not yet known, fusion remains a major hope for significant quantities of power. Once developed, fusion could provide a long-range solution to the world's energy shortages because a nearly inexhaustible supply of deuterium (the fuel necessary to produce fusion power) is found in water. Two problems which must be overcome by scientists are (1) containing, over a long period of time and under correct pressure, temperatures of 100,000,000$^{o}$C reached during a fusion reaction, and (2) disposing of fusion wastes. The date at which a fusion system can be implemented cannot be predicted; certainly it will not be commercially possible until the twenty-first century.

## Methods of Transporting Energy

Fuels are transported by highway, rail, water, or pipeline; electricity is transmitted by wire or cable. The method used depends upon the characteristics of the fuel, its location, its expected use, and comparative costs versus distance. Transportation cost is particularly important to the consumer since this can determine what is used to heat homes. Cost is related to the "energy intensiveness" of each mode of transportation; for example, it takes almost four times as much energy to move one ton of fuel one mile by truck as by water or rail. Energy intensiveness must be balanced against distance, minimum required transportation time, and end use in order to determine the most cost-effective mode of transportation.

Coal, oil, and natural gas (liquefied) are often transported by water. In 1973, almost 12 percent of all domestic coal was moved by barge. (A tow with up to 20 barges can carry 20,000 to 30,000 tons of coal at low costs.) Approximately one out of every five barrels of crude oil is transported to refineries by tanker (supertankers carry up to 300,000 tons), and about 30 percent of all refined oil is moved by water carrier. Natural gas can be moved by tanker only if it is in liquefied form; due to increased cost and the few number of special LNG (liquefied natural gas) tankers, this is not yet a common means of transporting natural gas.

Oil, natural gas, and coal can also be transported by pipeline. Natural gas and oil are particularly dependent on pipelines from well-head, to processing installation, to pumping station, to distribution center, to local gas company, to consumers. Coal pipelines, though technically feasible, are rare due to opposition by railroads and difficulties in acquiring rights-of-way. Recent legislation, however, granting five pipelines the right of eminent domain may bring about increased use of coal pipelines.

The most efficient form of land transport today, besides pipelines, is the railroad. Two-thirds of all domestic coal is moved by rail since shuttle cars can conveniently move the heavy, bulky load non-stop from mine to power plant or industrial site. More efficient diesel engines which can pull greater loads have reduced the cost and energy intensiveness of railroads.

In 1973 over 40 of all refined oil products were moved by truck--the most energy intensive (and the most expensive) means of transportation. Until the oil embargo of 1973-1974, the greater speeds at which trucks could travel on the interstate highway network reduced the cost per mile and increased their use. It does not appear that use has decreased, but higher costs have contributed to increased costs of foods and commodities. Considerably less coal is transported by truck (only 10 percent), usually in those cases where mines are accessible by rail or water.

Electricity is transmitted from the power plant to the user by overhead powerline or underground cable. Over 300,000 miles of power lines are supplemented or replaced by an increasing number of cables for environmental, aesthetic, and safety reasons. Unlike overhead lines, which increase the voltage of electricity in order to transmit it over long distances without major energy loss, and then reduce it again for consumption, cables can transmit electricity at lower voltages which is a more suitable way for end distribution to customers.

Methods of Storing Energy

Whenever possible fossil fuels, hydropower, electricity, and solar energy are stored for future use. The type of storage depends upon the particular energy resource. The type of electrical energy storage with which most people are familiar is a battery. Unfortunately, batteries are impractical for storing large amounts of energy. Recently, however, research has begun in developing efficient, long-lasting batteries. Improvements in storage batteries (zinc-air, lithium-sulfur, nickel-zinc) will facilitate energy storage for daily peak demand periods at generating facilities, emergency generation of electricity, and vehicles.

Each of the fossil fuels requires a different method of storage, depending on its production and how/when it is consumed. Coal is usually stockpiled outside the place where it will be burned. This is not very efficient since coal tends to deteriorate in the open air, but its bulk and weight precludes the use of any other storage method. Fortunately, better rail transportation direct from mine to user means shorter stockpiling times.

Natural gas must be stored in large underground reservoirs. Because the capacity of these storage pools is small (5.2 trillion cubic feet at most), utilities must cooperate closely with the producers in order to assure adequate gas supplies in the winter, when residential demand is five times as great as in summer.

Crude oil is stored in pipelines or large tanks until it is needed at the refineries. Refined petroleum products are stored until they are needed in the consumer sectors; for example, heating oil is stored in tanks until it is needed for winter heating. Residences that burn oil are generally equipped with 265-gallon tanks. In the future, these tanks may have a capacity as large as 1000 gallons. Though unsightly unless buried below ground level, these tanks will lessen the oil companies' storage and transportation costs. Gasoline, another refined petroleum product, is transported to service stations where it is stored in underground tanks until it is dispensed to motor vehicles.

Hydropower requires still different storage methods--either gravity water storage or pumped water storage. Rivers are natural energy resources that can be harnessed for their gravitational potential energy. The potential energy in the water was supplied by solar power, which earlier evaporated the water and transported it to higher elevations. Gravity water storage is used to collect and hold a river at high elevations so that the potential energy available from the river can be converted to electrical energy during peak electrical demand periods.

If rivers flowed continuously at a constant rate, the gravity water storage system would not be necessary. But rivers tend to dry up in the summer and flow at such powerful rates in the spring that most of the energy available would be lost without gravity water storage, which compensates for the minimum water energy available during summer. Thus, storage areas or reservoirs allow hydroelectric plants to operate continuously at the highest and most efficient level possible.

Water storage which involves the pumping of water rather than the flow of a river is called *pumped water storage*. The simplest system of this type uses energy from a thermal plant to pump water from one reservoir to a higher one. Later, gravity causes the water to flow back to the lower reservoir and electricity is generated. Pumped water storage systems are usually used in conjunction with gravity water storage systems. Many pumped water systems make use of some natural river flow; that is, river water flows into the higher reservoir and water is pumped to the higher reservoir from the lower reservoir. Thus more water is used for generating purposes than is actually pumped to the higher level.

The advantage of the pumped water system is that during periods of low electricity demand the thermal plant can consistently use the power it generates to pump water to the higher storage area. Then, during periods of peak demand, energy from the thermal plant and the pumped storage plant can be utilized to meet peak demand.

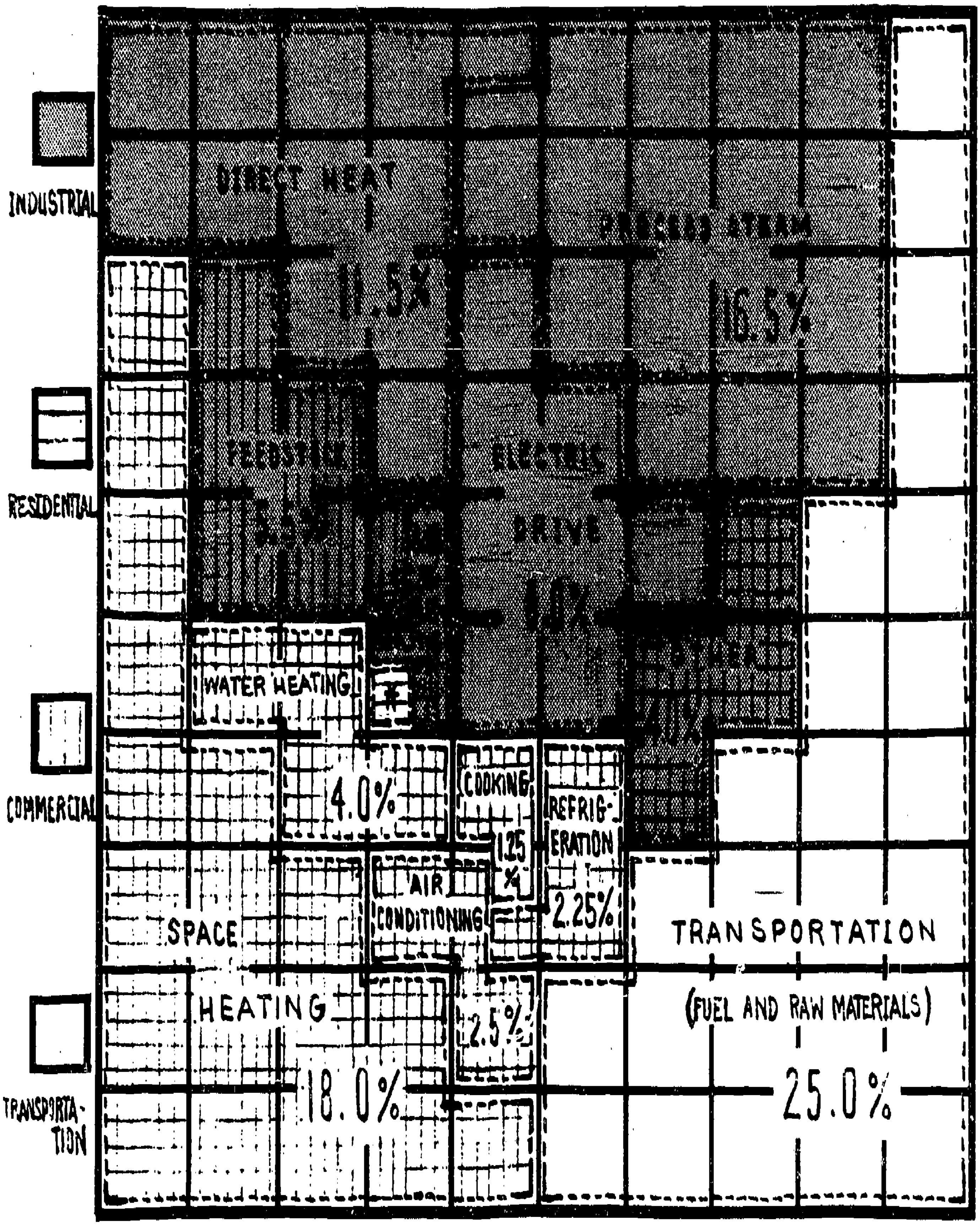
Efficient and sufficient methods of energy storage are some current obstacles facing developers of solar collectors. Currently, radiant heat collected during periods of sunlight is stored in concrete tanks filled with rocks or water. The drawback is that tanks must be extremely large in order to store enough energy to cover extended periods of cold or overcast weather. Research is being conducted to develop better insulation and materials for storage tanks.

## Patterns of Consumption by Sector

The U.S. consumes more energy per capita than any other nation in the world. This high-energy use rate is reflected in every sector of our society--commercial, residential, industrial, and transportation. Figure 4 shows the proportion of energy used in each sector, as well as its distribution for activities within sectors.

The commercial sector, the smallest of the four, includes businesses, government buildings, hotels, hospitals, restaurants, and offices. Half of their energy consumption went for space heating and air-conditioning. This sector has been growing at a faster rate than the others, and depends primarily on natural gas, oil, and electricity.

Space heating is also the single largest energy user in the residential sector, which is slightly larger than the commercial sector. The uses for which energy requirements are growing most rapidly are air-conditioning, clothes drying, and refrigeration. The rapid rise in air-conditioning has created a new problem for utilities--providing enough electricity to meet the disproportionately large demands. The result has been "brownouts" when




37 38

*CLOTHES DRYING - 0.25%

EACH BLOCK = 1%

FIGURE 4. ENERGY CONSUMPTION WITHIN SECTORS.
(Based on 1968 Figures.)

the generating facilities reduce the amount of power delivered to each customer. In rare cases, all power is cut off either intentionally or unintentionally--a "blackout."

The transportation sector accounts for over one-fourth of our total national energy consumption. Three-fourths of this is spent on highway transportation; the remainder is spent on airplanes, railroads, shipping, and pipelines. Clearly, most of the transportation energy use is due to the movement of people and goods on U.S. highways, with oil accounting for essentially all energy consumed in the transportation sector.

Most importantly, while the transportation sector is second largest (25 percent) in terms of total fuel energy consumption, an additional 15 percent of total fuel energy consumption comes from the other three sectors to support the transportation complex: energy is required not only to fuel transport machines but also to build and maintain them. It is easy to understand why the automobile portion of the transportation sector absorbed most of the shock of the 1973-1974 oil shortage. It is also easy to see why much attention is given to improving energy efficiency in that sector.

The largest consumer of fuel energy in the U.S. is the industrial sector. Heating processes, either by manufacturing steam or by directly burning fuel, account for half of industrial fuel consumption. The rest is used for electrolysis, feedstocks, heating/lighting, and running machines. Unlike the transportation sector which relies on oil, the industrial sector uses all three fossil fuels--gas, oil, and coal.

All of the four major energy consumption sectors largely depend upon dwindling fossil fuels. It is essential that alternate energy sources be developed. Present consumption patterns will help determine the priorities which should be given to various alternate energy resources; for example, solar energy--an energy source which can provide space heating, air conditioning, and water heating--may have a significant impact on the residential and commercial sectors but little impact on the transportation sector over the next 30 years or more.

## Future Trends in Energy Consumption

How will the patterns of energy usage change in the future? It seems certain that growth in energy usage will continue during the twentieth century, but how large will the increase be? What energy consumption sector will show the strongest growth in demand?

In an attempt to answer these questions, a forecast made by the Exxon Company ("Looking Ahead to 1990") has been compared to future trends suggested by the Federal Energy Administration (FEA). It was found that the projections by a large international petroleum company (Exxon) were also made by a government agency (FEA); in other words, oil companies' ideas are not, as many would believe, always contrary to government ideas or data. Of course, both estimates may be wrong.

*Exxon's Projection Assumptions.* Many factors must be considered in order to formulate energy consumption forecasts; these include population trends, future technological changes, past consumption trends, price trends, and future government policies. Exxon assumed the following items to be true in their forecast:

1. That government will not mandate curtailment of energy consumption below levels necessary for adequate national economic growth or enforce use of certain fuels in preference to others.

2. That government policies will facilitate expanded energy development; increase the leasing rate of offshore acreage as well as oil shale and coal acreage; moderate the delays in nuclear plant licensing and siting; and maintain a realistic balance between energy, economic, and environmental goals.

3. That government policies will not reduce the availability or inhibit the formation of capital funds required by the energy industries.

4. That the nation will continue its recovery from the 1974-1975 recession.

5. That there will be long-term growth toward full employment.

6. That higher energy costs will divert some capital investment in labor-saving equipment, resulting in lower than historical gains in productivity.

7. That (primarily for the reason above) long-term growth in real Gross National Product will be somewhat below the historic growth rate.

8. That full attainment of secondary air quality standards will be delayed temporarily to permit greater use of coal.

9. That oil imports will be available as needed.

10. That energy prices will increase at the U.S. inflation rate.

11. That high energy prices will significantly affect energy consumption, both depressing demand growth and influencing the mix of fuel utilized.

Note that Exxon assumed that higher energy prices will decrease the rate at which energy is demanded by sectors; for example, although the electrical power demand rate (based on the period from 1955 to 1967) is an annual increase of eight percent--a doubling time of nine years--the future electrical power demand rate may not increase by eight percent annually, in which case higher energy prices would depress demand. Given the above assumptions, Exxon described the future trends for four sectors: industrial, transportation, residential/commercial, and nonenergy. Before, the nonenergy sector was included in the industrial and commercial sectors under the title "feedstock." (Feedstocks are those energy resources used as raw materials in manufacturing rather than as fuels for burning.)

*Industrial Energy Consumption.* Exxon projected that industrial energy demand growth rate would decline sharply through 1980, efficiency in energy use would rapidly increase, and economic growth would be slower. Then, from 1980 to 1990, the demand growth rate would increase, the rate of efficiency improvement would slow, and economic growth would continue.

In April, 1976, FEA reported that industrial energy consumption in 1975 was 9.4 percent less than the 1974 consumption level and 10.9 percent less than the 1973 level. Furthermore, the 1975 level was 16.8 percent less than the projected level for 1975, based on 1964-1973 data.

This decrease in energy consumption for 1975 did not reflect an increased level of energy efficiency. However, certain energy-intensive companies which were visited and aided by staff members of FEA's Office of Energy Conservation showed marked improvement in energy efficiency. It is clear that energy efficiencies can be improved. In fact, despite falling (real) energy prices, industrial energy use per unit output fell steadily in the Fifties and Sixties at a rate of over one percent per year. With increasing prices, the rate of efficiency should increase significantly.

Exxon's forecast for the industrial sector was supported by FEA statistics. In the future, higher energy prices, among other economic factors, will most likely continue to slow economic growth, particularly in energy-intensive industries. At the present time, energy-intensive industries will probably improve their energy efficiency in the next decade. Also, to the extent that energy is substitutable, the higher energy price will slow energy growth but not economic growth.

*Transportation Energy Consumption.* Exxon forecasted that the annual energy consumption in the transportation sector would drop significantly below the historic rate. FEA statistics indicate that the 1975 transportation energy consumption was only 0.7 percent higher than the 1974 level and 3.3 percent below the 1973 level. On the basis of the 0.7 percent increase, it might appear now that the U.S. was recovering from the 1973-1974 international oil crisis, with the transportation energy consumption demand rate slowly increasing. Keep in mind, however, that the 1975 transportation energy consumption level was 12.1 percent below the projected trend for that year.

FEA's projected trend was based on 1964-1973 statistics and that gasoline consumption per capita, though 1.0 percent higher than the 1974 level, was 8.5 percent below the projected trend for 1975. The FEA statistics revealed that higher gasoline prices (2.8 percent above the 1974 level) and greater automobile efficiency helped reduce transportation energy consumption. According to FEA statistics, it seems safe to assume that the combination of a new conservation awareness (a by-product of the 1973-1974 international oil crisis) and higher energy prices reduced the transportation energy consumption demand rate. Furthermore, the present growth rate is significantly less than the growth rate projected by FEA and new regulations are set to ensure that autos become more efficient in the years to come.

Bearing in mind that domestic oil supplies are dwindling and that oil import prices can be expected to increase to as much as $15/barrel by 1985 if domestic alternatives are not developed (1974 import prices averaged $12.52/barrel, while domestic prices averaged $7.18/barrel; 1975 import prices rose to an average of nearly $14/barrel, while domestic prices rose at a lower rate to $8.39/barrel), there is no reason to doubt Exxon's prediction that demand growth rate in the transportation sector will drop significantly. In fact, it may not grow at all.

*Residential/Commercial Energy Consumption.* Exxon projected that the growth rate in the residential/commercial sector would decline after 1975, that energy demands would be met primarily by gas and electricity, and heating oil consumption would increase only moderately. According to FEA data, 1975 energy consumption in buildings (residential and commercial), though 2.2 percent above the 1974 average level, was the same as the 1973 level, and the 1975 building energy consumption was 9.1 percent below the projected trend for that year; in other words, the growth rate declined from that projected based on the 1964-1973 statistics. No doubt, the residential/commercial energy consumption demand rate will continue to decline from the projected level until it is below the actual 1973 consumption rate.

FEA data also showed that: (1) 1975 electrical energy usage by commercial sector and per household rose above the 1973 and 1974 levels; and (2) electrical usage decreased 10.9 percent from the projected trend in the commercial sector and 11.2 percent per household. The 1975 per capita energy usage in the residential/commercial sector was 6.6 percent below the 1973 average level, 3.6 percent below the 1974 level, and 12.4 percent below the projected trend for 1975. As in the transportation and industrial sectors, reduction in the rate of energy consumption was partly the result of conservation measures and partly the result of economic factors. It seems likely that, over the long term, the slowdown in population growth and improved efficiency in energy use in housing will continue to hold down demand growth to less than two percent per year.

It is clear that there are reliable government data to support Exxon's projection that the energy consumption demand rate for the residential/commercial sector will decline from that of the 1964-1973 period; as mentioned, the growth rate for 1975 was 9.1 percent less than the projected trend (based on 1964-1973 figures). Since 1973, demand for electricity and natural gas increased; demand for heating oil has decreased since 1974 (though it had moderately *in*creased since 1973).

*Summary and Conclusion.* Exxon projected that the demand growth rate in the industrial sector would first decline sharply through 1980, then increase; that the demand growth rate in the transportation sector would drop significantly below historic rates; that the demand growth rate in the residential/commercial sector would decline from the 1960-1974 period; and that the demand growth rate in the nonenergy sector would remain about the same. FEA statistics supported Exxon's forecast: their data show that the 1975 energy consumption in industry, transportation, and buildings was below the level projected on the basis of 1964-1973 data on consumption levels in those areas.

Increased conservation awareness as well as increased energy prices, due to dwindling easy-to-recover domestic energy supplies and to increased imported fuel costs, will result in further reductions in energy consumption. Total energy consumption for 1975 was 2.8 percent below the 1974 level and 5.2 percent below the 1973 level. These statistics were based on January through November of each year; in other words, the 1973 figure excludes the most energy-intensive month of the international oil embargo--December. If the U.S. aggregate energy consumption can go below the pre-embargo level, as it did in 1975, perhaps it can go below the consumption level for 1972 or even 1971.

Forecasts which state that the U.S. energy consumption level will double from its current level by 1990 may be true since energy consumption levels depend upon population increases, government policies, technological changes, and the price of energy in the future, but it is true that higher energy costs in 1975 brought energy consumption to 12.4 percent below the projected trend for that year. As population growth slows and as we have time to make a full response to higher energy prices, the efficiency with which each of us uses energy will increase in importance. The combined effects of consideration of energy efficiency and energy conservation within all sectors of our society could result in a nearly level demand for energy by the turn of the century.

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# ENERGY CONSERVATION

Why Energy Conservation?

Increased conservation awareness, higher prices, and new public policies have resulted in significant reductions of energy consumption; for example, in 1975 conservation measures helped bring energy consumption to 12.4 percent below the amount earlier projected for that year. Other estimates suggest that energy conservation can bring about a one-third reduction in energy consumption without curtailment.

"Conservation" means the wise use of energy; it can be a natural response to price change, a shift from less to more available fuel resources, or simply a well-insulated house with an efficient heating system.

"Curtailment," on the other hand, causes or induces denial; for example, an oil embargo requires curtailment or cutting back petroleum consumption. Curtailment means a cold house in the winter even though it's a well-insulated house. Conserving energy resources now means avoiding possible curtailment of those resources in the future. Conservation as a long-term necessity should be implemented for many reasons, including five suggested by one energy expert:

1. Conservation activities save money, and lower cost energy resources can often be used to achieve the same ends as high cost energy resources.

2. Conservation expands the range of energy choices because it permits citizens to select those energy supply technologies that are most acceptable (for example, solar energy) and reject those that are relatively objectionable (for example, coal energy).

3. The U.S. dependence on unreliable and costly supplies of foreign oil can be reduced by conservation measures.

4. Conservation can free scarce energy resources for use in developing countries. The value of an incremental supply of energy in a developing country may be much greater than in a developed country.

5. Conservation measures will help provide energy resources for future generations; furthermore, they will help to prevent future generations from having reduced standards of living.

Clearly, energy conservation makes sense.

The Role of the Teacher

A 1976 FEA conservation paper entitled "Group Discussions Regarding Consumer Energy Conservation" found that energy conservation is generally viewed as a "time-buying" strategy that will be implemented only until some new, infinite, inexpensive source of energy is found. The American society can then continue to be spoiled, self-indulgent, and extravagant. Conservation is not considered an end in itself. Many pre-teenagers romantically believe that a "Star Trek" world, with its "new" energy resources, will be theirs or at least their children's. But the "new" energy resources (fusion, for example) may not be implemented for quite a long time and, when they are, they will probably be more expensive than we hope. Until such resources are developed, we must act with the belief that "new" resources may never be available. Thus, conservation should be considered an end in itself.

Citizens must become aware of the need for and economic rationality of energy conservation. *It's simply a strategy for getting the most for our money.* Teachers especially are in a position to promote this understanding, but they should take note of the following warning in the *Citizen Action Guide to Energy Conservation:*

> *It should go without saying that if you are not practicing energy conservation, you can't very well ask others to do so--your enthusiasm and success will be the best reason that others will want to join you.*

After teachers have put into practice their conscious decisions to be active conservationists, but before they urge conservation measures on their students, they must carefully formulate for class presentation a whole range of reasons to justify their support of energy conservation. Their support of conservation measures should be based not only on national, social, political, and economic reasons, but also on a moral sense of waste and the need for stewardship--an energy conservation ethic.

## An Energy Conservation Ethic

Some sort of ethic stands behind every moral principle. Historically, Americans have believed in a "Work Ethic"--work as hard as possible, produce as much as possible, be as comfortable as possible, and be as successful as possible in terms of income and acquisitions. As a result of this productivity, our society has become increasingly prosperous and we have grown with little concern for future generations.

In the past, energy and technology increased worker productivity and provided an outlet for improved disposable income (longer vacations, more expensive cars, added conveniences at home). As a result, American society has become increasingly energy-intensive and wasteful. Now that American energy supplies are dwindling, it is essential that some behavioral changes occur in our society.

In order to slow the exponential energy demand growth rate which may limit energy options available to future generations, citizens must adopt an Energy Conservation Ethic. Such an ethic not only can induce cost-saving responses, but can also productively change the American way of living. Teachers have the opportunity to make clear to teenagers that such an ethic is based on a realistic comprehension that so many of the raw materials on which current living standards rely will not be available much longer.

It goes without saying that conservation measures cannot be effected without some action by the consumer; such measures may not only alter the "comfort" citizens derive from consumption but also their "freedom" to consume. As observed in the *Scientists' Statement on Energy Policy:* "One man's conservation may be another man's loss of job. Conservation, the first time around, can trim off the fat, but the second time will cut deeply."

On the other hand, conservation cuts waste. For example, insulation can decrease the wasteful use of heating oil. Over the long run, conservation can save money and increase energy efficiency. For example, it is possible to buy an air conditioner that is more efficient than another air conditioner of comparable size and quality. And the more efficient air conditioners often cost less than the less efficient ones! Even if initial costs are greater, more dollars will be saved in operating the more efficient model over a period of years. Consumers should carefully examine products with this in mind.

Conservation may eliminate some jobs, but, at the same time, it can create new jobs. For example, decreasing the production of disposable bottles can lead to a decrease in the number of people required to produce the disposable bottles, while increasing the number of people who must collect and wash returnable bottles. Likewise, conservation through improved insulation can reduce the number of people needed to bring heating oil to homes, but at the same time more jobs are created in the building industry.

However one may view conservation costs, it is clear that the cost consumers pay for energy conservation measures is worthwhile--the freedom and comfort of future generations will be assured. Though they can no longer be as wasteful, citizens can continue to enjoy a high standard of living.

The individual who lives by an Energy Conservation Ethic is acutely aware of the difference between essential needs and nonessential desires, and will give much thought to each of the following questions before buying a product:

- Do I really need it to be happy?
- Will buying it help promote a less "consumptive" lifestyle?
- Is it the cheapest, most effective item I can buy to meet my need?
- What energy resources are in it?
- Are the energy resources scarce or nonrenewable?
- From what country do the resources come?
- Are there other resources which could be used to make it?
- What could be used as a substitute or alternative?
- Did its production result in significant environmental/ecological damage?
- Will its use result in significant environmental/ecological damage?
- How long will it last and can it be recycled?
- Is it efficient and safe?

As can be seen from these questions, an Energy Conservation Ethic is a conscience in the individual that reminds him/her to think in terms of wise and efficient use of resources when developing, buying, or consuming them. It reminds him/her about the responsibility to maintain an ecological balance for survival, that the environment and life support systems are not limitless in their capacity to assimilate waste.

Energy Conservation Activities

There are four major types of conservation activities:

1. Activities that save energy and have no apparent disadvantage.

2. Activities that save money as well as energy.

3. Activities that save energy but have some minor associated disadvantage.

4. Activities that save energy and have major associated disadvantages.

Use of energy efficient appliances falls into the first category. For example, using an energy-efficient air conditioner saves energy and has no apparent disadvantages. Further, the more efficient air conditioners do not necessarily cost more than the less efficient ones.

An activity which saves energy *and* money is investing in improved insulation. This can drastically reduce heating and cooling bills, essentially off-setting any increased mortgage costs and investment in insulation materials. Also, caulking and weatherstripping doors and windows saves energy and money in the long run. Consumers can further save energy and money by washing clothes in warm or cold water and rinsing them in cold water.

Carpooling and taking showers instead of baths are activities which save energy and have only minor disadvantages. Driving at 55 m.p.h. rather than at 70 m.p.h. is another activity which saves energy (and lives) and has only a minor disadvantage--it takes a little longer to get there. In this case, the only "cost" to the consumer is time.

Fuel rationing is an activity that could save lots of energy but has major disadvantages in terms of inconvenience, cost, and lifestyle. Citizens should actively participate in activities in the first and second categories and live with those in the third so that those activities in the fourth can be avoided. Figure 5 presents a summary of these activities.

Teachers have the opportunity to encourage students to participate automatically in those conservation activities which have no apparent disadvantages as well as the opportunity to encourage students to volunteer to participate in activities which have minor personal disadvantages. Furthermore, educators can help students tolerate and accept those activities which may produce serious disruptions in their future lifestyles. Most important, educators can stress to their students that conservation measures must be undertaken NOW if the freedom and comfort of future generations is to be assured. In other words, educators can help the Energy Conservation

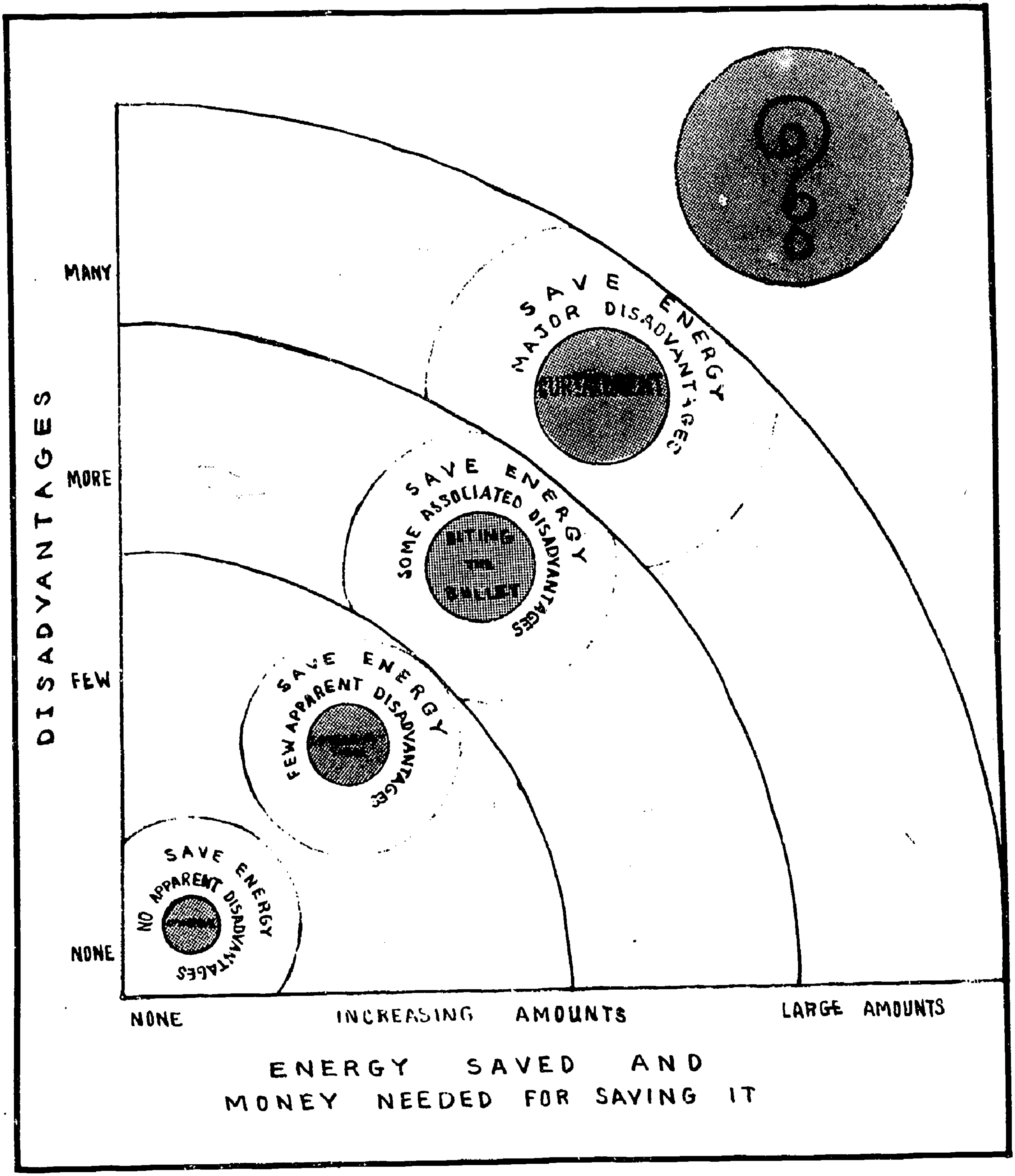


FIGURE 5. PERSONAL ENERGY CONSUMPTION OPTIONS.

Ethic become a way of life; they can help create a more efficient, durable society that will be able to leave a substantial energy inheritance to its future generations--and help the U.S. shift to a more just and sustainable level of energy consumption.

References and Sources of Information

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Gibbons, John H., and Roger W. Sant. "The Role of Conservation in the Changing Economics of Energy," *The Changing Economics of World Energy.* ed. Bernhard J. Abrahamsson. Boulder, Colorado: Westview Press, 1976.

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# IDEAS &

# ACTIVITIES

## INTRODUCTION

Just as the topic of energy conservation cuts across all boundaries of our society, so do the activities and ideas in this book cut across all subject areas and grade levels. A great variety of topics and types of activities have been included in the following 49 sections which relate to the preceding discussions about energy perspectives, resources, and conservation. Although subjects and grades have been suggested for all activities, it is expected that teachers who use this book will look for ideas in sections other than their own, and will adapt activities for other grade levels to their own classes.

Each activity begins with a brief paragraph describing the topic. This paragraph should be augmented by the teacher and/or students with information from the narrative portions of this book as well as with information obtained from outside reading and investigations. The sources of information (also provided for each activity), bibliography, and glossary at the end of this book provide guidance in this task. The activities concentrate on suggestions for individual or group studies, investigations, projects, and ideas which may be implemented within the limits of the classroom or expanded to include the surrounding community. The teacher may use as few or as many of the suggestions for each activity in designing appropriate classroom experiences.

Grade levels have not been indicated on the activities so that students will not be biased by a predetermined competency level. However, to assist teachers in using the materials in this book, grade levels and subject areas (also shown in the Table of Contents) are keyed by color:

| | | |
|---|---|---|
| Science | 7-9 | Green |
| Science | 10-12 | Light blue |
| Social Studies | 7-9 | Orange |
| Social Studies | 10-12 | Salmon |
| Communications/Language Arts | 7-9 | Light gold |
| Communications/Language Arts | 10-12 | Goldenrod |
| Multidisciplinary | 7-12 | Brown |

All other sections of the book are printed on white or gray paper.

The looseleaf pages enable easy duplication of charts, tests, and checklists or data collection instruments for distribution to the entire class. In addition, the notebook format will permit teachers to add sets of materials collected or developed for use with the activities and will allow the contents of the guide to be updated periodically.

## ACTIVITY 1 THE PETROLEUM SITUATION

OBJECTIVE: TO HELP STUDENTS DEVELOP AN UNDERSTANDING OF PETROLEUM USE AND AVAILABILITY IN TENNESSEE, THE NATION, AND WORLD. SCIENCE

Petroleum (oil) is produced from organic materials which have undergone millions of years of heat and pressure. This "fossil fuel" supplies most of our energy needs. Many experts believe most of the world's oil supply will be exhausted by 2010. For the past few years, the U.S. supply has failed to keep up with demand, so we now import nearly half of our petroleum.

Have students conduct library research and contact organizations to learn more about the production, use, and future of petroleum. Specifically, students should obtain answers to the following questions:

1. Why is petroleum referred to as a "fossil fuel"?
2. Where are oil reserves found in the nation? In other countries?
3. How is oil extracted, refined, stored, and transported?
4. For what purposes is oil used?
5. What is oil shale and what are the major problems associated with its mining and processing?
6. What are the environmental and economic advantages and disadvantages of burning oil (using it as a fuel)?
7. What kinds of pollution control devices are used to protect the environment when burning oil? How are oil spills on water cleaned up?
8. What percent of the total energy used in the United States is supplied by oil? In Tennessee?
9. At present consumption rates, how long would known reserves of oil in the United States last?
10. At current consumption rates, approximately how long would Alaskan oil sustain United States demand?

11. To what extent are we importing oil into the United States from other countries? Do we export any oil?

12. How is the United States trying to become energy independent? Does the State of Tennessee have any such plans?

13. What are the most important ways to conserve oil?

CONTACT ORGANIZATIONS

1. Energy Research and Development Administration, 20 Massachusetts Avenue, NW, Washington, D.C. 20545.

2. Environmental Protection Agency, 401 M Street, SW, Washington, D.C., 20460.

3. Geological Survey, U.S. Department of the Interior, 12201 Sunrise Valley Drive, Reston, Virginia 22092.

4. Tennessee Energy Office, Suite 250, Capitol Hill Building, 7th and Union, Nashville, Tennessee 37219.

5. Alyeska Pipeline Service Company, 1815 South Bragaw Street, Anchorage, Alaska 99504.

6. American Petroleum Institute, 1801 K Street, NW, Washington, D.C. 20006.

7. Association of Oil Pipelines, 1725 K Street, NW, Suite 1208, Washington, D.C. 20006.

8. Association of Oilwell Servicing Contractors, 1700 Davis Building, Dallas, Texas 65202.

9. Independent Petroleum Association of America, 1101 Sixteenth Street, NW, Washington, D.C. 20036.

10. Independent Refiners Association of America, 1801 K Street, NW, Suite 1101, Washington, D.C. 20006.

11. Any large, national oil company; their regional distributors often keep necessary literature and information in their offices.

ACTIVITY 2 THE COAL SITUATION

OBJECTIVE: TO HELP STUDENTS DEVELOP AN UNDERSTANDING OF COAL USE AND AVAILABILITY IN TENNESSEE, THE NATION, AND WORLD.

SCIENCE

Coal is the result of tremendous geological pressures that have changed organic materials into a concentrated carbon/hydrogen form over millions of years. Coal is the most abundant fossil fuel. Known reserves in the United States exceed those of all other countries of the world combined.

Have students conduct library research and contact organizations to learn more about the production, use, and future of coal. Specifically, students should obtain answers to the following questions:

1. Why is coal referred to as a "fossil fuel"?
2. Where are coal reserves found in Tennessee? In the nation? In other countries?
3. What percent of the total energy used in the United States is supplied by coal?
4. What is coal used for?
5. At present consumption rates, how long would known reserves of coal in the United States last?
6. To what extent do we export coal from the United States to other countries? Do we import any coal?
7. How is coal normally mined, stored, and transported?
8. Is it cheaper to strip-mine or deep-mine coal? What are the differences in these two mining methods?
9. What role does the Tennessee Department of Conservation have in coal mining? Are its policies effective? What else could/should the Department do?
10. How is strip-mined land reclaimed? (Visit a strip-mined area, if possible.)
11. What role does TVA play in strip mine reclamation? Are its policies effective? What else could/should TVA do?

12. What are the different kinds of coal and which is highest in sulfur content? What difference does this make?

13. What are the environmental and economic advantages and disadvantages of burning coal?

14. What are some of the kinds of pollution control devices used when combusting coal? Which kinds are more effective? Are they expensive? Explain.

15. What are the advantages of building coal-fired steam plants close to coal reserves or mines?

CONTACT ORGANIZATIONS

1. Energy Research and Development Administration, 20 Massachusetts Avenue, NW, Washington, D.C. 20545.

2. Tennessee Valley Authority, 400 Commerce Avenue, Knoxville, Tennessee 37902.

3. Tennessee Department of Conservation, 2611 West End Avenue, Nashville, Tennessee 37203.

4. East Tennessee Energy Group, 1538 Highland Avenue, Knoxville, Tennessee 37919.

5. Tennessee Energy Office, Suite 250, Capitol Hill Building, 7th and Union, Nashville, Tennessee 37219.

6. Tennessee Friends of the Earth, Box 12489, Nashville, Tennessee 37212.

7. Coal Mining Institute of America, 416 Ash Street, California, Pennsylvania 15419.

8. National Coal Association, 1130 Seventeenth Street, NW, Washington, D.C. 22036.

9. Resources for the Future, Inc., 1755 Massachusetts Avenue, NW, Washington, D.C. 20036.

10. Environmental Action Foundation, Inc., DuPont Circle Building, Room 720, Washington, D.C. 20036.

11. American Coke and Coal Chemicals Institute, 1010 Sixteenth Street, NW, Washington, D.C. 20036.

## ACTIVITY 3 THE NATURAL GAS SITUATION

OBJECTIVE: TO HELP STUDENTS DEVELOP AN UNDERSTANDING OF NATURAL GAS IN TENNESSEE, THE NATION, AND WORLD.

SCIENCE

Natural gas is the cleanest of the fossil fuels because when it is burned, it leaves only carbon dioxide, carbon monoxide, and water. Natural gas is being used up faster than new reserves are being discovered.

Have students conduct library research and contact organizations to learn more about the availability, use, and future of natural gas. Specifically, students should obtain answers to the following questions:

1. Why is natural gas referred to as a "fossil fuel"?
2. Where are natural gas reserves found in the nation? In other countries?
3. How is natural gas obtained, store, and transported?
4. What are the major uses of natural gas?
5. What are the advantages and disadvantages of burning natural gas?
6. What percent of the total energy used in the United States is supplied by natural gas?
7. At present consumption rates, how long will known reserves of natural gas in the United States last?
8. Which economic sector (residential, commercial, industrial, agricultural, transportation) should be given priority for using natural gas as reserves become depleted? Why?
9. How does government or industry know where natural gas shortages will take place? What special problems do we face in Tennessee?
10. What are the kinds of problems an industry will face if it must substitute another fuel for natural gas? For example, what would happen if all the industries in Tennessee which use natural gas had to switch to coal and oil?

11. What does the future look like for use of liquefied natural gas? For coal gasification?

12. Has natural gas been cheap or expensive in the past?

13. What federal agency regulates the price of natural gas?

14. What are the most important ways to conserve natural gas?

CONTACT ORGANIZATIONS

1. Energy Research and Development Administration, 20 Massachusetts Avenue, NW, Washington, D.C. 20545.

2. Federal Energy Administration, 12th and Pennsylvania Avenue, NW, Washington, D.C. 20461.

3. Federal Power Commission, 825 North Capitol Street, NE, Washington, D.C. 20426.

4. Tennessee Public Service Commission, Cordell Hull Building, Nashville, Tennessee 37219.

5. Tennessee Energy Office, Suite 250, Capitol Hill Building, 7th and Union, Nashville, Tennessee 37219.

6. American Gas Association, 1515 Wilson Boulevard, Arlington, Virginia 22209.

7. American Public Gas Association, 2600 Virginia Avenue, NW, Washington, D.C. 20037.

8. Interstate Natural Gas Association of America, 1660 L Street, NW, Suite 601, Washington, D.C. 20036.

9. National LP-Gas Association, 1800 North Kent Street, Arlington, Virginia, 22209.

10. Natural Gas Processors Association, 1812 First Place, 15 East 5th Street, Tulsa, Oklahoma 74103.

11. National gas companies or their local/regional distributors.

ACTIVITY 4 THE SOLAR ENERGY SITUATION

OBJECTIVE: TO HELP STUDENTS DEVELOP AN UNDERSTANDING OF SOLAR ENERGY TECHNOLOGY AND ITS POTENTIAL USE IN TENNESSEE, THE UNITED STATES, AND OTHER COUNTRIES.

SCIENCE

Some people support the development of solar power in Tennessee, while others believe it is inappropriate for this area. Have students conduct library research and contact organizations to learn more about solar energy and its potential use in the future. (A field trip to observe solar devices or home demonstrations would be beneficial.) When conducting the study, students should obtain answers to the following questions:

1. What is "solar energy"?

2. What are the major environmental and economic advantages and disadvantages of solar power?

3. How is solar energy converted into electricity? How is it stored?

4. What are the component parts of a solar collector? What materials are used to make one and how does it work? How much does it cost? Is the cost changing? How do collectors differ?

5. How efficient is the direct conversion of solar energy to electricity in a solar cell? How much does this cost?

6. How many days and hours per day (average) of sunlight do we have during a year in Tennessee? When (months, seasons) would it be best to operate solar systems?

7. What would be the best uses of solar power in Tennessee? Water heating? Air conditioning? Space heating? Agriculture?

8. What is a "solar energy farm"? Where would be the best places to locate them in the United States? Other countries?

9. Should solar power be developed as an alternative to fossil-fueled and nuclear plants? As a supplement?

10. Do you believe the federal government is adequately financing solar energy research and development? Why or why not?

CONTACT ORGANIZATIONS:

1. Environment Center, The University of Tennessee, South Stadium Hall, Knoxville, Tennessee 37916.

2. Energy Research and Development Administration, 20 Massachusetts Avenue, NW, Washington, D.C. 20545.

3. Solar Energy Society of America, P.O. Box 4264, Torrance, California 90510.

4. Solar Energy Industries Association, 1001 Connecticut Avenue, NW, Suite 632, Washington, D.C. 20036.

5. International Solar Energy Society, 12441 Parkline Drive, Rockville, Maryland 20852.

6. Mid-South Solar Energy Society, c/o Mechanical Engineering Department, Memphis State University, Memphis, Tennessee 38152.

7. ERDA Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.

8. National Solar Heating and Cooling Information Center, P. O. Box 1607, Rockville, Maryland 20850. (Toll-free number: 1-800-523-2929)

## ACTIVITY 5 THE HYDROELECTRIC DAM SITUATION

OBJECTIVE: TO PROVIDE STUDENTS WITH AN UNDERSTANDING OF HYDROELECTRIC POWER GENERATION, ITS PRESENT USE, AND ITS FUTURE POTENTIAL IN TENNESSEE.

SCIENCE

Hydroelectric plants use flowing water to generate electric power by means of hydraulic turbine-generator units. The main features of a hydroelectric plant are: (1) a dam to impound water in a reservoir; (2) a powerhouse that contains the turbine-generator units and accessories; and (3) a tunnel to carry water from the reservoir to each of the turbines.

Have students conduct library research and contact organizations to learn more about the construction, use, and future of hydroelectric power generation. Specifically, students should obtain answers to the following questions:

1. How does a turbine generation unit operate? Draw a unit and label its parts.
2. Are the major rivers in Tennessee already dammed to capacity? Where are dams located? How have they changed the surface geography of Tennessee? (Compare old maps with recent maps; prepare a chart/poster indicating completed, under-construction, and planned hydroelectric facilities on Tennessee waterways.)
3. What is the estimated life expectancy of the average dam in Tennessee?
4. Do TVA and the Corps of Engineers plan to construct any new dams in Tennessee? Where? Why?
5. What criteria do TVA and the Corps of Engineers use to locate sites for new dams? Would your criteria differ greatly from theirs?
6. Are lakes rapidly filled by siltation in Tennessee? Why or why not?
7. What are the environmental, economic, and societal advantages and disadvantages of hydroelectric power generation?
8. Do dams aid fish propagation and provide improvements in recreation facilities? What about flood control?

CONTACT ORGANIZATIONS:

1. Tennessee Valley Authority, 400 Commerce Avenue, Knoxville, Tennessee 37902.

2. Tennessee Department of Conservation, 2611 West End Avenue, Nashville, Tennessee 37203.

3. Corps of Engineers, Department of the Army, P.O. Box 1070, Nashville, Tennessee 37202.

4. Tennessee Wildlife Resources Agency, Ellington Agricultural Center, P.O. Box 40747, Nashville, Tennessee 37204.

5. Sierra Club, 1050 Mills Tower, 220 Bush Street, San Francisco, California 94104.

6. Tennessee State Planning Office, Capitol Hill Building, Nashville, Tennessee 37219.

7. Tennessee Environmental Council, P.O. Box 1422, Nashville, Tennessee 37202.

8. Any other large regional power distributor, such as the Pacific Gas and Electric Company, 77 Beale Street, San Francisco, California 94106.

# ACTIVITY 6 THE INCREASING NEED FOR ELECTRICITY

OBJECTIVE: TO HELP STUDENTS UNDERSTAND WHY WE HAVE AN INCREASING NEED FOR ELECTRICITY.

SCIENCE

Our well-being and way of life in today's society depends upon an adequate supply of electricity. The need for electricity has doubled about every ten years. Even if this tapers off, an enormous expansion of power generation would still be needed. The Tennessee Valley Authority has the responsibility for this expansion in much of Tennessee.

Have students conduct library research and contact organizations to obtain answers to the following questions:

1. Why is the need for electricity rising each year?
2. What percent of our electric energy comes from hydro, fossil fuels, and nuclear?
3. Which economic sectors (residential, industrial, commercial, transportation, agricultural) consume what percent of our electrical energy?
4. What are the ways we can slow down the need for electricity without drastically altering our standard of living?
5. How can we make sure we will have electricity in the years ahead?
6. About how many years after the decision is made to build a coal-fired generating plant is it ready for operation? Why this long?
7. About how many years after the decision is made to build a nuclear power generating plant is it ready for operation? Why this long?
8. How do TVA and private utilities finance huge construction programs?
9. In what ways does the TVA power program differ from that of a private utility?
10. What are the elements that figure in setting an electric rate?

CONTACT ORGANIZATIONS:

1. Your local utility or electric power distributor.

2. Tennessee Valley Authority, 400 Commerce Avenue, Knoxville, Tennessee 37902.

3. See Appendices for comparison of costs per kwh.

ACTIVITY 7 ENERGY CONSERVATION AT HOME

OBJECTIVE: TO HELP STUDENTS GAIN AN AWARENESS OF ENERGY USE AND WASTE IN THE HOME.

SCIENCE

Have students use the *ENERGY CONSERVATION CHECKLIST FOR THE HOME* prepared for this activity to determine where/why/how energy is wasted. Information gained from responses on the checklist can be used by students to develop energy conservation suggestions for their parents. Students should encourage their families to implement the energy conservation measures and do their part to make it work. Following this experience, the class might discuss such questions as:

1. What are the most inexpensive ways to conserve energy in the home?
2. What are the most effective ways to conserve energy in the home?
3. Is it possible to still pay higher utility bills after implementing an effective energy conservation program at home? If so, why?
4. How do you read electricity and gas meters?

CONTACT ORGANIZATIONS:

1. Your local gas or electric utility, power distributor, and building supply house.
2. Tennessee Energy Office, Suite 250, Capitol Hill Building, 7th and Union, Nashville, Tennessee 37219.
3. Tennessee Valley Authority, 400 Commerce Avenue, Knoxville, Tennessee 37902.
4. Environment Center, The University of Tennessee, South Stadium Hall, Knoxville, Tennessee 37916.
5. See appendices for estimates of yearly consumption by common household appliances.

*AN ENERGY CONSERVATION CHECKLIST FOR THE HOME*

Name & Address
of Resident: ______________________________

______________________________

______________________________

Name of Student: ______________________________

Date: ______________________________

*USE THIS CHECKLIST TO DETERMINE WHERE/HOW/WHY ENERGY IS WASTED AT HOME. THE MORE CHECKED "YES," THE MORE ENERGY CONSERVATION MEASURES BEING USED.*

| | YES | NO |
|---|---|---|
| 1. Are spaces around windows, doors, air conditioners, etc., properly caulked (sealed tightly)? | ___ | ___ |
| 2. Are there storm windows and doors throughout the home? | ___ | ___ |
| 3. Are windows tightly closed at all times during cold weather? | ___ | ___ |
| 4. Are exterior doors closed quickly after use? | ___ | ___ |
| 5. Are drapes and shades closed at night and on cloudy or windy days during the winter? | ___ | ___ |
| 6. Are drapes insulated? | ___ | ___ |
| 7. Are hot air ducts or radiators closed off in unused rooms or closets? | ___ | ___ |
| 8. Are hot water pipes and air ducts insulated? | ___ | ___ |
| 9. Is the air conditioner located on the shady side of the house? | ___ | ___ |
| 10. Are drapes and furniture located so they do not interfere with air ducts, radiators, thermostats? | ___ | ___ |
| 11. Are the walls insulated? | ___ | ___ |

| | | YES | NO |
|---|---|---|---|
| 12. | Does the floor have 2"-3½" of insulation? | ___ | ___ |
| 13. | Does the attic have six to eight inches of insulation? | ___ | ___ |
| 14. | Is an attic fan used in the summer? | ___ | ___ |
| 15. | Is the fireplace damper closed tightly when not in use? | ___ | ___ |
| 16. | Are heating and cooling filters clean? | ___ | ___ |
| 17. | Is the thermostat set at 68° or below during winter months? | ___ | ___ |
| 18. | Is the thermostat set at 78° or above during summer months? | ___ | ___ |
| 19. | Is the thermostat adjusted at night? | ___ | ___ |
| 20. | Do thermostats indicate accurately calibrated temperature settings? | ___ | ___ |
| 21. | Are lights turned off when not needed? | ___ | ___ |
| 22. | Is the TV, radio, or stereo turned off when not in use? | ___ | ___ |
| 23. | Are ovens and burners turned off immediately after use? | ___ | ___ |
| 24. | Is the oven used to bake more than one food at a time? | ___ | ___ |
| 25. | Is the refrigerator thermostat set at +40°F? | ___ | ___ |
| 26. | Are gaskets around refrigerator and freezer doors tight? | ___ | ___ |
| 27. | Is the frost on the refrigerator and freezer less than ¼-inch thick? | ___ | ___ |
| 28. | Is the water heater temperature setting between 120°F and 140°F? | ___ | ___ |
| 29. | Are all water faucets in good repair (not leaking)? | ___ | ___ |
| 30. | Do the residents take brief showers or use a small amount of water in the tub? | ___ | ___ |

| | | YES | NO |
|---|---|---|---|
| 31. | Are clothes washed only when there is a full load? | ___ | ___ |
| 32. | When washing clothing, is cold or warm water used if possible? | ___ | ___ |
| 33. | Are dishes washed only when there is a full load? | ___ | ___ |
| 34. | Are evergreens properly located around the outside of the house to provide a break against cold winter wind and shade against the hot summer sun? | ___ | ___ |
| 35. | Are deciduous plants located on the south of the house to admit the winter sun and protect from the summer sun? | ___ | ___ |
| 36. | Is there a humidifier in the home? | ___ | ___ |

## ACTIVITY 8 — HOME INSULATION

OBJECTIVE: TO HELP STUDENTS BECOME FAMILIAR WITH THE TYPES OF INSULATION AVAILABLE, THEIR USES, ADVANTAGES, DISADVANTAGES, AND COSTS.

SCIENCE

Proper home insulation is one of the best ways to conse· · energy and save money. Before buying any insulation, the consumer sho· d know three important things:

1. *What the R-value of the insulation should be.* R-value is a number that indicates how much resistance the insulation presents to heat flowing through it. The bigger the R-value number, the more effective the insulation. (See the Appendix for more information on R-value.)

2. *What kind of insulation to buy.*
   Batts: glass fiber; rock wool.
   Blankets: glass fiber; rock wool.
   Foam-in-place: ureaformaldehyde.
   Loose fill (blown in): glass fiber; rock wool; cellulosic fiber.
   Loose fill (poured in): glass fiber; rock wool; cellulosic fiber; vermiculite; perlite.
   Rigid board: extruded polystyrene bead board (expanded polystyrene); urethane board; glass fiber.

3. *How thick insulation should be.* For the R-value of each type of insulation, see the Appendix.

Have students consult current literature, visit building supply companies, and contact organizations to learn about the use, cost, and installation of insulation. Specifically, they should find answers to the following questions:

1. What are the advantages and disadvantages of each kind of insulation?

2. What kinds of insulation should be used in the house and where?

3. What is a vapor barrier? Why is it important?

4. What is the installation cost for each kind of insulation?

5. What tools are needed to install insulation?

6. What would be some good incentives to get people to better insulate their homes?

7. What priority would you assign to insulating a home as a means of saving money and energy?

CONTACT ORGANIZATIONS:

1. See "Insulation" in yellow pages of telephone book and contact dealers for specific information.

2. National Insulation Contractors Association, 8630 Fenton Street, Suite 506, Silver Spring, Maryland 20910.

3. National Mineral Wool Insulation Association, Inc., 211 E. 51st Street, New York, New York 10022.

4. Owens-Corning Fiberglas Corporation, Fiberglas Tower, Toledo, Ohio 43659.

## ACTIVITY 9 STORM WINDOWS AND DOORS

OBJECTIVE: TO FAMILIARIZE STUDENTS WITH THE COSTS AND SAVINGS OF USING STORM WINDOWS AND DOORS.

SCIENCE

Students can ask their parents to have a dealer come to their homes and give them a cost estimate for installing storm windows and doors. If a home already has storm windows and doors, the savings in fuel and money should be determined by obtaining and analyzing utility bills one year before and one year after the storm windows and doors were installed.

Some questions for students to answer include:

1. Over what period of time would storm windows and doors pay for themselves? What factors must be considered?
2. Are storm windows more energy efficient than thermopane windows?
3. As a conservation technique, are storm windows and doors more important than ceiling and wall insulation?
4. Why do storm windows steam up or show condensation?

CONTACT ORGANIZATIONS:

1. To contact a dealer, see "storm windows, doors, and windows" in the yellow pages of the telephone directory.
2. Federal Energy Administration, 12th and Pennsylvania Avenue, NW, Washington, D.C. 20461.
3. Tennessee Energy Office, Suite 250, Capitol Hill Building, 7th and Union, Nashville, Tennessee 37219.

## ACTIVITY 10 YOUR UTILITY BILL

OBJECTIVE: TO FAMILIARIZE STUDENTS WITH THE COST OF ENERGY IN THE HOME.

SCIENCE

Have students analyze utility bills sent to their homes for the past several years, or the past full year, if possible. How much money is spent each month for gas, water, and electricity?

Students may construct a chart for the monthly use of gas, water, and electricity. Charts should illustrate the amount of the resource used and the cost involved for each month. Past monthly records are available from local utility companies and may be used for comparison purposes.

Students should be encouraged to post the charts at home for the family's future reference.

SUGGESTIONS:

1. Show students how to read gas, water, and electric bills and meters.
2. Have students list ways to conserve gas, water, and electricity.
3. Point out the major changes in energy use which occur as seasons change.
4. Have students list watts, amps, volts of all appliances in their homes.

CONTACT ORGANIZATIONS:

1. Your local power distributor or utility company.
2. Consumer Affairs, Tennessee Department of Agriculture, Ellington Agricultural Center, Box 40627, Melrose Station, Nashville, Tennessee 37204.
3. Tennessee Valley Authority, 400 Commerce Avenue, Knoxville, Tennessee 37902.
4. Utility Rates and Services, Tennessee Public Service Commission, Cordell Hull Building, Nashville, Tennessee 37219.

## ACTIVITY 11 HEATING AND COOLING SCHOOL BUILDINGS

OBJECTIVE: TO ACQUAINT STUDENTS WITH SPACE HEATING AND COOLING IN THEIR SCHOOL BUILDING.

SCIENCE

Take students on a tour of the heating and cooling plant at your school. Obtain records of fuel use and costs over the past few years for comparison purposes. These records can be used to prepare graphs which facilitate an understanding of trends in fuel consumption and prices.

SUGGESTIONS:

1. Have the person in charge of plant maintenance discuss day-by-day operations of heating and cooling systems and have someone from the administration discuss costs and projected plans.

2. You may wish to have a local heating and cooling system dealer discuss alternative systems with the class.

3. Have students research and discuss the potential of using solar energy for part of the water heating, space heating, or air-conditioning.

Questions might include:

1. What kind of energy is used?

2. What temperature settings are used? How much energy could be saved by changing settings at night and on weekends? Is this being done?

3. Are the heating and cooling systems in good operating condition? How does one determine the condition?

4. If the systems are not working efficiently, what must be done to repair or replace them?

5. Who makes decisions relating to heating and cooling of the school?

6. In relation to the rising costs of fuels, is there a more efficient method of heating and cooling?

7. How long would it take to pay for this alternative system in fuel savings?

8. What problems would be encountered in purchasing, installing, maintaining, and operating alternative heating and cooling systems?

CONTACT ORGANIZATIONS:

1. Educational Facilities Laboratories, Inc., 850 Third Avenue, New York, New York 10022.

2. School Planning Laboratory, College of Education, The University of Tennessee, 19 Claxton Education Building, Knoxville, Tennessee 37916.

3. School Plant Operations, Tennessee Department of Education, 117 Cordell Hull Building, Nashville, Tennessee 37219.

4. See "Heating" or "Heating Contractors" in the yellow pages of your telephone directory.

## ACTIVITY 12 ENERGY FLOW THROUGH A FOOD CHAIN

OBJECTIVE: TO HELP STUDENTS UNDERSTAND HOW ENERGY FROM FOOD IS USED, TRANSFERRED, AND LOST.

SCIENCE

Discuss with students such terms as: food chain, producer, consumer, decomposer, respiration, biomass, trophic level, food pyramid, metabolism, and Calorie. Students should know why chemical energy available in life processes is constantly decreasing through the food chain.

Specifically, students should:

1. Be able to construct a simple food chain and describe how energy is passed along it.
2. Know the extent to which green plants absorb the sun's energy.
3. Know that most energy used in life processes of the plant is expended in respiration.
4. Know the Calories contained in some of the more common foods.
5. Know how energy is dissipated to maintain body metabolism.
6. Understand how energy is lost as it is passed along each trophic level.
7. Know how man, through the agricultural processing of foods, loses or wastes significant amounts of energy.

CONTACT ORGANIZATIONS:

Local Agricultural Extension Service; Home Economics or Agriculture departments at nearby colleges or universities.

REFERENCES:

See biology and ecology textbooks in school library.

ACTIVITY 13 THE NUCLEAR REACTOR

OBJECTIVE: TO HELP STUDENTS DEVELOP AN UNDERSTANDING OF THE NUCLEAR REACTOR AND ITS POTENTIAL FOR PRODUCING ELECTRICITY.

SCIENCE

The nuclear reactor is a device for the controlled fission of a fuel (uranium and thorium). Nuclear fission occurs when heavy atoms, on being struck in the right way by a subatomic particle called a neutron, split into two or more fragments and release energy in the process.

Have students conduct library research and contact organizations to learn about the operation of a nuclear reactor and its potential use in the future. Students should obtain answers to the following questions:

1. What are the components of the nuclear reactor system? How does the system operate?

2. How efficient is the nuclear power plant in comparison to the fossil-fueled plant?

3. Does nuclear energy compete economically with other forms of energy?

4. What are the most serious dangers involved in the production of nuclear energy?

5. What are the major kinds of safety systems built into the nuclear power plant?

6. What is the "emergency core cooling system" in a nuclear reactor? Explain.

7. How is radioactive waste transported, stored, and disposed of?

8. How do thermal discharges from the nuclear power plant affect the life cycles of aquatic plant and animal life?

9. Can we afford to bypass the construction of more nuclear power plants for cleaner and safer means of generating electric power? If so, what are the best alternatives to nuclear power?

10. What agency approves the licensing of a nuclear power plant?

11. How many nuclear power plants does TVA now have under construction in Tennessee? Where are these plants located? How many plants does TVA plan to build during the next 10 years? Where will these plants be located?

12. What criteria does TVA use to select sites for nuclear plants?

13. What is a nuclear park?

14. What is the Price-Anderson Act? Explain.

15. Where are known reserves of uranium located in the United States? In other countries? How long would uranium reserves in the United States last based upon present consumption rates? Could the breeder reactor greatly extend uranium supplies? If so, how? To what extent does the United States sell uranium to foreign countries? Why is this done? Does the United States import uranium?

16. What is a nuclear reprocessing plant and how does it function?

CONTACT ORGANIZATIONS:

1. Clinch River Breeder Reactor Plant Project, P.O. Box U, Oak Ridge, Tennessee 37830.

2. Energy Research and Development Administration, 20 Massachusetts Avenue, NW, Washington, D.C. 20545.

3. Nuclear Regulatory Commission, Washington, D.C. 20555.

4. Tennessee Valley Authority, 400 Commerce Avenue, Knoxville, Tennessee 37902.

5. East Tennessee Energy Group, 1538 Highland Avenue, Knoxville, Tennessee 37916.

6. Tennessee Energy Office, Suite 250, Capitol Hill Building, 7th and Union, Nashville, Tennessee 37219.

7. Tennessee Environmental Council, P.O. Box 1422, Nashville, Tennessee 37202.

8. Tennessee Friends of the Earth, Box 12489, Nashville, Tennessee 37212.

9. Tennessee Citizens for Wilderness Planning, 130 Tabor Road, Oak Ridge, Tennessee 37830.

10. American Association for the Advancement of Science, 1515 Massachusetts Avenue, NW, Washington, D.C. 20036.

11. American Nuclear Society, 244 East Ogden Avenue, Hinsdale, Illinois 60521.

12. Atomic Industrial Forum, Inc., 475 Park Avenue South, New York, New York 10016.

13. National Intervenors, 153 E Street, SE, Washington, D.C. 20003.

14. Scientists' Institute for Public Information, 49 East 53rd Street, New York, New York 10022.

Field Trip Sites:

15. American Museum of Atomic Energy, P.O. Box 117, Oak Ridge, Tennessee 37830.

## ACTIVITY 14 — AN ENERGY RESOURCE CENTER

OBJECTIVE: TO PROVIDE STUDENTS WITH AN OPPORTUNITY TO WORK WITH ENERGY EDUCATION/CONSERVATION INFORMATION.

SCIENCE

Have students begin an Energy Resource Center (ERC) for the school. Locate it in the library or a classroom. This project would require at least one semester--perhaps an entire school year. It is related to Activities 38 and 43. Some tasks would include:

1. Develop a vertical file system which contains timely information on such topics as energy production, energy consumption, environmental problems, energy economics problems, alternate energy sources, and energy conservation measures.

2. Compile a bibliography of available school and community print and nonprint materials on energy.

3. Provide copies of a current listing of institutions and agencies which can provide information on energy.

4. Write to local, state, and federal agencies explaining the ERC and requesting assistance and material.

5. Compile a list of community leaders who can speak on energy topics.

6. Make energy information available to students, teachers, parents, and community members.

7. Prepare a work schedule for students who will assist in the center--perhaps with the school librarian as the supervisor.

CONTACT ORGANIZATIONS:

1. Tennessee Energy Office, Suite 250, Capitol Hill Building, 7th and Union, Nashville, Tennessee 37219.

2. Environment Center, The University of Tennessee, South Stadium, Knoxville, Tennessee 37916.

3. Federal Energy Administration, 12th and Pennsylvania Avenue, NW, Washington, D.C. 20461.

4. Energy Research and Development Administration, 20 Massachusetts Avenue, NW, Washington, D.C. 20545.

5. Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, Tennessee 37830.

6. Center for Energy Information, 340 East 51st Street, New York, New York 10022.

## ACTIVITY 15 — AN ENERGY EDUCATION LESSON PLAN FOR ELEMENTARY SCHOOL STUDENTS

OBJECTIVE: TO GIVE HIGH SCHOOL STUDENTS THE OPPORTUNITY TO PREPARE AN ENERGY EDUCATION PROGRAM AND PRESENT IT TO YOUNGER STUDENTS.

SCIENCE

Have students develop a mini-course for use in an elementary school. After the students have developed the course content and practiced giving a few presentations, they could teach the course in a formal classroom situation or use it with other community youth groups. Students will need assistance in collecting or making slides or photographs, developing transparencies, designing posters and bulletin boards. Some topics of importance include:

1. What is energy?
2. Where does energy come from?
3. What are fossil fuels?
4. How do coal-fired, hydro, and nuclear power plants operate?
5. How does the development of energy resources affect the environment and our standard of living?
6. What are the most important ways for the individual to conserve energy?
7. What does the term "energy conservation ethic" mean?

CONTACT ORGANIZATIONS:

1. Energy and Man's Environment, 0224 S.W. Hamilton, Suite 301, Portland, Oregon 97201.
2. Environment Center, The University of Tennessee, South Stadium Hall, Knoxville, Tennessee 37916.
3. Tennessee Energy Office, Suite 250, Capitol Hill Building, 7th and Union, Nashville, Tennessee 37219.
4. National Science Teachers Association, 1742 Connecticut Avenue, NW, Washington, D.C. 20009.
5. Your own school library.

ACTIVITY 16 PLANTS AND ENERGY CONSERVATION

OBJECTIVE: TO FAMILIARIZE STUDENTS WITH THE INFLUENCE VEGETATION ON THE SCHOOL GROUNDS CAN HAVE ON ENERGY CONSUMPTION IN THE SCHOOL BUILDING.

SCIENCE

Have students survey the school yard for trees and other vegetation that aid in conserving energy in the school building. Plants can provide shade from direct rays of sun or intercept radiation from a surface such as a parking lot. Certain plants also control wind by stopping, diverting, or slowing it down.

Students should survey south, east, and west sides of the school building for exposure to the sun. Are there large trees that need to be protected from disease and maintained because of the shade they provide? Could additional trees be planted? What kinds? Where and why?

Deciduous trees, because they lose their leaves in the winter, provide shade in the warm months and allow the sun to warm the building during the cold months. Some vines grow fast and can provide protection in one season. Evergreens provide continuous wind protection around entrances and bus stops. Which are the best spots for the two types of trees and shrubs?

An expert from a local nursery (or a landscape architect) can assist in preparing a master plan for planting around the school.

CONTACT ORGANIZATIONS:

1. Contact a local nursery (see yellow pages in the telephone directory) or a professional landscape architect for assistance, or local college students studying the subject.
2. U.S. Department of Agriculture, Washington, D.C. 20250.
3. Federal Energy Administration, 12th and Pennsylvania Avenue, NW, Washington, D.C. 20461.
4. Tennessee Department of Agriculture, Ellington Agricultural Center, Box 40627, Melrose Station, Nashville, Tennessee 37204.

5. Agricultural Extension Service, P.O. Box 1071, Knoxville, Tennessee 37901.

6. Division of Forestry, Tennessee Department of Conservation, 2611 West End Avenue, Nashville, Tennessee 37203.

# ACTIVITY 17 POLLUTION, RESOURCE USE, AND COST

OBJECTIVE: TO HELP STUDENTS UNDERSTAND HOW POLLUTION CAN CHANGE THE VALUE OF RESOURCES AND INCREASE COSTS OF A PRODUCT OR SERVICE. SCIENCE

Have the students assume that there are two industries located along a river. The industry located upstream is a papermill which discharges certain wastes directly into the river. The second industry, located downstream, is an electric power plant. If the papermill were not upstream, the electric power plant could use the river water for cooling purposes with very little or no treatment, but by discharging waste directly into the river, the papermill has shifted some of the costs of producing paper (treating polluted water) onto the electric power plant. Even though the electric power plant hasn't polluted the water upstream, it must pay to clean up the water. On the other hand, the electric power plant is discharging heated water and changing the ecology of the river.

Questions the students should consider include:

1. For what purpose does the papermill use the river water?
2. For what purpose does the electric power plant use the river water?
3. What action, if any, could owners of the electric power plant take against the owners of the papermill?
4. How could the managers of the electric power plant determine their costs of treating the polluted water released by the papermill?
5. How does the electric power plant recover its costs for water treatment?
6. What should the owners of the electric power plant do about the heated discharges into the river?
7. If the papermill is allowed to use the river as a "free" dumping ground, will the cost of paper be cheaper?
8. If the papermill treated its waste water before releasing it, would this result in a significant increase in the cost of paper?
9. What competitive advantage is given to a papermill that doesn't have to treat its waste water over a papermill that does?

10. Who ends up paying for pollution caused by the papermill or electric power plant?

11. If you do not drink, fish, swim, or boat in the river, should you care about what is discharged into it? Why? How does clean water in the river benefit you?

12. Suppose the situation were reversed--with the papermill downstream from the electric power plant. Would the answers to any of these questions be different? Why or why not?

13. Suppose the papermill were required to discharge its wastes upstream from where it was located. Why and how do you think the papermill would change or not change its operations?

CONTACT ORGANIZATIONS:

1. Bureau of Environmental Health Services, Tennessee Department of Public Health. 344 Cordell Hull Building, Nashville, Tennessee 37219.

2. Environmental Protection Agency, 40 [illegible] reet, SW, Washington, D.C. 20461.

3. Tennessee Valley Authority, 400 Commerce Avenue, Knoxville, Tennessee 37902.

ACTIVITY 18

# DETERMINING PRIORITIES: ALTERNATIVE METHODS OF GENERATING ELECTRICITY

OBJECTIVE: TO HELP STUDENTS DEVELOP AN UNDERSTANDING OF THE MANY FACTORS INVOLVED IN DETERMINING PRIORITIES FOR FUNDING.

SCIENCE

Have students study the listing given below of alternative methods of electric power generation. After considering existing or available technologies and the economic, social, and environmental costs and benefits (advantages/disadvantages) of each method, they should then rank the items in order of their importance for receiving research and development funds. Students should be able to defend their rankings.

*Rank Items According to Importance: (1=Most Important; 11=Least Important)*

____Hydroelectric

____Oil

____Nuclear

____Refuse (resource energy)

____Coal

____Wind

____Nuclear (fusion)

____Ocean (tides, currents)

____Natural Gas

____Solar

____Geothermal

CONTACT ORGANIZATIONS:

1. Energy Research and Development Administration, 20 Massachusetts Avenue, NW, Washington, D.C. 20545.

## ACTIVITY 19 ELECTRIC ENERGY DEMAND AND LIFESTYLES

OBJECTIVE: TO HELP THE STUDENT GAIN AN UNDERSTANDING OF ENERGY DEMAND AND SOME COMMON HOUSEHOLD ELECTRICAL ITEMS WHICH INFLUENCE LIFESTYLES.

SOCIAL STUDIES

Have the students complete the *LIFESTYLE SURVEY FORM* which has been developed for this activity. Tally class results and make these available to the students. The *LIFESTYLE SURVEY FORM* can also be used with family or community members.

After completing the *LIFESTYLE SURVEY FORM*, students should give consideration to the following questions:

1. What do the terms "energy demand," "lifestyles," "standard of living," and "quality of life" mean?
2. How many electrical items are there in their homes and which ones, if any, would they be willing to give up? Can the "good things" of life, associated with energy, be obtained in other ways? With considerably less energy? Would such a change cost more or less?
3. To what extent do they value material things? Which are highly important and which are not terribly important?
4. How do their feelings toward material things differ from those of their parents?
5. How much electricity does the average person or homeowner use per year?
6. Is there some minimal level of energy consumption to which every individual has a right?
7. Does the government have any right to determine how or for what purpose the individual uses the energy available to him? On the other hand, does the government have a right to force individuals to give up land for a coal mine or power plant or transmission line or waste disposal site?

CONTACT ORGANIZATIONS:

1. Tennessee Municipal Electric Power Association, P.O. Box 611, Brentwood, Tennessee 37207.
2. American Home Economics Association, 2010 Massachusetts Avenue, NW, Washington, D.C. 20036.
3. Consumer Federation of America, 1012 Fourteenth Street, NW, Suite 901, Washington, D.C. 20005.
4. National Association of Electric Companies, 1140 Connecticut Avenue, NW, Washington, D.C. 20036.
5. Tennessee Valley Authority, 400 Commerce Avenue, Knoxville, Tennessee 37902.
6. Your local utility or electric power distributor.

## *LIFESTYLE SURVEY FORM*

Name: ____________________

Date: ____________________

*Place an X in the column which best describes your feeling about giving up a particular item.*

| ELECTRICAL APPLIANCE OR ITEM * | Do Not Have | Very Easily | With Some Difficulty | With Great Difficulty | Impossible |
|---|---|---|---|---|---|
| Radio | | | | | |
| Stereo | | | | | |
| Air Conditioning (at home) | | | | | |
| Air Conditioning (at work) | | | | | |
| Electric Fan | | | | | |
| Clock | | | | | |
| Freezer | | | | | |
| Typewriter | | | | | |
| Copy Machine | | | | | |
| Water Heater | | | | | |
| Power Tools | | | | | |
| Refrigerator | | | | | |
| Iron | | | | | |
| Dishwasher | | | | | |
| Electric Mixer | | | | | |
| Doorbell | | | | | |
| Electric Stove | | | | | |
| Hair Dryer | | | | | |
| Elevator | | | | | |
| Toaster | | | | | |
| Electric Blanket | | | | | |
| Garbage Disposal | | | | | |
| Blender | | | | | |
| Lights | | | | | |
| Clothes Washer | | | | | |
| Electric Guitar | | | | | |
| Telephone | | | | | |
| Sewing Machine | | | | | |
| Trashmasher | | | | | |
| Electric Curlers | | | | | |
| Color TV | | | | | |
| B/W TV | | | | | |
| Electric Toothbrush | | | | | |
| Clothes Dryer | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

*Add any other items you may have in your home.

ACTIVITY 20 | HOME ENERGY INDEPENDENCE

OBJECTIVE: TO ENCOURAGE CREATIVE THINKING ON ALTERNATIVE WAYS OF PRODUCING ENERGY.

SOCIAL STUDIES

Not too many years ago families were relatively independent as far as their energy production was concerned. They heated with a wood or coal stove and used kerosene lamps for lighting. Some people advocate returning to greater energy independence through the use of self-contained solar, wind, and hydro technologies. Returning to this type of energy independence might reduce the need for some large power plants. Students should seek answers to the following questions:

1. What are the advantages and disadvantages of producing energy in regional power plants versus individual or neighborhood units?

2. What would be the major political problems in changing from regional power systems to the individual or neighborhood units?

3. What are the major technological, social, economic, and environmental problems in emphasizing individual resourcefulness in producing energy?

4. What are some of the legal constraints faced by those who want to develop their own energy systems?

5. Does using more energy necessarily result in a better quality of life and happiness?

6. How practical are solar and wind energy technologies for Tennessee?

7. To what extent could the use of solar and wind energy technologies (combined with active energy conservation) affect national industrial growth, development, and employment rates?

8. What should the government's role be in energy resource development and conservation?

CONTACT ORGANIZATIONS:

1. Energy Research and Development Administration, 20 Massachusetts Avenue, NW, Washington, D.C. 20545.

2. Environmental Protection Agency, 401 M Street, SW, Washington, D.C. 20460.

3. Federal Energy Administration, 12th and Pennsylvania Avenue, NW, Washington, D.C. 20461.

4. Tennessee Valley Authority, 400 [illegible] Avenue, Knoxville, Tennessee 37902.

5. Bureau of Environmental Health [illegible], Tennessee Department of Public Health, 344 Cordell Hull Building, Nashville, Tennessee 37219.

6. Tennessee Energy Office, Suite 250, Capitol Hill Building, 7th and Union, Nashville, Tennessee 37219.

7. American Association for the Advancement of Science, 1515 Massachusetts Avenue, NW, Washington, D.C. 20036.

8. American Nuclear Society, 244 E. Ogden Avenue, Hinsdale, Illinois 60521.

9. Consumer Federation of America, 1012 Fourteenth Street, NW, Suite 901, Washington D.C. 20005.

10. Solar Energy Industries Association, 1001 Connecticue Avenue, NW, Suite 632, Washington, D.C. 20036.

11. Wind Energy Society of America, 1700 E. Walnut Street, Pasadena, California 91106.

12. *Alternate Sources of Energy*, Inc., Route 2, Box 90A, Milaca, Minnesota 56353.

13. *Mother Earth News*, 105 Stoney Mountain Road, Hendersonville, North Carolina 28739.

14. *Organic Gardening*, Rodale Press, Emmaus, Pennsylvania 18049.

## ACTIVITY 21 CITIZEN GROUPS AND ENERGY CONSERVATION

OBJECTIVE: TO FAMILIARIZE STUDENTS WITH ENERGY CONSERVATION EFFORTS BY AND INTERESTS OF CITIZEN GROUPS IN TENNESSEE.

SOCIAL STUDIES

Have students contact various civic, environmental, and conservation organizations across the State to determine whether they have energy conservation programs and the nature of them. Some questions for students to ask include:

1. What kinds of energy conservation programs are sponsored by citizen groups?
2. For what target groups have the energy conservation programs been developed?
3. How effective have citizen groups been as advocators of energy conservation?
4. How can you participate in these groups? How can you help develop programs?
5. Are most of the citizen groups in Tennessee actively committed to energy conservation?
6. What industries would you expect to push for conservation? What industries would you expect to give their attention to selling more energy rather than seriously promoting conservation?

CONTACT ORGANIZATIONS:

1. Your local Development District Office, Chamber of Commerce, and League of Women Voters will be able to provide names and addresses of organizations to contact (see telephone directory).
2. Environment Center, The University of Tennessee, South Stadium Hall, Knoxville, Tennessee 37916.
3. Tennessee Conservation League, 1720 West End Avenue, Suite 600, Nashville, Tennessee 37203.
4. Tennessee Energy Office, Suite 250, Capitol Hill Building, 7th and Union, Nashville, Tennessee 37219.

5. Tennessee Environmental Council, P.O. Box 1422, Nashville, Tennessee 37202.

6. Tennessee Citizens for Wilderness Planning, 130 Tabor Road, Oak Ridge, Tennessee 37830.

7. East Tennessee Research Corporation, Jacksboro, Tennessee 37757.

8. East Tennessee Energy Group, 1538 Highland Avenue, Knoxville, Tennessee 37916.

ACTIVITY 22 AN ENERGY FAIR

OBJECTIVE: TO GIVE STUDENTS THE OPPORTUNITY TO PROVIDE A HIGH IMPACT ACTIVITY ON ENERGY CONSERVATION FOR THE SCHOOL AND COMMUNITY.

SOCIAL STUDIES

Have students organize and conduct an "Energy Fair" one weekend. Throu a steering committee composed of students from a class, club, or student council, solicit assistance from students and teachers in the various subject areas (social studies, science, home economics, drivers education) at your school.

Social studies students could illustrate a history of individuals and events involved in energy development; a history of energy consumption patterns; a pictoral display of factors that led to our present energy problems; and a list of governmental agencies and institutions with responsibilities for developing energy resources. A list of energy education/conservation materials would be of value to students, teachers, and citizens. Determine what agencies and institutions already have materials that could be distributed at the Fair.

Science students could prepare "fact sheets" on energy production and possible economic and ecological trade-offs; exhibit some basic energy concepts such as photosynthesis; prepare displays on solar cells, wind mills, electric motors, and insulation materials. An exhibition of careers related to energy development would also be of value to students and parents.

This activity will be more successful if some source of funding assistance can be located through civic groups, local merchants, or the Chamber of Commerce. The Chamber of Commerce can assist with finding locations for holding the "Energy Fair" (perhaps a large shopping mall which regularly has exhibits).

CONTACT ORGANIZATIONS:

1. Tennessee Energy Office, Suite 250, Capitol Hill Building, 7th and Union, Nashville, Tennessee 37219.

2. Environment Center, South Stadium Hall, The University of Tennessee, Knoxville, Tennessee 37916.

3. Tennessee Valley Authority, 400 Commerce Avenue, Knoxville, Tennessee 37902.

4. Tennessee Environmental Council, P.O. Box 1422, Nashville, Tennessee 37202.

5. Federal Energy Administration, 12th and Pennsylvania Avenue, NW, Washington, D.C. 20461.

6. Energy Research and Development Administration, 20 Massachusetts Avenue, NW, Washington, D.C. 20545.

7. Concern, Inc., 2233 Wisconsin Avenue, Washington, D.C. 20007.

## ACTIVITY 23 SOCIOECONOMIC PROBLEMS AND ENERGY

OBJECTIVE: TO FAMILIARIZE STUDENTS WITH SOCIAL AND ECONOMIC ASPECTS OF ENERGY CONSUMPTION.

SOCIAL STUDIES

It is reasonable to assume that prices for natural gas, oil, and electricity will continue to rise. Students should study price trends over the last 25 years and make forecasts on future plausible prices through the year 2000. Specifically, students should:

1. Determine the past and present prices for natural gas, oil, and electricity.
2. Estimate possible future costs of natural gas and oil based upon availability and past trends.
3. Determine what sector (low-, middle-, upper-income) will be affected most by increased prices.
4. Determine what percentage of the family income is spent on energy. Does it vary by income bracket or remain constant?
5. Determine what can be done to help people cope with rising fuel costs.
6. Determine what sectors (low-, middle-, upper-income) would be more likely to conserve energy and why.
7. Propose some energy conservation ideas for low-income families.

CONTACT ORGANIZATIONS:

1. Your local utility or electric power distributor.
2. Energy Research and Development Administration, 20 Massachusetts Avenue, NW, Washington, D.C. 20545.
3. Federal Energy Administration, 12th and Pennsylvania Avenue, NW, Washington, D.C. 20461.
4. Federal Power Commission, 825 North Capitol Street, NE, Washington, D.C. 20426.

5. Rural Electrification Administration, Department of Agriculture, Room 4053-S, Washington, D.C. 20250.

6. Tennessee Valley Authority, 400 Commerce Avenue, Knoxville, Tennessee 37902.

7. Tennessee Department of Public Health, 344 Cordell Hull Building, Nashville, Tennessee 37219.

8. Tennessee Energy Office, Suite 250, Capitol Hill Building, 7th and Union, Nashville, Tennessee 37219.

9. Office of Management and Budget, Energy and Science Division, Executive Building, Washington, D.C. 20503.

10. American Gas Association, 1515 Wilson Boulevard, Arlington, Virginia 22209.

11. American Petroleum Institute, 1801 K Street, NW, Washington, D.C. 20006.

# ACTIVITY 24 POPULATION GROWTH AND RESOURCE CONSUMPTION

OBJECTIVE: TO HELP STUDENTS DEVELOP AN UNDERSTANDING OF POPULATION GROWTH AND ITS EFFECT ON RESOURCE CONSUMPTION.

SOCIAL STUDIES

As the population of the United States and world increases, more stress is placed on our limited natural resources. Here in the United States, our population is growing by about 1.7 to 2.5 million people annually. Although we comprise less than six percent of the world's population, Americans use over one-third of the world's resources and energy.

Have students conduct research and contact organizations to learn more about the population situation in Tennessee, United States, foreign countries, and the world. Specifically, students should obtain answers to the following kinds of questions:

1. What is the approximate population of Tennessee? Of the United States? The world? How fast is the population increasing in each of these?
2. What is population control? What are the major problems in trying to control population growth?
3. Is there any difference between birth control and population control? Explain.
4. What is the meaning of zero population growth?
5. Approximately how much money does the United States government spend each year on population research?
6. What would you believe to be the most important components of a national population policy (e.g., population size, rate of growth, distribution, etc.)?
7. What would be the advantages and disadvantages of a national population policy?
8. Should government have the right to limit the number of people who can live in a given area (community)? Explain.

9. What are China, India, USSR, and the United States doing to control population growth? Do any of these countries have a plan for guiding or controlling future population growth? Is there a worldwide plan for population control? Explain.

10. Compare the amounts of resources consumed by the person with an average income in the United States to that consumed by a person with an average income in China; in India; in the USSR. Consider basics like energy, food, clothing, and shelter.

11. Is population increase the root cause of our energy/environmental problems? Explain.

CONTACT ORGANIZATIONS:

1. Zero Population Growth, 1346 Connecticut Avenue, NW, Washington, D.C. 20036.

2. The Population Reference Bureau, 1754 N Street, NW, Washington, D.C. 20036.

3. The Population Institute, 110 Maryland Avenue, NE, Washington, D.C. 20002.

4. Worldwatch Institute, 1776 Massachusetts Avenue, NW, Washington, D.C. 20036.

5. Office of Population Affairs, Department of Health, Education, and Welfare, 330 Independence Avenue, SW, Washington, D.C. 20201.

6. Your local Planned Parenthood chapter.

## ACTIVITY 25 U.S. DEPENDENCE ON FOREIGN OIL

OBJECTIVE: TO HELP STUDENTS DEVELOP AN UNDERSTANDING OF THE EXTENT TO WHICH WE DEPEND ON FOREIGN COUNTRIES FOR OIL.

SOCIAL STUDIES

During October of 1973, the Arab members of the Organization of Petroleum Exporting Countries (OPEC) placed an embargo on the flow of oil to the United States. This caused a domestic shortage and served as a forceful reminder of our dependence on foreign oil.

Have students conduct research and contact organizations to learn more about our dependence on foreign oil. Answers should be obtained for the following questions:

1. What is the Organization of Petroleum Exporting Countries (OPEC)? What countries belong? What power does OPEC have?
2. Why did the Arabs impose an oil embargo on the United States in 1973?
3. Was the domestic shortage of oil during the embargo "created" by oil companies? Explain.
4. What conservation measures did the United States government take as a result of the embargo (e.g., 55 mile speed limit)?
5. To what extent did the Arab embargo cause unemployment in the United States and affect the gross national product (GNP)?
6. To what extent did United States fuel consumption drop between 1973 and 1974?
7. Has fuel consumption dropped or increased between 1974 and 1975?
8. Has fuel consumption since 1973 declined as rapidly in the U.S. as it has in many other developed countries? Explain.
9. How many million barrels of gasoline are used in the United States every day?
10. How much oil was imported into the United States in 1975? 1974? 1973? 1972? 1971? 1970? 1969? 1968? How was this oil used among the various sectors (e.g., residential, transportation, industry, etc.)?

11. Approximately how much does a barrel of imported oil currently cost the United States?

12. Has the nation's energy situation worsened since 1973? Explain.

13. Is the United States currently more vulnerable to an embargo than it was during the 1973-1974 stoppage? Explain.

14. What year did oil extraction peak in the continental United States?

15. When is oil scheduled to arrive to the lower 48 states from Alaska? What kinds of setbacks could slow this down?

16. To what extent does the United States currently depend upon non-renewable energy resources?

17. How does the United States government plan to attain energy independence? By what year?

18. What should the government's role be in developing energy resources? The role of the private sector (industry)?

19. Has the United States government made a major effort to conserve energy, particularly oil?

20. Does energy conservation mean "going without"?

21. In approximately what year is world oil production expected to peak?

22. What does "free enterprise" mean?

23. What would be the advantages and disadvantages of breaking down or nationalizing the oil companies?

CONTACT ORGANIZATIONS:

1. Federal Energy Administration, 12th and Pennsylvania Avenue, NW, Washington, D.C. 20461.

2. American Petroleum Institute, 1801 K Street, NW, Washington, D.C. 20036.

3. Energy Research and Development Administration, 20 Massachusetts Avenue, NW, Washington, D.C. 20545.

4. American Enterprise Institute, Natural Energy Project, 1150 Seventeenth Street, NW, Washington, D.C. 20036.

5. Society of Independent Gasoline Marketers of America, 230 South Bemiston, Suite 909, St. Louis, Missouri 63105.

# ACTIVITY 26 ENERGY PRODUCTION AND WASTE

OBJECTIVE: TO HELP STUDENTS DEVELOP AN UNDERSTANDING OF THE COSTS AND BENEFITS OF UTILIZING WASTE TO PRODUCE OR CONSERVE ENERGY.

SOCIAL STUDIES

Have students determine how the community is disposing of its solid waste and the potential for using it to generate electricity or produce fuel. Specifically, the students should:

1. Find out what agencies are responsible for solid waste management at local, state, and national levels.
2. Determine whether existing facilities are adequate.
3. Learn the difference between an "open dump" and a "sanitary landfill."
4. Learn about alternative methods of waste disposal (e.g., utilizing waste to generate electricity, using leaves and tree cuttings for mulch, etc.)
5. Learn about the benefits and problems of recycling wastes.

CONTACT ORGANIZATIONS:

1. Tennessee Department of Conservation, 2611 West End Avenue, Nashville, Tennessee 37203.
2. Solid Waste Management Office, Bureau of Environmental Health Services, Tennessee Department of Public Health, 344 Cordell Hull Building, Nashville, Tennessee 37219.
3. Energy Research and Development Administration, 20 Massachusetts Avenue, NW, Washington, D.C. 20545.
4. Environmental Protection Agency, 401 M Street, SW, Washington, D.C. 20460.
5. Federal Energy Administration, 12th and Pennsylvania Avenue, NW, Washington, D.C. 20461.

6. Tennessee Valley Authority, 400 Commerce Avenue, Knoxville, Tennessee 37902.

7. National Center for Resource Recovery, 1211 Connecticut Avenue, NW, Washington, D.C. 20036.

## ACTIVITY 27 RETAIL MERCHANTS AND ENERGY CONSERVATION

OBJECTIVE: TO PROVIDE STUDENTS WITH AN INSIGHT INTO THE RESPONSE OF LOCAL MERCHANTS ON THE NEED FOR ENERGY CONSERVATION.

SOCIAL STUDIES

Students should use the *Department Store Energy Audit Form* developed for this activity to conduct a survey in a local department store. This should be done with permission and cooperation of the store manager or a person designated to work with the students. Information obtained from the survey should be used in preparing a recommended energy conservation plan for the department store. Students should be quite familiar with all items on the form and be equipped with quantitative information of interest to the store operator (e.g., effects of thermostat setback).

Another activity would be to have students revise the attached form for use with public buildings, hospitals, grocery stores, or dairies. Interesting comparisons could be made between any two or more of these situations. Questions to consider would include:

1. Which one should receive highest priority in times of energy curtailment?

2. How much energy is required to keep a hospital functioning? What happens if power is cut off or curtailed? Which, if any, other community facilities face similar situations in case of emergency?

CONTACT ORGANIZATIONS:

1. Your local Chamber of Commerce may be able to help locate store managers who would cooperate in this Activity.

2. U.S. Department of Commerce, 15th and E Streets, NW, Washington, D.C. 20230.

3. Environment Center, The University of Tennessee, South Stadium Hall, Knoxville, Tennessee 37916.

4. Tennessee Energy Office, Suite 250, Capitol Hill Building, 7th and Union, Nashville, Tennessee 37219.

*DEPARTMENT STORE ENERGY AUDIT FORM*

STORE NAME:______________________________ Date:__________

ADDRESS:______________________________

______________________________

Student's Name:______________________________

Method(s) of Heating and Cooling:______________________________

______________________________

Does the store own the building? Explain why it matters.

______________________________

______________________________

Are energy purchases (types and amounts of fuel used) controlled by the store operator/manager? Explain.__________

______________________________

| | *yes* | *no* | *does not apply* |
|---|---|---|---|
| 1. Is thermostat setting for cooling 78°F or higher? | ___ | ___ | ___ |
| 2. Is thermostat setting for heating 68°F or lower? | ___ | ___ | ___ |
| 3. Where possible, is outside air used to control temperature? | ___ | ___ | ___ |
| 4. Is the thermostat adjusted during non-selling hours? | ___ | ___ | ___ |
| 5. Are all heating/cooling systems regularly inspected? | ___ | ___ | ___ |
| 6. Are doorways and windows closed when heating/cooling equipment is operating? | ___ | ___ | ___ |
| 7. Is weatherstripping and caulking evident around doors and windows? | ___ | ___ | ___ |
| 8. Are display items (dishwashers, lamps, small appliances) turned on only by request and not left on? | ___ | ___ | ___ |
| 9. Is cleaning done during store hours? (After hours requires additional energy.) | ___ | ___ | ___ |

| | | yes | no | does not apply |
|---|---|---|---|---|
| 10. | Is lighting in sales areas adequate but not excessive? | ___ | ___ | ___ |
| 11. | Is display lighting reduced to a minimum when the store is closed? | ___ | ___ | ___ |

Comments: ______________________________

## ACTIVITY 28 AN ENERGY CONSERVATION CAMPAIGN

OBJECTIVE: TO PROVIDE VARIOUS MEMBERS OF THE COMMUNITY WITH USEFUL INFORMATION ABOUT ENERGY PROBLEMS, SOLUTIONS, AND CONSERVATION TECHNIQUES.

SOCIAL STUDIES

Have students plan, organize, and conduct a community-wide educational campaign for energy conservation. Specifically, students should include the following:

1. Provide homeowners with carefully reasoned energy conservation tips (cooking, heating, cooling, insulation, thermostat control, night setback, reduced lighting, carpooling, vanpooling).

2. Collect and/or prepare energy conservation materials for citizens or community business and government leaders in the residential, commercial, industrial, transportation, agricultural, and governmental sectors.

3. Organize a program to train students how to conduct home energy audits.

4. Organize a speakers' bureau of both experts and laymen who will voluntarily make energy conservation presentations.

5. Inform citizens about the advantages and disadvantages of developing alternative energy resources.

6. Organize an energy conservation awards program for students and homeowners.

CONTACT ORGANIZATIONS:

1. Tennessee Energy Office, Suite 250, Capitol Hill Building, 7th and Union, Nashville, Tennessee 37219.

2. Environment Center, The University of Tennessee, South Stadium Hall, Knoxville, Tennessee 37916.

3. Tennessee Valley Authority, 400 Commerce Avenue, Knoxville, Tennessee 37902.

4. Federal Energy Administration, 12th and Pennsylvania Avenue, NW, Washington, D.C. 20461.

5. Energy Research and Development Administration, 20 Massachusetts Avenue, NW, Washington, D.C. 20545.

6. Tennessee Department of Conservation, 2611 West End Avenue, Nashville, Tennessee 37203.

7. Your local public library often provides space, time, and publicity for speakers, programs, and displays, as well as professional help in preparing materials.

ACTIVITY 29 AN ENERGY CONSERVATION ETHIC

OBJECTIVE: TO HELP EACH STUDENT DEVELOP AN "ENERGY CONSERVATION ETHIC."

COMMUNICATIONS/ LANGUAGE ARTS

Have students write their own definition of an "energy conseration ethic." They should then select an item or material thing (watch, stereo, clothing, ring, record) and answer the following questions about it:

1. Do I really need the item to be happy? Explain.
2. Will buying it mean a more "materialistic" lifestyle? Explain.
3. Is the item economical and efficient? Explain.
4. What natural resources were used to make it?
5. Were the resources renewable or nonrenewable?
6. From what sections of the country or world did the resources come?
7. What other resources could have been used to make it?
8. Did its production result in significant environmental/ecological damage? Explain.
9. Will its use result in significant environmental/ecological damage? Explain.
10. How long will it probably last and can it be recycled?

The answers to the above questions should be included in written and oral reports.

CONTACT ORGANIZATIONS:

1. Center for Energy Information, 340 East 51st St., New York, New York 10022.
2. Consumer Federation of America, 1012 Fourteenth Street, NW, Suite 901, Washington, D.C. 20005.

3. General Electric Company, P.O. Box 500, New Concord, Ohio 43762.

4. Motor Vehicle Manufacturers Association, 320 New Center Building, Detroit, Michigan 48202.

5. Resources for the Future, Inc., 1755 Massachusetts Avenue, NW, Washington, D.C. 20036.

## ACTIVITY 30 DIVERSITY OF ENERGY PROBLEMS

OBJECTIVE: TO HAVE STUDENTS GAIN AN UNDERSTANDING OF THE DIVERSITY AND COMPLEXITY OF ENERGY PROBLEMS.

COMMUNICATIONS/ LANGUAGE ARTS

Have students prepare a comprehensive listing of energy development problems in order to understand definitions of the terms "economic cost," "social cost," and "environmental cost" as they relate to developing energy resources. Students should divide into teams and prepare written material on energy development problems such as:

1. surface mining of coal in Tennessee;
2. transporting western U.S. coal to Tennessee;
3. deep mining coal in West Virginia;
4. gas and oil exploration in Appalachia and the Atlantic off-shore;
5. transporting or storing radioactive fuels or wastes;
6. siting a nuclear power plant;
7. strip mine reclamation;
8. uranium mining;
9. siting of transmission lines;
10. thermal discharges.

Team reports should describe the nature of the problem; its economic, social, and environmental impacts; and alternative solutions.

CONTACT ORGANIZATIONS:

1. Tennessee Valley Authority, 400 Commerce Avenue, Knoxville, Tennessee 37902.
2. Tennessee Department of Conservation, 2611 West End Avenue, Nashville, Tennessee 37219.
3. Bureau of Mines, Department of the Interior, 18th and C Streets, NW, Washington, D.C. 20240.
4. Council on Environmental Quality, 721 Jackson Place, NW, Washington, D.C. 20006.
5. Energy Research and Development Administration, 20 Massachusetts Avenue, NW, Washington, D.C. 20545.
6. Nuclear Regulatory Commission, Washington, D.C. 20555.
7. Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, Tennessee 37830.

8. East Tennessee Energy Group, 1538 Highland Avenue, Knoxville, Tennessee 37916.

9. Tennessee Environmental Council, P.O. Box 1422, Nashville, Tennessee 37202.

10. Tennessee Sierra Club, P.O. Box 2721, Nashville, Tennessee 37219.

11. Tennessee State Planning Office, Capitol Hill Building, Nashville, Tennessee 37219.

12. Tennessee Citizens for Wilderness Planning, 130 Tabor Road, Oak Ridge, Tennessee 37830.

## ACTIVITY 31 ENERGY FLOW IN MANUFACTURING

OBJECTIVE: TO HELP STUDENTS GAIN AN UNDERSTANDING OF HOW ENERGY IS USED TO PRODUCE AND OPERATE INDIVIDUAL PIECES OF MERCHANDISE.

COMMUNICATIONS/ LANGUAGE ARTS

Each student should select an item he/she has recently purchased or would like to purchase, then develop a research paper, essay, or oral presentation about it (including visual aids for emphasis) based on the following questions:

1. What were the original sources of energy used to make the object?
2. What types of energy were needed or transformed in manufacturing the item?
3. What raw materials were used in manufacturing the object?
4. Tracing the energy used to manufacture the object all the way back to its ultimate source:
   a. How much energy does it take to make the object?
   b. How much energy does it take to operate the object?
5. How durable is the object and what happens to it when it is no longer operational? Can it be recycled?

CONTACT ORGANIZATIONS:

1. Consumer Affairs, Tennessee Department of Agriculture, Ellington Agricultural Center, Box 40627, Melrose Station, Nashville, Tennessee 37204.
2. American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19102.
3. Consumer Federation of America, 1012 Fourteenth Street, NW, Suite 901, Washington, D.C. 20005.
4. Electric Energy Association, 90 Park Avenue, New York, New York 10016.
5. Energy Research Corporation, 6 East Valerio Street, Santa Barbara, California 93101.

6. Resources for the Future, Inc., 1755 Massachusetts Avenue, NW, Washington, D.C. 20036.

ACTIVITY 32 ENERGY AND ELECTRICAL APPLIANCES

OBJECTIVE: TO HELP STUDENTS GAIN AN UNDERSTANDING OF THE LARGE NUMBER OF ELECTRICAL APPLIANCES ON THE MARKET, THE EXTENT TO WHICH THEY ARE VALUED, AND PROCEDURES FOR SELLING THEM.

COMMUNICATIONS/ LANGUAGE ARTS

Have students prepare a comprehensive listing of every electrical household appliance they can think of. Each student (or team) should select one appliance, compile a complete portfolio of advertisements and marketing campaigns for it and examine these materials carefully, especially with regard to the recent "truth in advertising" requirements:

1. Legislation, if any, that applies to the appliances, such as energy efficiency ratings, care and maintenance instructions, and warranties.

2. Advantages and disadvantages of the appliance, with regard to energy consumption.

3. The amount of energy required to manufacture the appliance.

4. The amount of energy and cost of operating the appliance.

5. Its survival value in the family's lifestyle.

6. Whether the appliance is a "status item" and why.

7. The extent to which the appliance could adversely affect cultural or social patterns (e.g., the television and crime).

8. Similar appliances by different manufacturers.

9. How does advertising and marketing affect buying patterns? Is it worth it to you as a consumer?

CONTACT ORGANIZATIONS:

1. Consumer Affairs, Tennessee Department of Agriculture, Ellington Agricultural Center, Box 40627, Melrose Station, Nashville, Tennessee 37204.

2. Consumer Federation of America, 1012 Fourteenth Street, NW, Suite 901, Washington, D.C. 20005.

3. Home Economics Association, 1201 Sixteenth Street, NW, Washington, D.C. 20036.

4. American Home Economics Association, 2010 Massachusetts Avenue, NW, Washington, D.C. 20036.

5. Association of House Appliance Manufacturers, 20 North Wacker Drive, Chicago, Illinois 60606.

## ACTIVITY 33 DEVELOPING A VISUAL DISPLAY ON ENERGY

OBJECTIVE: TO HELP THE STUDENT GAIN AN UNDERSTANDING OF THE WORK AND SKILLS INVOLVED IN DEVELOPING A VISUAL DISPLAY ON ENERGY.

COMMUNICATIONS/ LANGUAGE ARTS

Have students develop a visual display dealing with energy production and consumption in their community. Exhibits could be developed which would:

1. Show the sections of the country or world where energy resource reserves (e.g., coal, oil, uranium, natural gas) are located.

2. Prepare a map which illustrates the geographic areas being served by various generating facilities (your community).

3. Trace electricity used in the home back to the generating facilities and the ultimate source of fuel.

4. Trace natural gas or petroleum used in the home back to the storage facilities, refineries, and original sources.

5. Show prices of processing, storing, and transporting fuel to consumers.

6. Examine the advantages and disadvantages of mining and burning coal.

7. Indicate how petroleum is taken from under the earth, refined, and used as a fuel.

8. Show how different sectors (residential, commercial, industrial, agriculture, transportation, and government) use energy.

CONTACT ORGANIZATIONS:

1. Bureau of Mines, Department of the Interior, 18th and C Streets, NW, Washington, D.C. 20240.

2. Energy Research and Development Administration, 20 Massachusetts Avenue, NW, Washington, D.C. 20545.

3. Environmental Protection Agency, 401 M Street, SW, Washington, D.C. 20460.

4. Federal Energy Administration, 12th and Pennsylvania Avenue, NW, Washington, D.C. 20461.

5. Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, Tennessee 37830.

6. Tennessee Department of Conservation, 2611 West End Avenue, Nashville, Tennessee 37203.

7. American Gas Association, 1515 Wilson Boulevard, Arlington, Virginia 22209.

8. American Nuclear Society, 244 East Ogden Avenue, Hinsdale, Illinois 60521.

9. American Petroleum Institute, 1801 K Street, NW, Washington, D.C. 20006

10. Coal Mining Institute of America, 416 Ash Street, California, Pennsylvania 15419.

ACTIVITY 34 ENERGY AND VISUAL ARTS

OBJECTIVE: TO GIVE STUDENTS AN OPPORTUNITY THROUGH VISUAL PRESENTATIONS TO EXPRESS THEIR VIEWS ABOUT THE ENERGY SITUATION AND WAYS TO CONSERVE ENERGY.

COMMUNICATIONS/ LANGUAGE ARTS

Have students develop a series of transparencies (or slides if resources permit), with accompanying narratives, which present a description of the world energy situation or ways to conserve energy. There are many different possibilities for presentations. For example: (1) different types of power plants (coal-fired, hydro, nuclear); (2) environmental problems caused by energy development; and (3) ways energy is wasted. For example, a slide presentation on home energy conservation could present consumer tips on the following topics:

Frame #1. Proper insulation

Frame #2. Kinds of insulation

Frame #3. Storm windows and doors

Frame #4. Weatherstripping on windows or around doors

Frame #5. Caulking compound

Frame #6. Plastic sheeting used for storm windows

Frame #7. Vegetation around house

Frame #8. Proper site orientation of house

Frame #9. Conservation sticker near light switch

Frame #10. Historical demand for household energy

Frame #11. Small car beside large one, with mileage

Frame #12. 55 mph speed limit sign

Frame #13. Materials (pamphlets, lists) on energy conservation tips

The presentation--about 15 minutes in length--may be given to the class, to other youth groups, and to interested civic organizations. The presentation should include the dissemination of free energy conservation tips which are currently available from many agencies and public interest groups.

CONTACT ORGANIZATIONS:

1. Tennessee Energy Office, Suite 250, Capitol Hill Building, 7th and Union, Nashville, Tennessee 37219.

2. Energy Research and Development Administration, 20 Massachusetts Avenue, NW, Washington, D.C. 20545.

3. Federal Energy Administration, 12th and Pennsylvania Avenue, NW, Washington, D.C. 20461.

4. Tennessee Valley Authority, 400 Commerce Avenue, Knoxville, Tennessee 37902.

5. U.S. Department of Transportation, 400 Seventh Street, SW, Washington, D.C. 20590.

# ACTIVITY 35 A HISTORY OF ENERGY DEVELOPMENT ACTIONS AFFECTING A COMMUNITY

OBJECTIVE: TO HELP STUDENTS GAIN AN UNDERSTANDING ABOUT THE ROLE ENERGY HAS PLAYED IN THE DEVELOPMENT OF THEIR COMMUNITY.

COMMUNICATIONS/ LANGUAGE ARTS

Students should conduct research to gather information and write a report on the role energy has played in community growth. Research should include use of the library, interviewing citizens and professionals, visits to local newspaper offices, and writing state agencies for information. Results should be compiled for appropriate intervals, going back to the beginning of the community, town, village, or city. Some relevant questions include:

1. Has the population of the community changed from rural to urban?
2. What have been the various lifestyles exhibited by the people?
3. What have been the major industries or employers?
4. Why did each industry choose to locate in the community?
5. How has transportation changed over the years? Why?
6. How has the price of energy (fuels and electricity) changed over the years (corrected for inflation)?
7. Has environmental quality in the community improved or worsened over the years? In what ways?
8. Who has regulated or controlled community development over the years?

CONTACT ORGANIZATIONS:

1. Local Chamber of Commerce, Planning Commission, Development District, State Planning Office (see telephone directory).
2. U.S. Department of Commerce, 15th and E Street, NW, Washington, D.C. 20230.
3. Tennessee Valley Authority, 400 Commerce Avenue, Knoxville, Tennessee 37902.
4. Division for Industrial Development, Andrew Jackson State Office Building, Room 1222, Nashville, Tennessee 37219.

5. Tennessee State Planning Office, Capitol Hill Building, Nashville, Tennessee 37219.

6. Local newspapers.

*COMMUNITY DATA COLLECTION FORM*

*Directions: Fill out one sheet for each fuel or power source used in your community--wood, coal, oil, natural gas, hydro, nuclear, solar. Additional information should be collected if deemed appropriate.*

| | Year* | Transportation % Used | Residential % Used | Industry % Used | Schools and Government % Used | Population % Urban | Population % Rural | Unit Price |
|---|---|---|---|---|---|---|---|---|
| | 1850 | | | | | | | |
| | 1875 | | | | | | | |
| | 1900 | | | | | | | |
| | 1914 | | | | | | | |
| | 1929 | | | | | | | |
| | 1932 | | | | | | | |
| | 1943 | | | | | | | |
| | 1950 | | | | | | | |
| | 1960 | | | | | | | |
| | 1970 | | | | | | | |
| | 1971 | | | | | | | |
| | 1972 | | | | | | | |
| | 1973 | | | | | | | |
| | 1974 | | | | | | | |
| | 1975 | | | | | | | |
| | 1976 | | | | | | | |
| Projected | 1980 | | | | | | | |
| Projected | 1985 | | | | | | | |
| Projected | 2000 | | | | | | | |

*Begin with year in which your community was established; use significant historical dates, such as wars, depressions, presidential administrations.

## ACTIVITY 36 — SOURCES OF FUEL AND TECHNOLOGICAL ACHIEVEMENTS

OBJECTIVE: TO HELP STUDENTS GAIN AN UNDERSTANDING OF SOURCES OF FUEL AND TECHNOLOGICAL ACHIEVEMENTS.

COMMUNICATIONS/ LANGUAGE ARTS

Students should develop a comprehensive listing of fuels and depict the historical progression of their use. Fuels to consider include wood, coal, oil, natural gas, and uranium. Questions include:

1. What were/are the reasons for shifting from one kind of fuel to another?

2. What are the advantages and disadvantages of each kind of fuel?

3. What are the relationships between fuel supply, price, and demand?

4. In what parts of the United States or world are the different fuels found?

5. How has the availability and/or discovery of fuel contributed to technological achievements?

Students should then develop charts, transparencies, or other visual aids describing energy-related technological achievements, when and where they were developed, and the historical progression of their use. Some technological achievements to consider include: water wheel, windmill, automobile, train, steam engine, diesel engine, airplane, conventional nuclear reactor, breeder reactor, heat pump, highly effective insulation, refrigeration, air conditioning, incandescent light, fluorescent light, electric oven, radio, and television. Questions to consider about each technology include:

1. Why did we shift away from or toward it?

2. What were/are its advantages and disadvantages?

3. How has it changed lifestyles, the standard of living, or quality of life?

4. How have technological achievements contributed to changes in the use of different fuels?

CONTACT ORGANIZATIONS:

1. Department of the Interior, 18th and C Street, NW, Washington, D.C. 20240.

2. Energy Research and Development Administration, 20 Massachusetts Avenue, NW, Washington, D.C. 20545.

3. Environmental Protection Agency, 401 M Street, SW, Washington, D.C. 20460.

4. American Gas Association, 1515 Wilson Boulevard, Arlington, Virginia 22209.

5. American Nuclear Society, 244 E. Ogden Avenue, Hinsdale, Illinois 60521.

6. American Petroleum Institute, 1801 K Street, NW, Washington, D.C. 20006.

7. Coal Mining Institute of American, 416 Ash Street, California, Pennsylvania 15419.

8. Environmental Action Foundation, Inc., Room 720, DuPont Circle Building, Washington, D.C. 20036.

9. Natural Gas Supply Committee, 1025 Connecticut Avenue, NW, Washington, D.C. 20036.

10. U.S. Department of Agriculture, Washington, D.C. 20250.

## ACTIVITY 37 — ENERGY RESEARCH REPORTS

OBJECTIVE: TO HELP STUDENTS DEVELOP SKILLS IN LIBRARY RESEARCH AND REPORT WRITING.

COMMUNICATIONS/ LANGUAGE ARTS

Students should prepare a comprehensive listing of topics about energy and conservation which could be used as report titles. Each student should then select and prepare a report using an accepted format and style. Some topics might include:

1. "The Costs and Benefits of Nuclear Power"
2. "Energy Conservation in the Home"
3. "Energy Conservation at School"
4. "Government's Role in Solving the Energy Problem"
5. "Industry's Role in Solving the Energy Problem"
6. "Common Energy Myths"
7. "The Role of the Media in Energy Conservation"
8. "The Role of the Educational Process in Solving the Energy Problem"
9. "Can the 'Energy Problem' Be 'Solved'?"
10. "An Energy Conservation Ethic for Consumers"
11. "How to Conserve Energy in Food Production"
12. "The Family Automobile: What are the Alternatives?"
13. "Lifestyles and Energy"
14. "Criteria for Siting Power Plants and Transmission Lines"
15. "Strip Mining in Tennessee"
16. "Conserving Energy With Vegetation Around the House"

CONTACT ORGANIZATIONS:

Varies according to topic selected. Refer to local telephone directory, *APPENDIX: SELECTED SOURCES OF ENERGY INFORMATION*, and libraries.

## ACTIVITY 38 SOURCES OF ENERGY INFORMATION

OBJECTIVE: TO ASSIST STUDENTS IN IDENTIFYING THE BEST SOURCES OF ENERGY INFORMATION; WHERE AGENCIES ARE LOCATED.

COMMUNICATIONS/ LANGUAGE ARTS

Students should prepare a comprehensive listing of energy concerns (including those listed in the *APPENDIX: SELECTED SOURCES OF ENERGY INFORMATION)* and request detailed information about their energy programs and services. Student teams should be organized so there is no needless duplication in contacting agencies. The material obtained in response to questions about programs should be written as class reports. In brief, the report should include an alphabetical listing of energy and conservation agencies (federal, state, local) including the complete address (include zip code) and a description of the programs or services available. The report should be made available to teachers, librarians, and students and its availability should be advertised in local newspapers.

CONTACT ORGANIZATIONS:

1. Your local utility or electric power distributor and Chamber of Commerce.
2. See *APPENDIX: SELECTED SOURCES OF ENERGY INFORMATION*
3. See Activities 14 and 43.

ACTIVITY 39 ENERGY AND THE MEDIA

OBJECTIVE: TO HELP STUDENTS GAIN A BETTER UNDERSTANDING OF HOW ENERGY CONSERVATION CAN BE ADVOCATED BY NEWS MEDIA.

COMMUNICATIONS/ LANGUAGE ARTS

Have students divide into groups of five. Each group should be reponsible for preparing one article on energy. The article could be published in the school paper, sent to the editor of a local newspaper, or submitted to the manager of a television station. Two students from the class should edit all the articles, seeing that each article is as objective as possible, and supervise printing and dissemination. Articles should deal with such topics as:

1. The Energy Problem--Is it Real?
2. Lifeline Electric Rate Structure
3. Government's Response to the Energy Crisis
4. The Heat Pump
5. Solar Water Heating
6. Night Setback of Thermostats
7. The Role of Education in Solving the Energy Problem
8. The Community Response to the Energy Crisis
9. Criteria for Siting Nuclear Power Plants
10. Energy Myths
11. Energy Conservation and Transportation
12. Environmental Problems Caused by Energy Development

Students should answer the following questions in class:

1. Do citizens have adequate access to energy conservation information?
2. What is the role of media in solving the energy problem?

3. What kinds of information do citizens need in order to make wise decisions about energy?

4. What are the most important target group(s) for the media to reach with energy conservation information?

5. What are the feelings of citizens about energy development and conservation as obtained through student interviews?

6. What are the feelings of local leaders of business, industry, and government about energy development and conservation?

CONTACT ORGANIZATIONS:

1. Your local newspaper offices, TV and radio stations.

2. Energy Research and Development Administration, 20 Massachusetts Avenue, NW, Washington, D.C. 20545.

3. Federal Energy Administration, 12th and Pennsylvania Avenue, NW, Washington, D.C. 20461.

4. Tennessee Valley Authority, 400 Commerce Avenue, Knoxville, Tennessee 37902.

5. Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, Tennessee 37830.

ACTIVITY 40 VALUES CLARIFICATION ON ENERGY

OBJECTIVE: TO PROVIDE A MEANS FOR STUDENTS TO EXAMINE THEIR VALUES AND BELIEFS ABOUT ENERGY.

MULTIDISCIPLINARY

Students should complete the *ENERGY OPINIONAIRE* prepared for this activity. For each statement, they should list as many reasons as possible to substantiate their opinions or beliefs. Students should be asked to defend their positions in class. They should know how an opinion can effect their behavior or lifestyle. Where they are uncertain about their opinions, they should conduct sufficient research to uphold an opinion.

Those Opinionaire items which elicit the most obvious differences of opinion or strong value judgments could be expanded into debate topics. Items 7, 11, 12, and 16 are examples.

CONTACT ORGANIZATIONS:

NONE

*ENERGY OPINIONAIRE*

Name ______________________ Date ____________

Class ______________________ Teacher ____________

*Directions: Please cross out the word or phrase within the parentheses which least indicates your opinion. Be prepared to defend your opinion or belief.*

I believe that:

1. The energy resources in the United States (are, are not) controlled by monopolies.
2. There (is, is not) a shortage of oil in our country.
3. We (should, should not) generate more energy by nuclear and fossil fuels.
4. Solar energy technology for generating electricity (is, is not) well established at this time.
5. Government funds (should, should not) be used to develop the railroads and barge traffic.
6. If fuel prices were to decline, consumption (would, would not) greatly increase.
7. American lifestyles (are, are not) wasteful of energy.
8. Manufacturers (should, should not) be forced to reveal the energy costs of their products.
9. Nonreturnable and disposable containers (should, should not) be discontinued.
10. Rising energy costs (have, do not have) a direct, personal impact on everyone.
11. Everyone (should, should not) observe reduced speed limits to conserve energy.
12. The use of energy (is, is not) a moral problem involving stewardship of resources.
13. The government (should, should not) restrict the size of cars.
14. The cost of pollution control (should, should not) be included in the individual customer's bill.

15. An individual (can, cannot) have an impact on energy consumption.

16. Individuals (will, will not) conserve energy if they realize there is a problem.

17. We (should, should not) develop energy resources regardless of environmental costs.

18. All demands for energy (will, will not) be met in the year 2000.

19. People (are, are not) born greedy and selfish in respect to use of natural resources.

20. Strict federal laws (will, will not) be the major factor in energy consumption.

21. Nuclear power (is, is not) too dangerous to be used in producing electricity.

22. Our government (is, is not) being effective in solving our energy problems.

23. Everyone (should, should not) be required to pay for energy regardless of economic level.

24. The production of an adequate supply of energy (is, is not) a major problem in our country today.

25. The energy problem (is, is not) political rather than technological.

26. The average citizen (is, is not) getting honest information on energy problems and their solutions.

27. Energy production (should, should not) be controlled by government rather than private industry.

28. Alternative energy sources such as wind, geothermal, solar, and tidal power (are, are not) receiving adequate funds for their development.

29. Foreign countries (do, do not) have the right to charge any price they please for their natural resources.

30. My family (is, is not) doing an adequate job of conserving energy.

## ACTIVITY 41 ENERGY USE SITUATION AND DECISION-MAKING

OBJECTIVE: TO PROVIDE STUDENTS AN OPPORTUNITY TO BETTER APPRECIATE THE DECISION-MAKING PROCESS ABOUT ENERGY USE.

MULTIDISCIPLINARY

Have students select one or more of the 29 *ENERGY USE SITUATIONS* prepared for this activity. Situations should be considered as though they are occurring in the students' own community. Students should be able to defend their decisions or answers. This might require some library research or contacts with agency officials. If maps are needed, they may be obtained from the Chamber of Commerce, Soil Conservation Service, or Local Planning Commission Office.

NOTE: It is advisable to omit any references to local personalities by name or inference in this activity.

CONTACT ORGANIZATIONS:

Refer to *APPENDIX: SELECTED SOURCES OF ENERGY INFORMATION*

*ENERGY USE SITUATIONS*

1. *Assume* you *are in a position to considerably influence energy consumption patterns in your community:*

   a. Would you limit energy use? In what ways? Why? What factors would you consider?

   b. What provisions would you make for the elderly on fixed incomes? The unemployed? The sick?

   c. What special considerations, if any, would be given to hospitals? To schools? To public office buildings? To jails?

2. *Assume* you *hold a political office and have the power to influence decisions on energy use:*

   a. How would you reach decisions? How might they be put into effect?

   b. Would one group of citizens receive more attention than others? Why?

   c. What factors would influence your decision? Wealth? Power? Knowledge?

   d. Would you make unpopular decisions? Why? State an example.

3. *Assume* you *are in a position to assist in recreational planning for your community:*

   a. Would you give consideration to having athletic events only during daylight hours? What problems would you encounter?

   b. What areas near major concentrations of people could be utilized for parks?

   c. Would bicycle trails throughout the city be popular? Could you suggest a location for a bicycle trail?

4. *Assume* you *are in a position to determine the location of street lights in your community:*

   a. Are there locations in which you would add lights for safety or security reasons? Where are they?

   b. Are there locations in which you would eliminate lighting? Where are they? Why?

   c. Are there types of lighting that require less electricity than others? What kinds of lights last the longest period of time? Justify the reasons for using different types of lights at different places.

5. *Assume you are in a position to promote mass transit in your community:*

a. Where would you encourage special bus, van, or carpool lanes? What criteria would you use in deciding their locations?

b. Are there adequate areas to park cars so individuals could then take part in mass transit? Where are these areas?

c. Where would you obtain the funds to start your programs?

6. *Assume you are owner/manager of a grocery store in your community:*

a. Are there items you, as an energy conservationist, would not sell, knowing your personal income might be reduced? Explain.

b. Are there items you would not sell because of the energy used in packaging? What are the alternatives to packaging?

c. What other ways could you promote the conservation of energy at your grocery store?

7. *Assume you are going to purchase a family automobile:*

a. What type of automobile would you buy? Why?

b. Would you buy a new or used automobile? Why?

c. On what basis would you choose options (radio, air conditioning, power steering, power windows, etc.)?

d. What effect do you think the new anti-pollution systems have on gas mileage or engine efficiency? What is the effect of running an air conditioner on mileage?

8. *Assume you are in a position to give a homeowner in your community an award of $100 for energy conservation:*

a. What energy conservation features would you look for on the exterior of the home?

b. What energy conservation features would you look for on the interior of the home?

c. How does the homeowner's lifestyle contribute to energy conservation?

9. *Assume you have been asked to develop an advertising campaign on energy conservation for your community:*

   a. Would there be different approaches for different segments of the community? What would they be?

   b. What types of programs would you develop for television, radio, and newspapers?

   c. Where would you go for assistance (information, manpower, money, etc.)?

10. *Assume you are in charge of transporting coal from the mine to a power plant?*

   a. What type of transportation would you use (roads, a river, and railroads are all available)? Why?

   b. What social factors would be considered in your decision?

   c. What economic factors would be considered in your decision?

   d. What environmental factors would be considered in your decision?

11. *Assume you are in charge of operating a strip mine operation in Tennessee:*

   a. What would you do to reclaim stripped land? Why?

   b. How would you deal with citizen objections to your operation?

   c. What type of reclamation laws are now in effect? To what extent are they enforced? Who (what agency) is responsible for enforcement?

12. *Assume you are an automobile salesperson:*

   a. How would you describe the air pollution controls on the new models? (See driver's manual of a new car.)

   b. What energy conservation tips would you offer?

   c. Would you feel any obligation to lead your customers to an energy conserving model?

13. *Assume* *you* *are interested in promoting solar energy technologies (or hydroelectric facilities, conventional nuclear power plants, coal-fired steam plants, or liquid metal fast-breeder reactor) in Tennessee:*

a. Where would you go for assistance?

b. What type of opposition might you encounter? Why?

c. Are there any solar demonstrations in the state?

d. How would you inform citizens about your energy choice?

14. *Assume* *you* *are mayor of your city and, in attempting to involve more citizens in decision-making situations, are going to establish a citizens' advisory committee on energy conservation:*

a. What type of individuals (educational background, occupations, political philosophy, age, experience, and wealth) would you choose? How many individuals would you choose? Why?

b. What problem areas would you assign this committee?

c. What responsibilities would the committee have? How much decision-making power?

15. *Assume* *you* *want to live a simple, uncomplicated, and less consumptive lifestyle:*

a. Where would you establish your home? Why? Where would you not live and why?

b. How would you support yourself?

c. In what ways would you use less energy?

d. What kind of home would you buy or build?

16. *Assume* *you* *are on the Board of Directors of the Tennessee Valley Authority and must approve the site of a nuclear or coal-fired power plant:*

a. What economic factors would you consider?

b. What social factors would you consider?

c. What environmental factors would you consider?

d. What other kinds of data or information would you want in order to make your decision?



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17. *Assume you, a consumer, are about to buy some clothing:*

a. Would you want synthetic (e.g., polyester) material? Why? Why not? How much energy is required to produce it? To maintain it?

b. Would you want natural (e.g., cotton) material? Why? Why not? How much energy is required to produce it? To maintain it?

18. *Assume you, a consumer, are purchasing a television set:*

a. What size set would you buy? Why?

b. Would you buy a black-and-white or color set? Would you buy a tube set or a solid-state set? Which ones utilize the most energy? Why?

c. If you had unlimited funds, how many television sets would you have in your house? Why?

19. *Assume you are the fleet manager for a large governmental agency or private firm:*

a. What type of vehicles would you purchase? Why?

b. What options would you consider for vehicles in the fleet?

c. In what ways would you encourage drivers to conserve energy? How could you enforce energy conservation?

20. *Assume you are the manager of an apartment complex:*

a. How would you encourage tenants to conserve energy?

b. In what ways could energy be conserved in maintenance of the apartments?

c. What energy conserving actions would you take in the public areas of the complex?

21. *Assume you are designing an apartment complex in your community:*

a. Is there a site that could result in saving transportation costs for the prospective residents? Where?

b. What type of recreational facilities could be developed on this site to encourage residents to stay home during leisure hours?

c. How could the apartments be designed and situated (oriented on the site) to conserve energy?

22. *Assume you are looking for a way to store additional amounts of frozen food:*

a. Would you buy an upright or chest-type freezer? Which conserves the most energy? What would be advantages and disadvantages of having your own freezer at home?

b. Is freezer locker space available in your community? Where? Would you conserve energy by storing food this way? What would be the advantages and disadvantages of using this system?

23. *Assume you are buying a water heater for your home:*

a. Where would you place the heater? Is the location important? Why?

b. What is the quick recovery system on a water heater? Is it possible to disconnect this system? Why would this be done?

c. How often should you drain the water heater? Why?

24. *Assume you are a state legislator preparing a bill introducing a state energy policy:*

a. What energy conserving measures would you include and why?

b. What would be the major steps you would have to follow in order to get the bill passed by the legislature?

c. Could your state policy affect operational procedures of a federal agency like the Tennessee Valley Authority? How?

25. *Assume you are buying tires for your automobile:*

a. What are the advantages/disadvantages of bias ply tires? Radials?

b. Does the speed at which you drive affect the lifetime of tires?

26. *Assume you are going to insulate your house:*

a. What are the most important areas of the house to insulate?

b. What insulation materials would you use and why?

c. How is the effectiveness of insulation specified on the material?

d. Within what time period could the insulation pay for itself in lowered utility bills?



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27. *Assume you are remodeling your present home:*

a. Where would you place new lights and why?

b. Where would you use fluorescent light fixtures? Why?

c. Where could you reduce wattage and size of lights?

28. *Assume you are planning a vegetable garden:*

a. What would you plant and why?

b. How could you conserve energy in gardening? In canning or freezing your own foods? In cooking?

29. *Assume you are a planner for the State Department of Transportation:*

a. Would you encourage mass transit? Why? How?

b. How should highways be designed to conserve energy? For safety?

c. Would you recommend a right turn on red after stop? Why?

d. What would you want the speed limit to be on interstate highways?



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ACTIVITY 42 EVALUATING ENERGY MATERIAL

OBJECTIVE: TO HELP STUDENTS BECOME FAMILIAR WITH THE WIDE RANGE OF ENERGY MATERIALS AND THE DIFFICULTY IN DETERMINING WHETHER IT IS OBJECTIVE AND ACCURATE.

MULTIDISCIPLINARY

Anyone who searches for material on energy will find we are suffering from information overload. It is difficult to know who or what to believe.

Have students collect (obtain complimentary copies or borrow from the school library) at least 20 energy publications. (See Activities 14 and 38.) They should then break down into teams of five members each. There should be five to seven "Material Review Teams." Before reviewing and evaluating documents, students should develop special criteria which include reading level, objectivity, cost, etc. Answers should also be obtained for the following questions:

1. Who (person/agency) designed and/or funded the study and for what purpose?
2. Did the author(s) make any general assumptions or take things for granted?
3. Did the author(s) clearly state how data were obtained and how conclusions were reached?
4. Did the author(s) conduct the study to further support an action (or opinion) which had already been decided upon at an earlier date by an agency or special interest group?
5. Did the author(s) ask biased questions in order to obtain the answers needed to support the views of a special interest group?
6. Did the author(s) double-check data for accuracy?
7. Were sources of data or information used in the study reliable, accurate, and up-to-date?
8. Did the author(s) look for, describe, and select from alternatives when arriving at solutions or conclusions?
9. Did the author(s) look thoroughly into the environmental, economic, and social aspects of the problem?

The composite findings of all teams should be used to prepare an "Energy Education/Conservation Bibliography" for students. Students might want to annotate the best publications and include these annotations in the bibliography.

CONTACT ORGANIZATIONS:

None



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## ACTIVITY 43 ORGANIZING A SCHOOL ENERGY CONTEST

OBJECTIVE: TO PROVIDE STUDENTS WITH AN OPPORTUNITY TO USE THEIR UNDERSTANDING OF ENERGY PROBLEMS TO COMMUNICATE ENERGY CONSERVATION PRACTICES TO OTHERS.

MULTIDISCIPLINARY

Sponsoring an energy contest will afford students an excellent opportunity to apply their knowledge about the energy situation and need for conservation. There are numerous possibilities, including: poster, photography, or essay contests, speeches, and debates. You will want to consider the following when developing a plan for the contest:

1. What specific kind of contest will it be?
2. What energy topics (problems, concerns, technologies) will be included?
3. Who is eligible to enter? How may they enter?
4. What criteria apply to the specific contest (e.g., if photography, the size, color, and mounting of photographs)?
5. What prizes or awards (e.g., cash, savings bonds, certificates) will be offered?
6. Who will select winners? Students? A panel of community members? What criteria will be used to select judges?
7. When would the contest begin and end?
8. To whom are entries submitted? A program coordinator? A teacher? The chairman of the panel of judges?
9. How will publicity be handled?
10. What companies or organizations might sponsor the contest?
11. Will there be an awards ceremony (reception, assembly, or luncheon) to announce the winners?

CONTACT ORGANIZATIONS:

1. Contact your local utility or electric power distributor.
2. Federal Energy Administration, 12th and Pennsylvania Avenue, NW, Washington, D.C. 20461.
3. Tennessee Energy Office, Suite 250, Capitol Hill Building, 7th and Union, Nashville, Tennessee 37219.
4. Your school librarian.

## ACTIVITY 44 RECYCLING AT SCHOOL

OBJECTIVE: TO HELP STUDENTS GAIN AN UNDERSTANDING OF RECYCLING AND ITS RELATION TO ENERGY CONSERVATION.

MULTIDISCIPLINARY

Students should develop a recycling program plan for the school and implement it, if possible. They should obtain literature on recycling programs developed at other schools and communities. Some questions that should be answered in the plan include:

1. What items (paper, glass, metal) should/can be recycled?
2. What amount (pounds) of the items are generated monthly at the school? At students' homes?
3. Can the school recycling program be part of a community-wide recycling program?
4. Who would sort and collect the items?
5. What dangers are involved in handling the items (e.g., broken glass or aluminum)?
6. What would be used for containers and where would collecting stations be located?
7. How often would items be picked up?
8. What price would the different items bring? Would the program be cost-effective?
9. If glass must be crushed, what safety precautions must be taken?
10. Would the school administration support be absolutely necessary?
11. How would items be transported from the collecting stations to the recycling center?
12. What would be done with revenues received from the recycling program?

CONTACT ORGANIZATIONS:

1. Your local or nearest recycling center (see telephone directory)
2. Solid Waste Management, Bureau of Environmental Health Services, Tennessee Department of Public Health, 344 Cordell Hull Building, Nashville, Tennessee 37219.
3. National Center for Resource Recovery, 1211 Connecticut Avenue, NW, Washington, D.C. 20036.
4. Chattanooga Glass Company, 400 West 45th Street, Chattanooga, Tennessee 37410.
5. National Can Corporation, 110 South Byhalia Road, Collierville, Tennessee 38017.
6. UT Recycling Project, Volunteer Boulevard, The University of Tennessee, Knoxville, Tennessee 37919.
7. American Can Company, 5185 East Raines Road, P.O. Box 18343, Memphis, Tennessee 38116.
8. National Association of Recycling Industries, 330 Madison Avenue, New York, New York 10017.
9. American Paper Institute, Inc.,Paper Stock Conservation Committee, 260 Madison Avenue, New York, New York 10016.
10. Aluminum Recycling Association, 200 L Street, NW, Suite 502, Washington, D.C. 20036.



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# ACTIVITY 45 TRANSPORTATION: CARPOOLING AT SCHOOL

OBJECTIVE: TO HELP STUDENTS UNDERSTAND THE SAVINGS WHICH CAN BE ACHIEVED BY CARPOOLING.

MULTIDISCIPLINARY

Using the following information, have students figure the costs of commuting to and from school:

| Car Size | Vehicle Cost Depreciated | Maintenance Accessories, Parts & Tires | Gas & Oil (Excluding Taxes) | Insurance | State and Federal Taxes | Total Cost (per mile) |
|---|---|---|---|---|---|---|
| Standard | 4.5¢ | 3.7¢ | 5.5¢ | 1.7¢ | 1.6¢ | = 17¢ |
| Intermediate | 4.2¢ | 3.4¢ | 5.3¢ | 1.6¢ | 1.5¢ | = 16¢ |
| Compact | 2.9¢ | 2.7¢ | 4.7¢ | 1.5¢ | 1.2¢ | = 13¢ |
| Subcompact | 2.3¢ | 2.5¢ | 3.8¢ | 1.5¢ | 0.9¢ | = 11¢ |

Adapted from U.S. Dept. of Transportation-Federal Highway Administration Statistics

*EXAMPLE - How to figure your present commuting cost (Standard car-Ford LTD) traveling 30 miles round trip*

1. MULTIPLY (.17) x (30) = $5.10
   Cost per mile / Miles per day
2. ADD Daily parking cost +0
3. TOTAL DAILY COST = $5.10
4. MULTIPLY DAILY COST By number of school days per month x 21
5. COST PER MONTH TO DRIVE ALONE = $107.10

*6. DIVIDE BY NUMBER OF PEOPLE IN CARPOOL ÷ 4

7. NEW INDIVIDUAL COST BY CARPOOLING =$26.77

8. MONTHLY CARPOOL SAVING ($107.10 -26.77 = $80.33

* IMPORTANT - For a successful carpool when the driver-owner does all the driving, fair share rates should be figured on paying riders only. The driver owner should ride free.

1. MULTIPLY _____ X _____ = $ _____
Cost per mile; Miles per day

2. ADD
Daily parking cost _____

3. TOTAL DAILY COST = _____

4. MULTIPLY DAILY COST
By number of school
days per month X _____

5. COST PER MONTH TO
DRIVE ALONE = _____

6. DIVIDE BY NUMBER OF
PEOPLE IN CARPOOL ÷ _____

7. NEW INDIVIDUAL COST
BY CARPOOLING = _____

8. MONTHLY CARPOOL SAVING (#5-#7) = _____

CONTACT ORGANIZATIONS:

1. Transportation Research Center, The University of Tennessee, South Stadium Hall, Knoxville, Tennessee 37916.
2. Tennessee Energy Office, Suite 250, Capitol Hill Building, 7th and Union, Nashville, Tennessee 37219.
3. U.S. Department of Transportation, 400 Seventh Street, SW, Washington, D.C. 20590.
4. Tennessee Department of Transportation, 817 Highway Building, Nashville, Tennessee 37219.



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ACTIVITY 46 TRANSPORTATION AND ENERGY

OBJECTIVE: TO HELP STUDENTS DEVELOP AN UNDERSTANDING OF ENERGY CONSUMPTION AND CONSERVATION IN THE TRANSPORTATION SECTOR.

MULTIDISCIPLINARY

It is said that Americans travel farther and faster than any other people in the world. Transportation (fuel manufacturing and maintenance, highways) accounts for about 42 percent of our total energy budget in the United States. There is great potential for saving energy in the transportation sector.

Have students conduct research and contact organizations to learn more about conserving energy through transportation. As a result of their research, they should prepare a plan for themselves and their families. In conducting research, students should consider the following points:

1. Methods of making vehicles more energy-efficient.
2. Methods of saving energy in manufacturing and maintaining vehicles.
3. Methods of saving energy in road construction and maintenance.
4. Driving habits which result in energy conservation (e.g., fewer rapid accelerations, less quick braking).
5. Kinds of energy conservation legislation to mandate or encourage energy conservation through transportation (e.g., 55 m.p.h. speed limit, right-turn-on-red-after-stop).
6. Requirement of pollution control devices.
7. Advantages/disadvantages of radial tires, ignition systems, streamlining designs, increasing passengers per vehicle, abandoning automatic transmissions.
8. Salvaging metals, etc., from junked vehicles.
9. Unnecessary trips or travel.
10. Ways to conserve energy while on vacation.
11. Growth, decline, advantages, and disadvantages of travel by walking, bicycle, automobile, bus, railroad, water, airplane.



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12. Alternatives to individual transportation: carpools, vanpools, mass transit.

CONTACT ORGANIZATIONS:

1. Energy Research and Development Administration, 20 Massachusetts Avenue, NW, Washington, D.C. 20545.

2. Environmental Protection Agency, 401 M Street, SW, Washington, D.C. 20460.

3. Federal Energy Administration, 12th and Pennsylvania Avenue, NW, Washington, D.C. 20461.

4. Tennessee Valley Authority, 400 Commerce Avenue, Knoxville, Tennessee 37902.

5. Department of Transportation, 400 Seventh Street, SW, Washington, D.C. 20590.

6. American Petroleum Institute, 1801 K Street, NW, Washington, D.C. 20006.

7. General Motors Corporation, General Motors Building, Room I-101. Detroit, Michigan 48202.

8. Transportation Research Center, South Stadium, The University of Tennessee, Knoxville, Tennessee 37916.

ACTIVITY 47 ENERGY-ENVIRONMENT OPINIONAIRE

OBJECTIVE: TO HELP ASSESS THE OPINIONS OF STUDENTS IN AREAS OF ENERGY AND ENVIRONMENT.

MULTIDISCIPLINARY

Have students react to the statements in the *ENERGY-ENVIRONMENT OPINIONAIRE* prepared for this activity. The opinionaire can be used with school administrators, teachers, and parents. An answer sheet and form for collecting information on the respondent is included.

CONTACT ORGANIZATIONS:

None

## *ENERGY-ENVIRONMENT OPINIONAIRE*

*Directions:* *Circle the letter on the answer sheet which corresponds to your opinion on the scale. Please do not write on the opinionaire.*

1. Nuclear breeder reactors should be developed because they would be cost-effective and safe.

2. Nuclear power plants should be placed underground.

3. The government should develop floating nuclear power plants at sea.

4. Automobiles should be banned from certain streets in the largest cities during certain times of day.

5. Global environmental standards must be established and followed if man is to survive.

6. Basic changes in lifestyles will be necessary in order to offset the energy crisis and environmental problems.

7. Electricity will probably never be cheaper than it is today.

8. Regional urban waste management systems should become a major responsibility of the federal government.

9. It will eventually be necessary to have gasoline rationing to conserve fuel.

10. There should be an additional charge on bottles, newspapers, and automobiles which would be refunded if and when the items were recycled.

11. Vehicles and household appliances should be designed to allow for nearly total reclamation.

12. The United States needs a cohesive land-use policy.

13. The United States needs a cohesive energy policy.

14. Additional taxes should be imposed on industries which do not clean up their air and water pollution.

15. Effective energy conservation programs will result in increased unit costs and slow down economic growth.

16. Zero population growth would result in an improved quality of life.

17. Population size must be limited.

18. The population must be redistributed.



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19. A real problem in establishing environmental standards lies in determining "how much" of any pollutant is "too much."

20. Citizens will eventually have to place more value on government controls if they are to live in a healthy environment.

21. Citizens have the responsibility of analyzing and lessening the magnitude and number of environmental problems.

22. A major concern of pollution control technologies in the United States is the degree to which the air, water, and land can assimilate poisons and wastes.

23. Most environmentalists are radicals and oppose economic growth and development.

24. Most environmentalists are staunch preservationists.

25. Ecological principles and systems apply to man in the same ways they apply to other animals.

26. Stability and diversity are important elements in an ecosystem.

27. Pollution control devices are essential for maintaining balanced ecosystems.

28. Any change man can bring to a natural system will be beneficial.

29. The average citizen doesn't realize the extent to which he/she is dependent upon the proper functioning of natural ecological systems for survival.

30. The National Environmental Policy Act (NEPA) is very valuable legislation.

31. Greater consumption of energy is currently rewarded by lower prices per unit.

32. Society really doesn't want to pay the cost of maintaining a quality environment.

33. It is currently more profitable to pollute in the United States than to apply pollution abatement technologies.

34. TVA is a leader in strip-mine reclamation.

35. The cost of controlling pollution must, in most instances, be passed on to the consumer.

36. Technology assessment refers to determining the full impact of a new technology, including secondary effects, before the technology is applied.



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37. The world population doubles about every 35 years.

38. Short-range and self-centered thinking linked with a lack of commitment and responsibility are primary factors of human behavior contributing to environmental degradation.

39. The only time there is an energy crisis is when demand exceeds supply.

40. There was no energy crisis; the whole problem was contrived by the oil companies.

41. Building codes should be modified to encourage energy conservation in homes and other buildings.

42. The public has the right to get all the electric power it wants whenever they want it.

43. It is neither reasonable nor economically desirable to limit the growth and use of energy in the United States.

44. Utilities must develop better methodologies for communicating effectively with the people they serve.

45. There should be no governmental limitations placed upon energy production.

46. It is extremely unlikely that there would be a disaster in the United States from a nuclear accident.

47. The quality of the environment is primarily a social issue, not an economic one.

48. Most people would buy a less expensive polluting detergent over a more expensive nonpolluting one, even if they knew the difference.

49. Environmentalism is just a fad and most people couldn't care less about it.

50. American society is destroying the quality of life by producing more and more goods.

51. Although used widely, the gross national product (GNP) is a misleading index for measuring the quality of life because it deals only with economic activity.

52. If the less developed nations of the world accepted our capitalistic economic system, there would be added negative impacts on the world's environment.

53. As cities increase in industrialization, pollution increases to the point where it is not assimilated effectively by the environment, thus endangering the health of the residents.

54. Stockholders of industry, the consumer, and the taxpayer have all benefited economically from the lack of environmental control by not being charged the full costs of products and their impact on the environment.

55. It is not known to what extent environmental degradation has affected the health and life span of people.

56. To date, government and industry have done very little to measure the value which society places on a quality environment.

57. It is extremely difficult to place a dollar value on recreation areas or the aesthetics of viewing a clean river.

58. Some government agencies and industries have tended to ignore the real environmental issues and blamed the "radical environmentalists."

59. Engineers and chemists make the best resource or environmental managers.

60. The government has made an excellent attempt to conserve energy.

61. Effective strip mine reclamation laws would increase the cost of coal and electricity.

62. An adequate energy supply is as important to society as food, clothing, and shelter.

63. Most citizens get involved in the energy-environment decision-making process very effectively through voting, participating in hearings, and writing letters to members of Congress, the Senate, and newspapers.

64. Effective energy conservation programs will help alleviate shortages, extend supplies of resources, and result in improvements to the environment.

65. It is possible to attain zero energy growth by the year 2000 and still have an adequate supply of energy.

66. TVA should not play a role in the development of energy-efficient appliances or machinery.

67. The government should not encourage the implementation of any new energy technologies until it is sure there would be no unacceptable consequences to society.

68. Locating power plants in rural or undeveloped areas would facilitate economic growth.

69. Some significant environmental problems will have to go unsolved in the short run to provide an adequate supply of energy to meet current demand.

70. The public wants to have a voice in the energy development decision-making process, but this should be left to the experts.

71. TVA is unresponsive to changing social needs and must be forced by public pressure to implement programs which improve the overall quality of life and environment.

72. Solar heating is not technologically feasible at this time and offers little potential for the future.

73. There is a great need for providing citizens with sound economic and environmental information so they can make personal decisions which save them money and preserve natural resources.

74. All electrical appliances should contain a label revealing the resources used in making them, their energy requirements, and expected operating costs.

75. If industries use more electricity, they should pay more and not be rewarded by cheaper rates for higher consumption.

ENERGY-ENVIRONMENT OPINIONAIRE

ANSWER SHEET

Name (optional)________________________________ Date______________

*A = Strongly agree*
*B = Mildly agree*
*C = Not Sure or Don't Know*
*D = Mildly disagree*
*E = Strongly disagree*

*Directions: Please circle the letter which best describes your opinion on each corresponding statement.*

1. A B C D E
2. A B C D E
3. A B C D E
4. A B C D E
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6. A B C D E
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68. A B C D E
69. A B C D E
70. A B C D E
71. A B C D E
72. A B C D E
73. A B C D E
74. A B C D E
75. A B C D E



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ENERGY-ENVIRONMENT OPINIONAIRE

INFORMATION ON RESPONDENT

DATE ______________________________

NAME ______________________________ ____URBAN ____RURAL

ORGANIZATION ______________________ SEX: ____M ____F

AGE: ______Under 18
______18-25
______26-35
______36-50
______51-65
______over 65

RACE: ______White
______Black
______Other

OCCUPATION: ______Student
______Teacher
______Other (explain) ______________________

CIRCLE HIGHEST GRADE LEVEL COMPLETED IN SCHOOL/COLLEGE:

6 7 8 9 10 11 12 13 14 15 16 17+

## ACTIVITY 48 ENERGY DISCUSSION TOPICS

OBJECTIVE: TO PROVIDE STUDENTS WITH "FOOD FOR THOUGHT" ABOUT ENERGY USE AND CONSERVATION.

MULTIDISCIPLINARY

The following statements and questions are designed for class discussion or written assignments. If used for class discussion, it may be advisable to give students the assignment at least three days in advance.

1. Have you or your family been able to stabilize or lower energy costs since 1973? If so, how?

2. What do the terms "cost-benefit analysis" and "cost-effectiveness" mean? What procedures do planners use in applying these processes to the development of energy resources or facilities?

3. Why has the federal government had difficulty in formulating an energy policy? Which agencies are involved in determining energy policy?

4. What kind of power plant (coal, oil, gas, nuclear) do you believe would be the most acceptable to your community? Which facilities would not be acceptable and why?

5. In your opinion, have the American people learned to think in terms of future energy needs? Do we still seem to think only of present needs and desires? If so, why? Support your answer with examples.

6. It is often said we are a "crisis-oriented" society and really don't consider a potential problem adequately until it is upon us. How have industries, governmental agencies, and individuals failed to adequately consider long-range planning? Give examples.

7. Is government regulation likely to increase because of the energy problem? In what areas? Explain.

8. Which countries--industrialized or non-industrialized--have suffered the most from the increased costs of energy? Explain.

9. What attitudinal changes are required for an adjustment from plentiful to limited supplies of critical commodities? How will these changes come about? Have you changed any of your attitudes in the last three years?

10. A cartoonist depicted one urbanite saying to a friend, "The way I see it, there's a price for everything. You want a high standard of living, you settle for a low quality of life . . ." What does "quality of life" mean to you? Does it mean the same thing to your friends? To your family? Can you have a high standard of living and a high quality of life, too? What are the trade-offs?

11. The true costs of coal often include black lung disease, ruined land, silted water, and air pollution. There are solutions to these problems, but they require money. Do you believe people are willing to incorporate these costs in their fuel bills to keep the environment clean? Explain.

12. Although expensive, it is possible to convert some heating systems to use other fuels (coal, oil, gas). For what purposes would one want to shift from one fossil fuel to another?

13. Some scientists maintain that petroleum is too precious to be utilized as a heating fuel. Rather, they advocate that it be used as raw material for products such as drugs, fertilizers, and plastics. What do you think about this position?

14. Many people have indicated that the Tennessee Valley Authority has contributed to the existing energy shortage by: (1) encouraging more use of electricity through the rate structure; (2) not supporting adequate research programs on alternate sources of energy (e.g., solar, refuse burning); (3) not reaching a substantial number of consumers with energy conservation options; (4) lack of effective long-range planning; and (5) failure to involve the people in its decision-making process. How could these areas be improved by TVA? How extensive is TVA's responsibility in each of these areas?

CONTACT ORGANIZATIONS:

Refer to *APPENDIX: SELECTED SOURCES OF ENERGY INFORMATION*



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## ACTIVITY 49 ENERGY EDUCATION/CONSERVATION EXAMINATION

OBJECTIVE: TO HELP MEASURE THE GENERAL AWARENESS LEVEL OF STUDENTS IN THE AREA OF ENERGY AND ITS CONSERVATION.

MULTIDISCIPLINARY

Have students answer the questions in the *ENERGY EDUCATION/CONSERVATION EXAMINATION* prepared for this activity. The examination can be given as a pre-test and administered later (after a study of energy) as a post-test. It could also be used with school administrators, teachers, or parents. An answer sheet form to be used for responses and a key for the answers are included.

CONTACT ORGANIZATIONS:

NONE

*ENERGY EDUCATION/CONSERVATION EXAMINATION*

*Directions: Please do not write on the examination. On the answer sheet provided, circle True (T) or False (F) as it pertains to each statement on the examination.*

1. Coal is the most widely used fuel in the U.S. for generating electricity.

2. "R-value" is a measure of the resistance to heat flow through a material.

3. At this time, the use of solar cooling for buildings, wind energy conversion, and electricity from photovoltaics (solar cells) is both technologically practical and economical.

4. The technology for converting fuels such as coal, oil, and uranium to electricity is firmly established.

5. The population of the United States doubles about every 46 years and the demand for electricity doubles about every 10 years.

6. The breeder reactor will probably be used widely in the late 1980's.

7. The light water reactors will be used widely, continuing beyond the time the breeder reactor becomes a commercial reality.

8. The eastern part of the U.S. has more coal with lower sulfur content than the western states.

9. Open refrigerators or freezers in supermarkets waste energy.

10. A fuel cell converts gas directly into electricity.

11. Widespread conversion of urban refuse into fuels could supply approximately 25 percent of our total annual energy consumption.

12. Pumped storage systems are a common means of storing large amounts of energy.

13. At this time, the use of solar heating and hot water systems is technically practical and economical.

14. Solar radiation is a source of non-polluting energy but cannot be described as "free" because of the expense required in capturing the sun's energy in one manner or another.

15. Effective energy conservation programs will give us the needed time to find and develop new reserves and technologies to meet our growing energy needs.

16. It is not technically possible today to collect energy in space and transmit it to earth by microwave.

17. A significant portion of the total weight of organic waste is water, which cannot be used to produce energy.

18. The most efficient method of extracting energy from tides is to use dams and sluice gates across bays or estuaries where tidal head can be used to run hydraulic turbines.

19. The first step toward reducing energy demand is to identify and eliminate areas where energy is being wasted.

20. Charts of average wind velocities for the entire United States are now available for use in determining optimum locations for wind turbine generators.

21. The problem with using wind to supply our energy needs is that it is unpredictable and unsteady.

22. The main reason we have wasted so much energy in the past has been because the price has been low.

23. There are very few problems associated with the development of geothermal energy.

24. The largest coal reserves in the western U.S. are found in Idaho.

25. If all coal from reserves in the U.S. were mined and made available, there would be enough to last us for several hundred years if used at the present rate of consumption.

26. The cost of transporting coal can often equal the cost of mining.

27. The costs of reclaiming strip-mined areas and installing pollution abatement equipment must be passed on to the consumer.

28. Oil is the cleanest burning of the fossil fuels and is, therefore, in great demand.

29. The Federal Power Commission regulates the transport and sale of natural gas in interstate commerce.

30. The most significant variable affecting fuel consumption in an automobile is its weight.

31. Urban refuse has approximately twice the heating va[illegible] of coal.

32. Radial tires permit up to six percent better gas mileage than standard tires.

33. Fusion energy will probably not be available until about the year 2000, if at all.

34. Glass and metals make up about 33 percent of urban refuse.

35. Nuclear fission is caused by the splitting of a nucleus of an atom into two approximately equal fragments whose combined mass is less than the original nucleus.

36. The fission energy from one ounce of uranium fuel pellets is equivalent to the chemical energy of 100 tons of coal.

37. Uranium-238 can be used to produce energy when transformed into plutonium through neutron bombardment.

38. When spent fuel elements are removed from a power reactor, they are no longer radioactive.

39. If a reservoir has little or no storage capacity, it has limited value for producing energy.

40. The "Price-Anderson Act" provides for the insuring and indemnifying of nuclear power plants.

41. Siting and licensing requirements for all reactors are governed by the regulations set forth by the Federal Energy Administration (FEA).

42. A breeder reactor makes it possible to utilize up to 60 percent of the heat energy content of uranium ore, while water-cooled reactors utilize approximately one or two percent.

43. The breeder reactor could greatly extend the length of time present uranium reserves would last.

44. The potential value of fusion power lies in the virtually inexhaustible supply of inexpensive fuel which can be extracted from water.

45. The most favorable sites for large solar power installations appear to be in the southwest.

46. Some scientists believe the earth's atmosphere is increasing in temperature due to an increasing level of carbon dioxide from pollution.

47. Fluorescent lights are less efficient than incandescent.

48. Frost-free refrigerators and/or freezers use 50 percent more energy than manual units.

49. A house without ceiling or wall insulation will cost at least twice as much to heat as one properly insulated.

50. The south side of a building gets more sun than the north side.

51. Good insulation in houses is only important in the winter.

52. The best location for the thermostat is on the coldest wall.

53. The energy used to drive a car initially came from the sun via green plants.

54. A solid state color TV set consumes about 33 percent more energy than a black and white solid state set.

55. An insulation material having an R-value of 10 is better than one having an R-value of 18.

56. Fully insulating a home can cut the electric bill by about 50 percent.

57. The heat lost through the house is primarily through the ceiling.

58. Covering a window or wall air conditioner in the winter does not help conserve energy.

59. Operating fuel heaters in an airtight room could lead to the consumption of all the oxygen in the air and could cause suffocation.

60. Lowering the thermostat from $72^0$ to $68^0$ and leaving it there during winter months can result in a 20 percent reduction in your heating bill.

61. Setting back the thermostat at night can result in significant savings of energy and money.

62. It is best to use the central heating system and the fireplace at the same time.

63. An air conditioner cools and removes moisture from the air.

64. With more efficient production techniques in industry, over 30 percent of energy used now could be saved.

65. In the Tennessee Valley region, the water heater accounts for about 50 percent of the electric bill.

66. The United States has only about six percent of the world's population, but over 45 percent of the world's cars.

67. In the United States we now consume roughly 17 to 18 million barrels of oil a day, and at a five percent rate of increase, this is almost a million barrels a day additional requirement per year.

68. Large quantities of low sulfur coal can still be mined at a reasonable cost without the associated risks of deep mining.

69. Five years lead time is required to get a nuclear plant operating in the United States.

70. High-compression engines develop more power and are more efficient than low-compression engines, but they have a greater tendency to knock and consequently require gasolines of higher octane.

71. The anti-knock quality of a gasoline is usually expressed in terms of octane.

72. The lower the air or engine temperature, the greater the octane requirement.

73. The use of lead components has been the most economical way to increase the octane of gasoline.

74. Octane is the sole criterion of a quality gasoline.

75. Natural gas reserves are rapidly declining in the United States.

76. The liquid metal fast breeder reactor uses sodium as the reactor coolant and uranium-238 as the fertile material which is converted to plutonium as the reactor is operated.

77. A one-inch cube of uranium contains enough energy to supply a six-room house with electricity and heat for 1,000 years.

78. The breeder reactor would consume more fuel than it produces.

79. Thermal discharges can greatly affect life cycles of aquatic organisms.

80. The EPA regulates the amount of radiation permitted to be discharged from a nuclear reactor.

81. To date, in the United States, there has been no radioactive release from commercial nuclear reactors which has exceeded recommended population exposure guides.

82. Nuclear reactor vessels are enclosed in huge concrete and metal containers which, along with many automatic safety features, are designed to prevent leakage of radiation.

83. Higher fuel prices have been the primary reason for energy conservation to date.

84. Serious accidents have occurred in past shipment and storage of radioactive waste.

85. Hearings are held for license application in an area where a nuclear plant is proposed and the public, along with state and local authorities, can attend and testify.



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86. The electric range uses less electricity than the clothes dryer, window air conditioner and dishwasher combined.

87. Studies have shown that the average bath requires 10 gallons of water, whereas the average shower requires about twice that much.

88. Solar energy is responsible for producing fossil fuels.

89. A British thermal unit (Btu) is the amount of heat required to raise the temperature of a pound of water 1°F.

90. The Tennessee Public Service Commission sets electric rates for TVA and its local power distributors.

91. Radioactive wastes have been safely disposed of in salt beds.

92. The Middle East countries possess about 80 percent of the world's oil reserves.

93. The U.S. was self-sufficient in energy until about 1950, but since then has deteriorated.

94. Mercury vapor lamps are more efficient and produce more light with less energy than incandescent street lights.

95. Ceiling insulation should be at least six to ten inches thick.

96. Almost 20 percent of all the energy consumed in the U.S. is used in our households.

97. A 40-watt fluorescent tube provides more light than three 60-watt incandescent bulbs.

98. Automobiles consume about 14 percent of all the energy used in the U.S.

99. The amount of material needed to do a good insulating job in your home depends on the type of material used.

100. The U.S. uses more energy per capita than any other nation in the world.

*ENERGY EDUCATION/CONSERVATION EXAMINATION*

Answer Sheet

Name (optional)__________________________________Date____________________

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | T | F | 21. | T | F | 41. | T | F | 61. | T | F | 81. | T | F |
| 2. | T | F | 22. | T | F | 42. | T | F | 62. | T | F | 82. | T | F |
| 3. | T | F | 23. | T | F | 43. | T | F | 63. | T | F | 83. | T | F |
| 4. | T | F | 24. | T | F | 44. | T | F | 64. | T | F | 84. | T | F |
| 5. | T | F | 25. | T | F | 45. | T | F | 65. | T | F | 85. | T | F |
| 6. | T | F | 26. | T | F | 46. | T | F | 66. | T | F | 86. | T | F |
| 7. | T | F | 27. | T | F | 47. | T | F | 67. | T | F | 87. | T | F |
| 8. | T | F | 28. | T | F | 48. | T | F | 68. | T | F | 88. | T | F |
| 9. | T | F | 29. | T | F | 49. | T | F | 69. | T | F | 89. | T | F |
| 10. | T | F | 30. | T | F | 50. | T | F | 70. | T | F | 90. | T | F |
| 11. | T | F | 31. | T | F | 51. | T | F | 71. | T | F | 91. | T | F |
| 12. | T | F | 32. | T | F | 52. | T | F | 72. | T | F | 92. | T | F |
| 13. | T | F | 33. | T | F | 53. | T | F | 73. | T | F | 93. | T | F |
| 14. | T | F | 34. | T | F | 54. | T | F | 74. | T | F | 94. | T | F |
| 15. | T | F | 35. | T | F | 55. | T | F | 75. | T | F | 95. | T | F |
| 16. | T | F | 36. | T | F | 56. | T | F | 76. | T | F | 96. | T | F |
| 17. | T | F | 37. | T | F | 57. | T | F | 77. | T | F | 97. | T | F |
| 18. | T | F | 38. | T | F | 58. | T | F | 78. | T | F | 98. | T | F |
| 19. | T | F | 39. | T | F | 59. | T | F | 79. | T | F | 99. | T | F |
| 20. | T | F | 40. | T | F | 60. | T | F | 80 | T | F | 100. | T | F |

*ENERGY EDUCATION/CONSERVATION EXAMINATION*

ANSWER KEY

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | T | 21. | T | 41. | F | 61. | T | 81. | T |
| 2. | T | 22. | T | 42. | T | 62. | F | 82. | T |
| 3. | F | 23. | F | 43. | T | 63. | T | 83. | F |
| 4. | T | 24. | F | 44. | T | 64. | T | 84. | F |
| 5. | T | 25. | T | 45. | T | 65. | F | 85. | T |
| 6. | F | 26. | T | 46. | T | 66. | T | 86. | F |
| 7. | T | 27. | T | 47. | F | 67. | T | 87. | F |
| 8. | F | 28. | F | 48. | T | 68. | T | 88. | T |
| 9. | T | 29. | T | 49. | T | 69. | F | 89. | T |
| 10. | F | 30. | T | 50. | T | 70. | T | 90. | F |
| 11. | F | 31. | F | 51. | F | 71. | T | 91. | T |
| 12. | T | 32. | T | 52. | F | 72. | F | 92. | F |
| 13. | T | 33. | T | 53. | T | 73. | T | 93. | T |
| 14. | T | 34. | F | 54. | T | 74. | F | 94. | T |
| 15. | T | 35. | T | 55. | F | 75. | T | 95. | T |
| 16. | F | 36. | T | 56. | T | 76. | T | 96. | T |
| 17. | T | 37. | T | 57. | T | 77. | T | 97. | T |
| 18. | T | 38. | F | 58. | F | 78. | F | 98. | T |
| 19. | T | 39. | T | 59. | T | 79. | T | 99. | T |
| 20. | T | 40. | T | 60. | T | 80. | F | 100. | T |

*ENERGY EDUCATION/CONSERVATION EXAMINATION*

PERSONAL INFORMATION

DATE:________________

NAME (Optional):______________________ ___URBAN ___RURAL

ORGANIZATIONS:________________________ SEX: ____M ____F

AGE: ____Under 18

____19-25

____26-35

____36-50

____51-65

____over 65

RACE: ____White

____Black

____Other

OCCUPATION: ___Student

___Teacher

___Other

CIRCLE HIGHEST GRADE LEVEL COMPLETED IN SCHOOL/COLLEGE:

0-6 7 8 9 10 11 12 13 14 15 16 17+

# APPENDICES

## SOURCES OF ADDITIONAL INFORMATION

Agriculture, U.S. Department of (U.S.D.A.), Washington, D.C. 20250.

Air-Conditioning and Refrigeration Institute, 1915 N. Ft. Myer Drive, Arlington, Virginia 22209.

Aluminum Recycling Association, 200 L Street NW, Suite 502, Washington, D.C. 20036.

Alyeska Pipeline Service Company, 1815 South Bragaw Street, Anchorage, Alaska 99504.

American Association for the Advancement of Science (AAAS), 1515 Massachusetts Avenue, NW, Washington, D.C. 20036.

American Association of Petroleum Geologists, Box 979, Tulsa, Oklahoma 74101.

American Automobile Association (AAA), 8111 Gatehouse Road, Falls Church, Virginia 20042.

American Can Company, 5185 East Raines Road, P.O. Box 18348, Memphis, Tennessee 38118

American Chemical Society, 1155 Sixteenth Street, NW, Washington, D.C. 20036.

American Coke and Coal Chemicals Institute, 1010 Sixteenth Street, NW, Washington, D.C. 20036.

American Enterprise Institute, National Energy Project, 1150 Seventeenth Street, NW, Was ton, D.C. 20036.

American Federation of ineralogical Societies, 4139 South Van Ness Street, Los Angeles, California 90062.

American Gas Association, 1515 Wilson Boulevard, Arlington, Virginia 22209.

American Geological Institute, 2201 M Street, NW, Washington, D.C. 20037.

American Home Economics Association (AHEA), 2010 Massachusetts Avenue, NW, Washington, D.C. 20036.

American Institute of Architects, 1735 New York Avenue, NW, Washington, D.C. 20006.

American Institute of Chemical Engineers, 345 East 47th Street, New York, New York 10017.

American Nuclear Society, 244 E. Ogden Avenue, Hinsdale, Illinois 60521.

American Oil Chemists Society, 508 South 6th Street, Champaign, Illinois 61820.

American Paper Institute, Inc., Paper Stock Conservation Committee, 260 Madison Avenue, New York, New York 10016.

American Petroleum Institute, 1801 K Street, NW, Washington, D.C. 20006.

American Petroleum Refiners Association, 1110 Ring Building, 1200 Eighteenth Street, NW, Washington, D.C. 20036.

American Public Gas Association, 2600 Virginia Avenue, NW, Washington, D.C. 20037.

American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc., 345 E. 47th Street, New York, New York 10017.

American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19102.

Area Mass Transit (Bureau of), Tennessee Department of Transportation, 817 Highway Building, Nashville, Tennessee 37219.

The Asphalt Institute, The Asphalt Institute Building, College Park, Maryland 20740.

Association of House Appliance Manufacturers (AHAM), 20 North Wacker Drive, Chicago, Illinois 60606.

Association of Oil Pipelines, 1725 K Street, NW, Suite 1208, Washington, D.C. 20006.

Association of Oilwell Servicing Contractors, 1700 Davis Building, Dallas, Texas 75202.

Association of Petroleum Refiners, Box 7116, Arlington, Virginia 22207.

Atomic Industrial Forum, Inc., 475 Park Avenue South, New York, New York 10016.

Better Heating-Cooling Council, 35 Russo Place, Berkeley Heights, New Jersey 07922.

Bureau of Mines (BOM), U.S. Department of the Interior, 18th and C Streets, NW, Washington, D.C. 20240.

Center for Energy Information, 340 East 51st Street, New York, New York 10022.

Center for Environmental Education, 1621 Connecticut Avenue, NW, Washington, D.C. 20009.

Chase Manhattan Bank, Energy Economics Division, One Chase Manhattan Plaza, New York, New York 10015.

Chattanooga Glass Company, 400 West 45th Street, Chattanooga, Tennessee 37410.

Chemical Specialities Manufacturers Association, Suite 1120, 1101 Connecticut Avenue, NW, Washington, D.C. 20036.

Citizens' Advisory Committee on Environmental Quality, 1700 Pennsylvania Avenue, NW, Washington, D.C. 20006.

Clinch River Breeder Reactor Plant Project, P.O. Box U, Oak Ridge, Tennessee 37830.

Coal Mining Institute of America, 416 Ash Street, California, Pennsylvania 15419.

Coast Guard, 400 Seventh Street, SW, Washington, D.C. 20590.

Colony Development Operation, Suite 1500, Security Life Building, 1616 Glenarm Place, Denver, Colorado 80202.

Commerce (U.S. Department of),15th & E Streets, NW, Washington, D.C. 20230.

Concern, Inc., 2233 Wisconsin Avenue, Washington, D.C. 20007.

Conservation Foundation, 1250 Connecticut Avenue, NW, Washington, D.C. 20036.

Conservation (Tennessee Department of), 2611 West End Avenue, Nashville, Tennessee 37203.

Consumer Federation of America, Energy Policy Task Force, 1012 Fourteenth Street, NW, Suite 901, Washington, D.C. 20005.

Council on Environmental Quality (CEQ), 721 Jackson Place, NW, Washington, D.C. 20006.

Cooling Tower Institute, 3003 Yale Street, Houston, Texas 77018.

Division for Industrial Development, Andrew Jackson State Office Building, Room 1222, Nashville, Tennessee 37219.

East Tennessee Energy Group, 1538 Highland Avenue, Knoxville, Tennessee 37916.

East Tennessee Research Corporation, Jacksboro, Tennessee 37757.

Edison Electric Institute, 90 Park Avenue, New York, New York 10016.

Education (Tennessee State Department of), Cordell Hull Building, Nashville, Tennessee 37219.

Educational Facilities Laboratories, Inc., 850 Third Avenue, New York, New York 10022.

Electric Energy Association, 90 Park Avenue, New York, New York 10016.

Electric Power Research Institute (EPRI), 3412 Hillview Avenue, P.O. Box 10412, Palo Alto, California 94309.

Electrical Apparatus Service Association, Inc., 7710 Carondelet Avenue, St. Louis, Missouri 63105.

Electrical Industries Association, 6055 East Washington Boulevard, Los Angeles, California 90040.

Energy and Man's Environment, 0224 SW Hamilton, Suite 301, Portland, Oregon 97201.

Energy Opportunities Consortium, c/o Chamber of Commerce, 301 Church Avenue, SE, Knoxville, Tennessee 37901.

Energy Research and Development Administration (ERDA), 20 Massachusetts Avenue, NW, Washington, D.C. 20545.

Energy Research Corporation, 6 East Valerio Street, Santa Barbara, California 93101.

Environmental Action Foundation, Inc., DuPont Circle Building, Room 720, Washington, D.C. 20036.

Environmental Policy Center, 317 Pennsylvania Avenue, SE, Washington, D.C. 20003.

Environmental Protection Agency, 401 M Street, SW, Washington, D.C. 20460.

Exxon Corporation, 1251 Avenue of the Americas, New York, New York 10020.

Federal Energy Administration (FEA), 12th and Pennsylvania Avenue, NW, Washington, D.C. 20461.

Federal Power Commission (FPC), 825 North Capitol Street, NE, Washington, D.C. 20426.

The Fertilizer Institute, 1015 Eighteenth Street, NW, Washington, D.C.20036.

First National City Bank, Petroleum Dept., 399 Park Ave., New York,NY 10022.

The Ford Foundation, Energy Policy Project, P.O. Box 23212, Washington, D.C. 20024.

Gas Appliance Manufacturers Association, 1901 North Fort Meyer Drive, Arlington, Virginia 22209.

General Electric Company, P.O. Box 500, New Concord, Ohio 43762.

General Motors Corporation, Public Relations Staff, General Motors Building, Room I-101, Detroit, Michigan 48202.

Geological Survey, U.S. Department of the Interior, 12201 Sunrise Valley Drive, Reston, Virginia 22092.

Gulf Oil Corporation, Gulf Building, Pittsburgh, Pennsylvania 15230.

Health, Education and Welfare, U.S. Department of (HEW), Office of Consumer Affairs, North Building, Washington, D.C. 20201.

Home Economics Education Association, 1201 Sixteenth Street, NW, Washington, D.C. 20036.

Illuminating Engineering Society, 345 E. 47th Street, New York, New York 10017.

Independent Petroleum Association of America, 1101 Sixteenth Street, NW, Washington, D.C. 20036.

Independent Refiners Association of America, 1801 K Street, NW, Suite 1101, Washington, D.C. 20006.

International Association of Drilling Contractors, 7400 Harwin Drive, Houston, Texas 77036.

International Solar Energy Society, 12441 Parkline Drive, Rockville, Maryland 20852.

Interstate Natural Gas Association of America, 1660 L Street, NW, Suite 601, Washington, D.C. 20036.

Interstate Oil Compact Commission, 900 NE 23rd Street, Oklahoma City, Oklahoma 73105.

League of Women Voters of the United States, 1730 M Street, NW, Washington, D.C. 20036.

Manufacturing Chemists Association, 1825 Connecticut Avenue, NW, Washington, D.C. 20009.

Mayor's Energy Conservation Committee, c/o Environmental Planning and Management Project, Metropolitan Government of Nashville and Davidson County, Stahlman Building, Suite 615, Nashville, Tennessee 37201

Mineralogical Society of America, 1707 L Street, NW, Washington, D.C. 20036.

Mobil Oil Corporation, 150 East 42nd Street, New York, New York 10017.

Motor Vehicle Manufacturers Association, 320 New Center Building, Detroit, Michigan 48202.

National Association of Electric Companies, 1140 Connecticut Avenue, NW, Washington, D.C. 20036.

National Association of Recycling Industries, 330 Madison Avenue, New York, New York 10017.

National Audubon Society, Educational Services Department, 950 Third Avenue, New York, New York 10022.

National Bureau of Standards, Gaithersburg, Maryland 20230.

National Can Corporation, 110 South Byhalia Road, Collierville, Tennessee 38017.

National Center for Resource Recovery (NCRR), 1211 Connecticut Avenue, NW, Washington, D.C. 20036.

National Coal Association, 1130 Seventeenth Street, N.W., Washington, D.C. 20036.

National Congress of Petroleum Retailers, 2945 Banksville Road, Pittsburgh, Pennsylvania 15216.

National Education Association (NEA), 1201 Sixteenth Street, NW, Washington, D.C. 20036.

National Energy Resources Organization, 821-15th Street, NW, Suite 636, Washington, D.C. 20005.

National Insulation Contractors Association, 8630 Fenton Street, Suite 506, Silver Spring, Maryland 20910.

National Intervenors, 153 E Street, SE, Washington, D.C. 20003.

National LP-Gas Association, 1800 North Kent Street, Arlington, Virginia 22209.

National Lubricating Grease Institute, 4625 Wyandotte Street, Kansas City, Missouri 64112.

National Mineral Wool Insulation Association, Inc., 211 E. 51st Street, New York, New York 10022.

National Ocean Industries Association, 1100 Seventeenth Street, NW, Suite 410, Washington, D.C. 20036.

National Oil Jobbers Council, 1750 New York Avenue, NW, Suite 230, Washington, D.C. 20006.

National Petroleum Council, 1625 K Street, NW, Washington, D.C. 20006.

National Petroleum Refiners Association, 1725 DeSales Street, NW, Suite 802, Washington, D.C. 20036.

National Science Teachers Association (NSTA), 1742 Connecticut Avenue, NW, Washington, D.C. 20009.

National Wildlife Federation, 1412 16th Street, NW, Washington, D.C. 20036.

Natural Gas Processors Association, 1812 First Place, 15 East 5th Street, Tulsa, Oklahoma 74103.

Natural Gas Supply Committee, 1025 Connecticut Avenue, NW, Washington, D.C. 20036.

Nuclear Regulatory Commission, Washington, D.C. 20555.

Oak Ridge Associated Universities, Box 117, Oak Ridge, Tennessee 37830.

Oak Ridge National Laboratory (ORNL), P.O. Box X, Oak Ridge, Tennessee 37830.

Office of Management and Budget (OMB), Energy and Science Division, Executive Building, Washington, D.C. 20503.

Office of Population Affairs, Department of Health, Education, and Welfare, 330 Independence Avenue, SW, Washington, D.C. 20201.

Oil and Gas International Year Book, 10 Bolt Court, Fleet Street, London EC4A 3HL, England.

Owens-Corning Fiberglas Corporation,Fiberglas Tower, Toledo, Ohio 43659.

Petrochemical Energy Group, 1701 Pennsylvania Avenue, NW, Suite 335, Washington, D.C. 20006.

Petroleum Equipment Institute, 1579 East 21st Street, Tulsa, Oklahoma 74117.

Petroleum Equipment Suppliers Association, 1703 First City National Bank Building, Houston, Texas 77002.

Petroleum Industry Electrical Association, 4302 Airport Boulevard, Austin, Texas 78722.

Petroleum Industry Research Foundation, 122 East 42nd Street, New York, New York 10017.

Phillips Petroleum Company, 4A4 Phillips Building, Bartlesville, Oklahoma 74003.

Platt's Oilgram, 1221 Avenue of the Americas, New York, New York 10020.

The Population Institute, 110 Maryland Avenue, NW, Washington, D.C 20002.

The Population Reference Bureau, 1754 N Street, NW, Washington, D.C. 20036.

Public Health (Tennessee Department of), 344 Cordell Hull Building, Nashville, Tennessee 37219.

Publications Officer (name of Committee), U.S. Senate, Washington, D.C. 20510.

Publications Officer (name of Committee), U.S. House of Representatives, Washington, D.C. 20515.

Resources for the Future, Inc.(RfF), 1755 Massachusetts Avenue, NW, Washington, D.C. 20036.

Rural Electrification Administration (REA), Department of Agriculture, Room 4053-S, Washington, D.C. 20250.

Safety (Tennessee Department of), Andrew Jackson State Office building, Nashville, Tennessee 37219.

Scientists' Institute for Public Information, 49 East 53rd Street, New York, New York 10022.

Shell Oil Company, P.O. Box 2463, Houston, Texas 77001.

Sierra Club, 1050 Mills Tower, 220 Bush Street, San Francisco, California 94104.

Society of Automotive Engineers, 2 Penn Plaza, New York, New York 10001.

Society of Exploration Geophysicists, P.O. Box 3098, Tulsa, Oklahoma 74101.

Society of Independent Gasoline Marketers of America, 230 South Bemiston, Suite 909, St Louis, Missouri 63105.

Society of Petroleum Engineers of AIME, 6200 North Central Expressway, Dallas, Texas 75206.

Society of Plastics Industry, 250 Park Avenue, New York, New York 10017.

Solar Energy Industries Association, 1001 Connecticut Avenue, NW, Suite 632, Washington, D.C. 20036.

Solar Energy Society of America, P.O. Box 4264, Torrance, California 90510.

Standard Oil of California, 225 Bush Street, San Francisco, California 94120.

Standard Oil of Indiana, Mail Code 3705, 200 East Randolph, Chicago, Illinois 60601.

State Building Materials Association, 2700 Franklin Road, Nashville, Tennessee 37204.

Synthetic Organic Chemical Manufacturers Association, 1075 Central Park Avenue, Scarsdale, New York 10583.

Tennessee Citizens for Wilderness Planning, 130 Tabor Road, Oak Ridge, Tennessee 37830.

Tennessee Conservation League, 17[illegible]0 West End Avenue, Suite 600, Nashville, Tennessee 37203.

Tennessee Energy Office (TEO), Suite 250, Capitol Hill Building, 7th and Union, Nashville, Tennessee 37219.

Tennessee Environ[illegible] Council (TEC), P.O. Box 1422, Nashville, Tennessee 37202.

Tennessee Friends of the Earth, Box 124[illegible]9, Nashville, Tennessee 37212.

Tennessee Municipal Electric Power Association, P.O. Box 611, Brentwood, Tennessee 37207.

Tennessee Public Service Commission, Cordell Hull Building, Nashville, Tennessee 37219.

Tennessee Sierra Club, P.O. Box 2721, Nashville, Tennessee 37219.

Tennessee State Planning Office, Capitol Hill Building, Nashville, Tennessee 37219.

Tennessee Valley Authority (TVA), 400 Commerce Avenue, Knoxville, Tennessee 37902.

Tennessee Valley Public Power Association, 325 Pioneer Bank Building, Nashville, Tennessee 37402.

Tennessee Wildlife Resources Agency, Ellington Agricultural Center, P.O. Box 40747, Nashville, Tennessee 37204.

Tennessee Beautiful, Inc., P.O. Box 12429, 2020 21st Avenue, S., Nashville, Tennessee 37212.

Texaco, Inc., 1[illegible] East 42nd Street, New York, New York 10017.

Thermal Insulation Manufacturers Association, Inc., 7 Kirby Plaza, Mt. Kisco, New York 105[illegible].

Thomas Alva Edison Foundation, Inc., [illegible]ridge Office Plaza, Suite 143, 1828 North Ten Mile Pike, Southfield, Michigan 48075.

Transportation, U.S. Department of (DOT), 400 Seventh Street, SW, Washington, D.C. 20590.

United States Jaycees, Box 7, Tulsa, Oklahoma 74101.

University of Tennessee Agricultural Extension Service, P. O. Box 1071, Knoxville, Tennessee 37901.

University of Tennessee Environment Center, South Stadium Hall, Knoxville, Tennessee 37916.

University of Tennessee Recycling Project, 2300 Volunteer Boulevard, Knoxville, Tennessee 37916.

University of Tennessee School Planning Laboratory, 19 Claxton Education Building, Knoxville, Tennessee 37916.

University of Tennessee Transportation Center, South Stadium Hall, Knoxville, Tennessee 37916.

U.S. Army Corps of Engineers. Department of The Army, P.O. Box 1070, Nashville, Tennessee 37202.

U.S. Corps of Engineers, Department of the Army, James Forrestal Building, Washington, D.C. 20314.

Wind Energy Society of America, 1700 E. Walnut Street, Pasadena, California 91106.

World Oil, Gulf Publishing Company, P.O. Box 2608, Houston, Texas 77001.

Worldwatch Institute, 1776 Massachusetts Avenue, NW, Washington, D.C. 20036.

Zero Population Growth, 1346 Connecticut Avenue, NW, Washington, D.C. 20036.

## ENERGY CONVERSION TABLE : Btu's

| To Convert From | To Btu's | Multiply by |
|---|---|---|
| kwh | | 3,400 |
| hph (horsepower hour) | | 2,544 |
| 1 lb. bituminous coal | | 13,100 |
| 1 ton bituminous coal | | 26,200,000 |
| 1 ton coke | | 24,800,000 |
| 1 bbl crude oil | | 5,800,000 |
| 1 bbl residual oil #5 | | 6,287,400 |
| 1 bbl distillate fuel oil | | 5,825,400 |
| 1 bbl gasoline (motor fuel) | | 5,218,080 |
| 1 gal gasoline (motor fuel) | | 124,240 |
| 1 bbl gasoline (aviation) | | 5,048,400 |
| 1 gal gasoline (aviation) | | 120,200 |
| 1 cubic foot natural gas | | 1,032 |
| 1 cubic foot manufactured gas | | 540 |
| 1 therm natural gas | | 100,000 |
| 1 bbl tar and pitch | | 6,720,000 |
| 1 bbl kerosene | | 5,670,000 |
| 1 cord wood (128 cubic feet) | | 20,960,000 |
| 1 K cal | | 0.25 |

bbl = billion barrels

## ENERGY CONVERSION TABLE: HEATING CONTENT

| | | |
|---|---|---|
| One short ton of bituminous coal is equivalent in heating content to: | 7,680.0 | kwh's |
| | 10,297.0 | hp-hours |
| | 2,000.0 | lbs of bituminous coal |
| | 1.5 | tons of coke |
| | 4.5 | bbl of crude oil |
| | 4.2 | bbl of residual fuel oil |
| | 4.5 | bbl of distillate fuel oil |
| | 5.0 | bbl of gasoline (motor fuel) |
| | 211.0 | gal of gasoline (motor fuel) |
| | 5.2 | bbl of gasoline (aviation fuel) |
| | 218.0 | gal of gasoline (aviation fuel) |
| | 25,000.0 | cubic feet of natural gas |
| | 48,519.0 | cubic feet of manufactured gas |
| | 262.0 | therms of natural gas |
| | 3.9 | bbl of tar and pitch |
| | 4.6 | bbl of kerosene |
| | 1.3 | cords (128 cubic feet) of wood |
| 1,000 cubic feet of natural gas is equivalent in heating value to: | 0.04 | tons of coal (80 lbs.) |
| | 8.44 | gal of gasoline |
| | 0.18 | bbl of crude oil |
| | 7.56 | gal of crude oil |
| One gallon of gasoline is equivalent in heating value to: | 0.0047 | tons of coal (9.4 lbs.) |
| | 118.0 | cubic feet of natural gas |
| | 0.0214 | bbl of crude oil (0.9 gal) |
| One barrel of crude oil is equivalent in heating value to: | 0.22 | tons of coal (440 lbs.) |
| | 5,535.0 | cubic feet of natural gas |
| | 46.7 | gal. of gasoline (motor fuel) |
| One cubic foot of coal is equivalent in heating value to: | | approximately 3 cubic feet of wood |

ENERGY CONVERSION TABLE: Kcal's

| To Convert From | To Kcal's | Multiply by |
|---|---|---|
| Kilowatt-hour | | 853 |
| Horsepower-hour | | 636 |
| 1 lb bituminous coal | | 3,250 |
| 1 ton bituminous coal | | 6,550,000 |
| 1 ton coke | | 6,200,000 |
| 1 bbl crude oil | | 1,450,000 |
| 1 bbl residual oil #5 | | 1,571,850 |
| 1 bbl distillate fuel oil | | 1,456,350 |
| 1 bbl gasoline motor fuel | | 1,304,520 |
| 1 gal gasoline motor fuel | | 31,060 |
| 1 bbl gasoline (aviation) | | 1,262,100 |
| 1 gal gasoline (aviation) | | 30,050 |
| 1 cubic foot natural gas | | 258 |
| 1 cubic foot manufactured gas | | 135 |
| 1 therm natural gas | | 25,000 |
| 1 bbl tar and pitch | | 1,680,000 |
| 1 bbl kerosene | | 1,417,500 |
| 1 cord wood | | 5,240,000 |

# R-VALUES, U-VALUES, AND HEAT LOSS

The "R-value" is a measure of the resistance of a material to heat flow. The higher the R-value, the less heat will flow. Here are some R-values commonly used building and insulation materials:

| | |
|---|---|
| 1/2-inch gypsumboard . . . . . . . . . . . . . | 0.45 R-value |
| 1/2-inch plywood . . . . . . . . . . . . . . | 0.62 |
| common brick, per inch thickness . . . . . . | 0.20 |
| 1/2-inch insulated board sheathing . . . . . | 1.32 |
| linoleum, vinyl, or rubber floor tile . . . . . . . . . . . . . . . . . . . | 0.05 |
| carpet and fibrous pad . . . . . . . . . . . | 2.08 |
| carpet and foam rubber pad . . . . . . . . . | 1.23 |
| 3/8-inch built-up roof . . . . . . . . . . . | 0.33 |
| 1-4 inches of air space . . . . . . . . . . | 1.00 |
| 2 to 2-1/2 inches insulation . . . . . . . . | 7.00 |
| 3 to 4 inches insulation . . . . . . . . . . | 11.00 |
| 5 to 7 inches insulation . . . . . . . . . . | 19.00 |

The net insulation provided by several materials is calculated by adding the R-values together. For example, consider an exterior wall:

| Wall Construction | Uninsulated Wall Resistance | Insulated Wall Resistance |
|---|---|---|
| 3-inch common brick | 0.6 | 0.6 |
| 1/2-inch insulated board | 1.32 | 1.32 |
| 3 1/2-inch air space | 1.0 | 0.0 |
| 3 1/2-inch insulation | 0.0 | 11.0 |
| 1/2-inch gypsumboard | .45 | .45 |
| | 3.37 | 13.37 |

Heat loss is calculated by converting the R-factor into the U-factor (U=1/R). Units have been set so that heat flow (Btu's per hour per square foot) result from multiplying the U-factor by the temperature difference (°F) between inside and outside. Thus, if inside temperature is 68°F and outside is 28°F, the heat flow is (68-28)x(1/13.37) = 2.9[illegible] for the insulated wall.

U-factors for some glass windows are:

| | |
|---|---|
| single glass | 1.1 U's |
| insulating glass | 0.6 |
| storm windows (1-4-inch air space) | 0.5 |

## ANNUAL ENERGY REQUIREMENTS OF ELECTRIC HOUSEHOLD APPLIANCES

| Appliance | Average Wattage | Annual kwh Consumption | | Annual Cost @ 3¢/kwhr |
|---|---|---|---|---|
| Air cleaner | 50 | 216 | | $ 6.48 |
| Air conditioner (room) | 997 | 1,032* | | 30.96 |
| Bed covering | 177 | 147 | (1.0/night) | 4.41 |
| Blender | 386 | 15 | (0.2/use) | .45 |
| Broiler | 1,436 | 100 | | 3.00 |
| Carving knife | 92 | 8 | | .24 |
| Clock | 2 | 17 | (1.5/month) | .51 |
| Clothes dryer | 4,856 | 993 | (3.0/load) | 29.79 |
| Coffee maker | 894 | 106 | (.25/pot) | 3.18 |
| Deep fryer | 1,448 | 83 | | 2.49 |
| Dehumidifier | 257 | 377 | | 11.31 |
| Dishwasher | 1,201 | 363** | (1.0/load) | 10.89 |
| Egg cooker | 516 | 14 | | .42 |
| Fan (attic) | 370 | 291 | | 8.73 |
| Fan (circulating) | 88 | 43 | | 1.29 |
| Fan (window) | 200 | 170 | | 5.10 |
| Floor polisher | 305 | 15 | | .45 |
| Freezer (15 cu. ft.) | 341 | 1,195 | (5.0/day) | 35.85 |
| Freezer, frostless (15 cu. ft.) | 440 | 1,761 | | 52.83 |
| Frying pan | 1,196 | 186 | (1.0/hr) | 5.58 |
| Hair dryer | 381 | 14 | (.33/hr) | .42 |
| Heater (portable) | 1,322 | 176 | (1.5/hr) | 5.28 |
| Heating pad | 65 | 10 | | .30 |
| Hot plate | 1,257 | 90 | | 2.70 |
| Humidifier | 177 | 163 | | 4.89 |
| Iron | 1,008 | 144 | (1.0/hr) | 4.32 |
| Mixer | 127 | 13 | (.05/use) | .39 |
| Oven (microwave) | 1,450 | 190 | | 5.70 |
| Radio | 71 | 86 | | 2.58 |
| Radio/record player | 109 | 109 | (.10/hr) | 3.27 |
| Range, with oven | 12,200 | 1,175 | (1.5/meal) | 35.25 |
| Range, with self-cleaning oven | 12,200 | 1,205 | | 36.15 |
| Refrigerator/Freezer(14 cu.ft.) | 326 | 1,1[illegible] | | 34.11 |
| Refrigerator/Freezer, frostless (14 cu. ft.) | 615 | 1,829 | | 54.87 |
| Roaster | 1,333 | 205 | | .15 |
| Sandwich grill | 1,161 | 33 | | .99 |
| Sewing machine | 75 | 11 | (1.0/month) | .33 |
| Shaver | 14 | 1.8 | (.001/shave) | .05 |
| Sun lamp | 279 | 16 | | .48 |

*Based upon 1,000 hours of operation per year; this figure will vary widely depending on geographic area and size of unit.

**Does not include kilowatt-hours for heating water.

ANNUAL ENERGY REQUIREMENTS OF ELECTRIC HOUSEHOLD APPLIANCES (continued)

| Appliance | Average Wattage | Annual kwh Consumption | | Annual Cost @ 3¢/kwhr |
|---|---|---|---|---|
| Television (black and white), tube type | 160 | 350 | | $ 10.50 |
| Television (black and white), solid state | 55 | 120 | (.16/hr) | 3.60 |
| Television (color), tube type | 300 | 660 | | 19.80 |
| Television (color), partial solid state | 200 | 440 | | 13.20 |
| Toaster | 1,146 | 39 | (.04/slice) | 1.17 |
| Toothbrush | 7 | 0.5 | (.001/brushing) | .015 |
| Trash compactor | 400 | 50 | | 1.50 |
| Vacuum cleaner | 630 | 46 | (.63/hr) | 1.38 |
| Vibrator | 40 | 2 | | .06 |
| Waffle iron | 1,116 | 22 | (.25/waffle) | .66 |
| Washing machine (automatic) | 512 | 103** | (.33/load) | 3.09 |
| Washing machine (manual) | 286 | 76 | | 2.28 |
| Waste disposer | 445 | 30 | (.01/load) | .90 |
| Water heater (standard) | 2,475 | 4,219 | (12.0/day) | 126.57 |
| Water heater (quick-recovery) | 4,474 | 4,811 | | 144.33 |

**Does not include kilowatt-hours for heating water.

Source: All figures courtesy of Electric Energy Association, New York, New York, 1973, and the Tennessee Energy Office, 1975.

Estimated Percent of Heating Fuel Saved from Night Thermostat Setback for Eight Hours and 24 Hours, Selected Cities

| City | Approximate percent savings from eight-hour night setback of | | | Approximate percent savings from 24-hour setback of | | | |
|---|---|---|---|---|---|---|---|
| | 3°F | 5°F | 10°F | 1°F | 3°F | 5°F | 7°F |
| Chicago | 4 | 7 | 11 | 4 | 12 | 20 | 28 |
| Columbus | 4 | 7 | 11 | 4 | 13 | 22 | 30 |
| Dallas | 7 | 11 | 15 | 7 | 20 | 32 | 41 |
| Denver | 4 | 7 | 11 | 4 | 13 | 22 | 30 |
| Des Moines | 4 | 7 | 11 | 4 | 11 | 19 | 27 |
| Detroit | 4 | 7 | 11 | 4 | 13 | 22 | 30 |
| Kansas City | 5 | 8 | 12 | 5 | 14 | 23 | 32 |
| Los Angeles | 9 | 12 | 16 | 13 | 34 | 47 | 61 |
| Louisville | 5 | 9 | 13 | 5 | 14 | 24 | 33 |
| Madison | 3 | 5 | 9 | 3 | 10 | 17 | 24 |
| Minneapolis | 3 | 5 | 9 | [illegible] | 10 | 16 | 22 |
| Omaha | 4 | 7 | 11 | 4 | 11 | 19 | 26 |
| Pittsburgh | 4 | 7 | 11 | 4 | 13 | 22 | 30 |
| Portland, Oregon | 7 | 9 | 13 | 7 | 20 | 32 | 41 |
| Salt Lake City | 4 | 7 | 11 | 4 | 13 | 22 | 30 |
| San Francisco | 8 | 10 | 14 | 9 | 26 | 39 | 51 |
| Seattle | 6 | 8 | 12 | 7 | 20 | 31 | 40 |
| Syracuse | 4 | 7 | 11 | 4 | 12 | 20 | 28 |
| Washington, D.C. | 6 | 9 | 13 | 6 | 17 | 27 | 36 |

Source: Honeywell, Inc., "Reducing Fuel Consumption by Dialing Down the Thermostat," Minneapolis, 1973 (pamphlet), in Newman and Day, *The American Energy Consumer* (Cambridge, Massachusetts: Ballinger Publishing Company, 1975), pp. 50, 51 (Tables 3-15 and 3-16).

# ENERGY BASICS

ENERGY BASICS

"Energy" is a term familiar to most people, but one which is not easily defined due to its varied form and changeable characteristics. Energy is usually thought of as either "physical vitality" or "electricity." These are only two of its most apparent forms. Energy also appears as sound energy, light energy, potential and kinetic energy, work, power, and fuel; it exists as part of every atom in the universe--in fact, it is just as basic. This concept is better understood when viewed within the context of Einstein's *Law of Conservation of Energy and Matter* and the two *Laws of Thermodynamics*.

During the first half of the nineteenth century, the relationships among energy, heat, and work, known as the *Laws of Thermodynamics*, were formulated:

*Law 1: Energy and matter can be neither created nor destroyed.*

*Law 2: The energy of the universe is constant, but the entropy (a measure of the unavailable energy in the universe) increases toward a maximum.*

The importance of these laws cannot be overstated. They permitted a theoretical understanding of energy which could be applied to industrial production. The efficiency of machinery could be greatly increased, lessening the gap between energy input and output. (The early steam engines, for example, lost 99 percent of their available energy during the process of converting coal to steam energy.) Ultimately, this led to the technological society in which we now live.

Still greater technological advances were made possible by Einstein's equation, $E = mc^2$, which says that energy and mass are interrelated. Mass may be converted into energy and energy may be converted into mass. Both types of conversion are continually occurring in the universe, but the total amount of energy and matter remains constant at all times. This fact is expressed in the *Law of Conservation of Matter and Energy*.

These laws are still insufficient for a complete understanding of the complex nature of energy. A thorough grasp of the concept begins with the sun--the original source of all the earth's energy supplies. Radiant energy, produced by thermonuclear reactions on the sun's surface, is transmitted in waves to the earth. As shown in Figure 6, 50 percent of the total solar radiation is absorbed at the earth's surface where it can be transformed into the many forms of energy which we use today; 30 percent is reflected back to space; and the remaining 20 percent is absorbed by the atmosphere. This "energy budget" is a determinant in climate and weather patterns, agricultural activities and photosynthesis, solar energy utilization technology, and hydro power. In fact, it is a determinant in every aspect of our existence. Without it, we would not have the "hydrologic cycle" (Figure 7) which, among other things, permits us to utilize the flow of water in generating electricity.

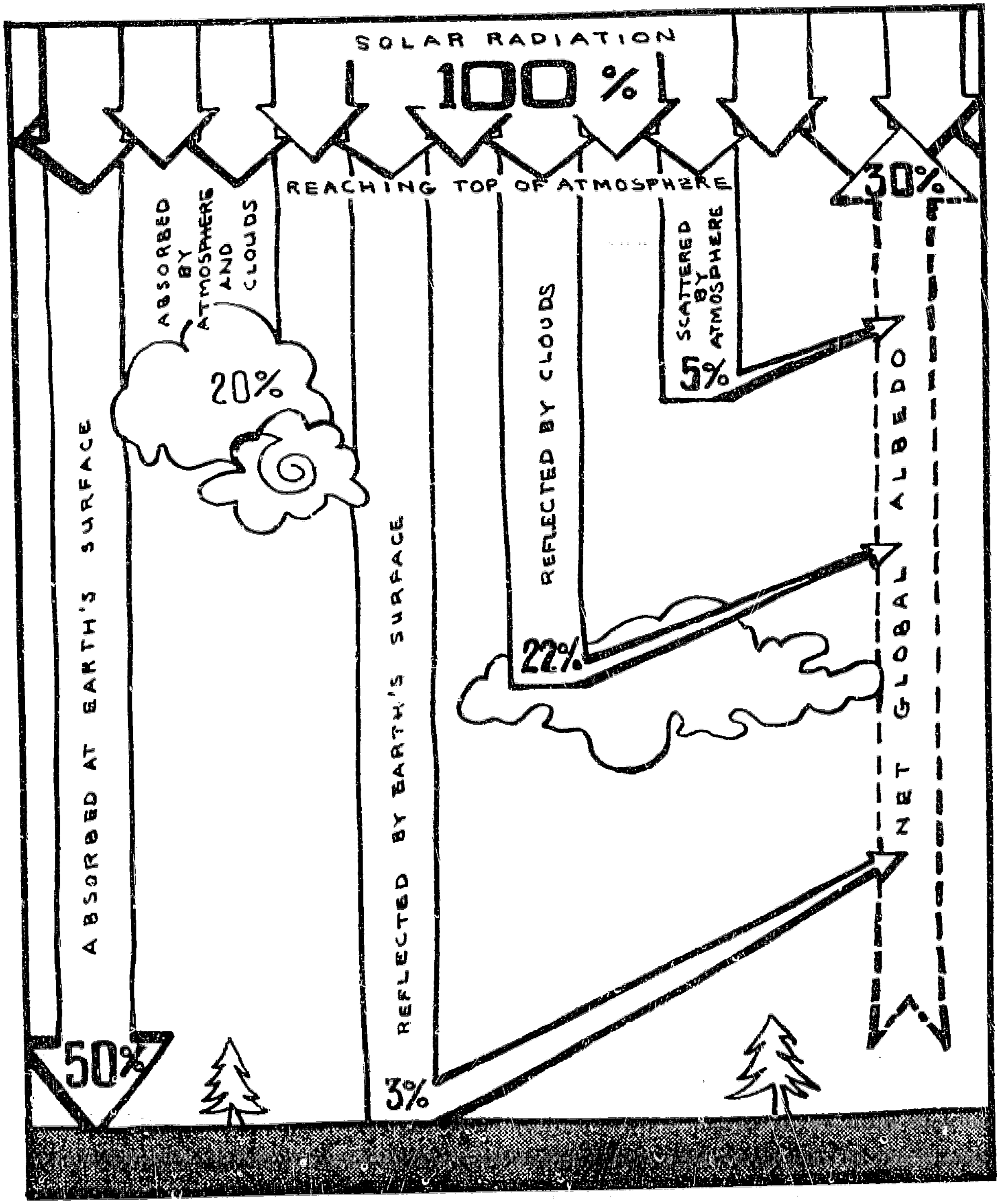


FIGURE 6. SOLAR RADIATION ENERGY BUDGET.

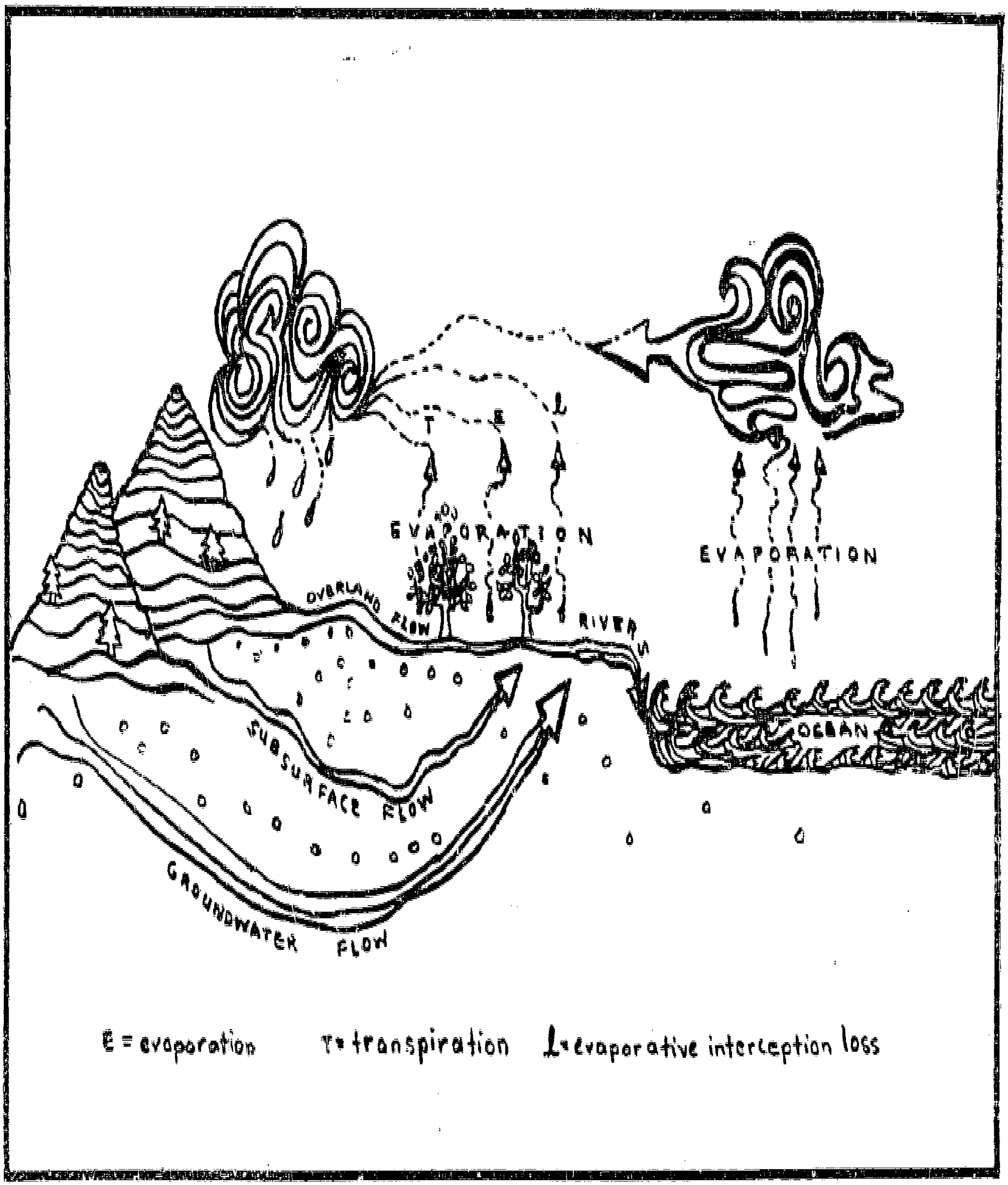


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FIGURE 7. THE HYDROLOGIC CYCLE.

The waves transmitted from the sun to the earth are responsible for other types of energy, as well: sound, light, ultraviolet, x-rays, and gamma rays. These are all part of the "electromagnetic spectrum." Whether they can be experienced by our senses depends upon their frequency or wave length. Figure 8 identifies these types of radiant energy waves by their appropriate places on the spectrum. Most of the dangerous radiation (x-rays and gamma rays) is absorbed by elements of the earth's atmosphere (the ozone layer, for example) before they can reach the earth's surface. (Again, see Figure 6.)

Energy is either in motion (kinetic) or stored (potential) and can be converted from one type to another, as illustrated by a very simple example. A book on a shelf appears to have no energy, but if it falls and strikes your head, a force is exerted by the book to your head and then to the floor where it lands. Energy was transferred from the book to your head. This energy was acquired by the book when it was lifted to the shelf, it was stored in the book, and then released when it fell. Energy was converted from kinetic to potential to kinetic. The amount of work which is contained in an object as potential energy or which can be produced by an object as kinetic is measured in *joules*.

To measure *potential energy*, multiply mass ($M$) by distance ($h$) by acceleration due to gravity ($g$): $E = Mgh$(joules)

To measure *kinetic energy*, multiply mass ($M$) by velocity squared ($v^2$) and divide by 2: $E = \frac{Mv^2}{2}$(joules)

Other measures of energy frequently encountered are the calorie, the British thermal unit (Btu), and the kilowatt-hour (kwh). One calorie, in mechanical terms, is the equivalent of 4.18 joules, but is actually used to measure heat energy. One thousand calories (a kilocalorie or K-calorie) is a Calorie--the basic unit measure of food energy. The Btu is also used to measure heat energy. It is the equivalent of 1055 joules or approximately 252 calories. The Btu is used to describe the total amount of energy needed for a specific operation (running an air conditioner, for example, as in "7000 Btu's per hour"), or to measure the energy content of fuels (for example, a gallon of gasoline has a heating value of about 136,000 Btu's). The kilowatt, used to measure electrical energy, is the equivalent of 3,410 Btu's. (For means of comparison, one watt equals one joule per second; 1000 watts equal one kilowatt; and one horsepower equals approximately 3/4 kilowatts.) The kwh is a measure of the rate (per hour) at which electrical energy (kilowatts) is used.

Familiarity with the basic forms of energy is advisable in order to understand principles of energy conversion and methods of energy conservation. Potential energy is electrical, gravitational, or nuclear; kinetic energy includes sound, radiant, and mechanical. Chemical energy (basically electrical in character) is a third form of energy. Thermal energy is the total potential and kinetic energy associated with a substance. Each of these energy forms are discussed briefly in this section.

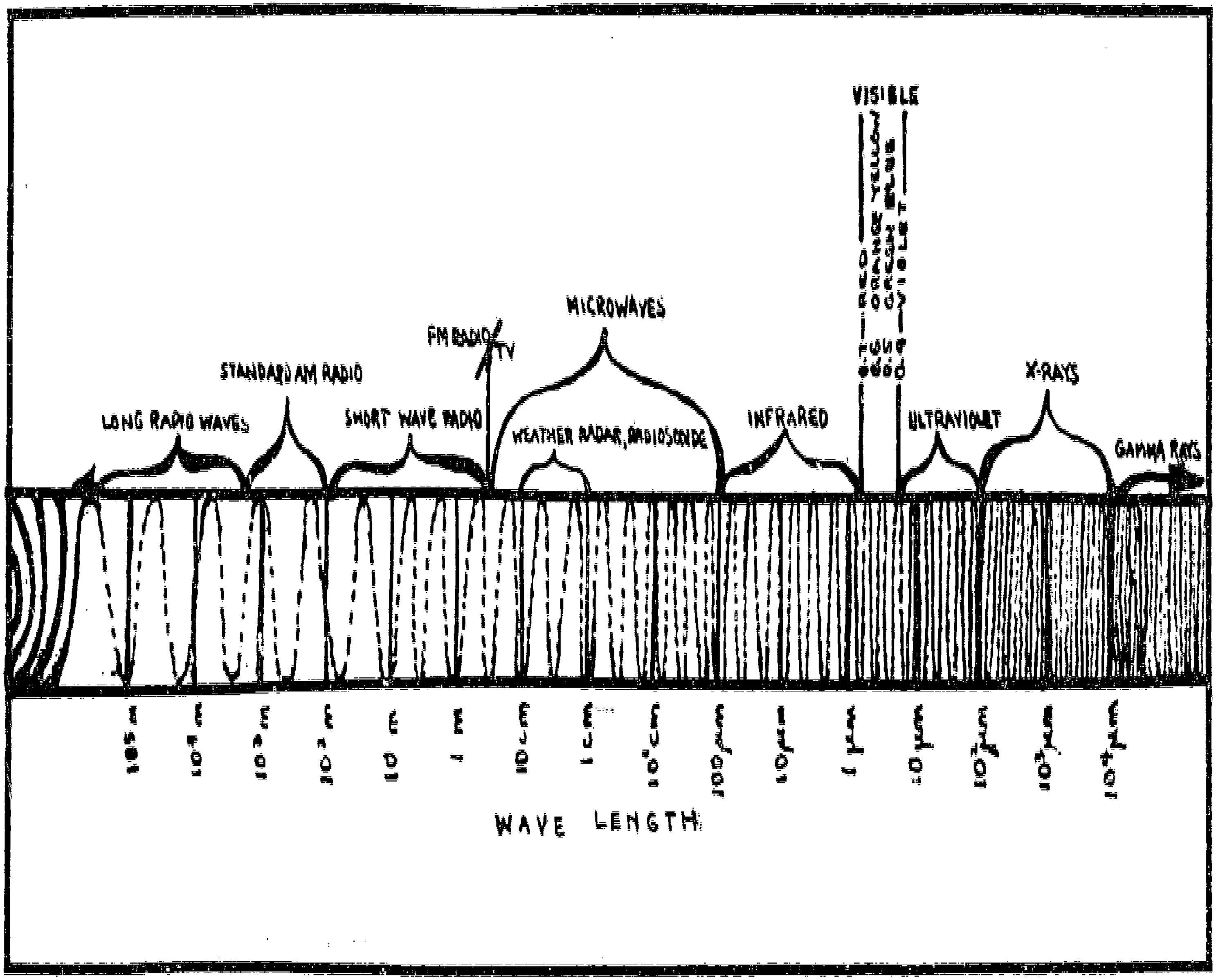



FIGURE 8. THE RADIANT ENERGY SPECTRUM.

*Electrical energy* can be either static or current. Static electricity is produced by separating electrons from protons--rubbing a comb with a piece of wool, for example (electrons are lost by the wool and gained by the comb). The result is a difference in potential energy measured in volts. An electrical current, on the other hand, is produced when a substance has atoms with electrons which are relatively free to move from atom to atom. Some metals have "free" electrons and so are called "good conductors" of electricity.

There are two main kinds of current: direct and alternating. Work must be done to create either a direct or an alternating current in a circuit; in both cases, the energy expended comes from outside the system. Direct current often uses chemical energy to move electrons (as in a voltaic cell), while alternating current uses the force of a rotating magnetic field to induce current. In both cases, the current can be used to perform work.

*Direct current (dc)* flows continuously in the same direction until the circuit is broken or the power fails. Dc generators are used in automobiles to supply the electrical energy needed to keep the storage battery fully charged. A current which has one direction during part of a generating cycle and the opposite during the remainder of the cycle is called an *alternating current (ac)*. Alternating current is more widely used than direct current for two reasons: (1) simpler generating machines and electric motors are possible with alternating current; and (2) alternating current can be readily transformed into high voltages while direct current cannot. Most household appliances use alternating current.

Although electricity is a form of energy, it is not a source of energy; rather, it serves as an energy transport system. Electricity is usually generated from the following sources: petroleum, natural gas, coal, hydro power, or nuclear power.

*Gravitational potential energy* is acquired by a substance by virtue of its position in a space dominated by a gravitational field. This concept is best understood through examples. Two natural energy resources can be harnessed for their gravitational potential energy: tides and rivers. When high tides go out, their gravitational potential energy may be converted into kinetic energy which can be harnessed to create electrical energy. Similarly, the flowing water of rivers is frequently stored by hydroelectric facilities in reservoirs (dams). The stored water can later be released to turn the plant turbines which generate electricity.

*Nuclear energy* is the result of the rearrangement of protons and neutrons into new configurations, releasing chemical energy in the process. There are two types of nuclear energy: fission and fusion. *Fission* occurs when the nucleus of an atom is split into two parts. When a neutron hits an atom of a fissionable (splitable) element, it may be captured by the atom's nucleus. If it is, the atom may split into two smaller atoms, each having approximately half the mass of the original atom. The original atom releases two or three neutrons which may then hit other atoms and cause them to split, creating a chain reaction.

*Fusion* occurs when two lightweight atomic nuclei (neutrons and protons) unite to form a heavier nucleus. A fusion reaction is also called a thermonuclear reaction because it takes place only at extremely high temperatures. At the present time, man does not know how to make hydrogen atoms fuse in a useful way (other than in an explosion) because a method to produce the extreme temperatures needed has not been found. Hydrogen fusion could be a useful energy alternative because its fuel comes from water. Unlike fission, hydrogen fusion would produce fewer radioactive wastes.

*Chemical energy* is acquired and stored by substances as the result of chemical reactions with oxygen. When the new compound is formed, heat is released and causes electricity to flow. For example, when wood burns, the potential chemical energy in the gasoline is released as heat energy. All "fossil" energy sources are chemical in nature (e.g., coal, gas, oil). Natural gas is primarily composed of methane which reacts with oxygen to produce carbon dioxide, water, and energy. For the reaction to occur, several atomic bonds must be broken and new ones formed. Since methane and oxygen together have more electrical potential energy than carbon dioxide and water, the oxidation of methane releases energy. One gram of methane releases slightly over 52 Btu's when burned.

Two forms of kinetic energy--*radiant* and *sound*--were discussed earlier in this section. A third type of motional energy is *mechanical energy*. A "machine" may be defined as any device used to accomplish a task faster and more efficiently than it otherwise could be accomplished. A machine is used for one of five purposes: (1) to transform energy; (2) to transfer energy; (3) to multiply force; (4) to change the direction of a force; or (5) to multiply speed. Although machines are generally associated with kinetic energy, machines are constantly involved in an interplay of kinetic and potential energy. The interplay of kinetic and potential energy in machines is known in physics as the *Law of Conservation of Mechanical Energy*. This law states that the sum of the potential and kinetic energy of an ideal energy system (an ideal machine) remains constant. Of course, there is no ideal machine. All machines are hindered by dissipative forces such as friction (which produces heat rather than mechanical energy). Because of the presence of dissipative forces, no machine is 100 percent efficient. The ratio of the useful or conservative work output of a machine to the total work input is called its efficiency.

*Thermal energy* is the total potential and kinetic energy associated with the random motion of a substance's particles. The quantity of thermal energy possessed by a body determines its temperature. But the same quantity of thermal energy possessed by different bodies does not give both the same temperature. For this reason, the terms *temperature* and *heat* are often confused. Temperature is the ability of a substance to gain or lose heat; this kinetic energy is easy to measure. Heat is the amount of thermal energy (potential *and* kinetic) which a substance gives out, absorbs, or transfers; it is not easily measured.

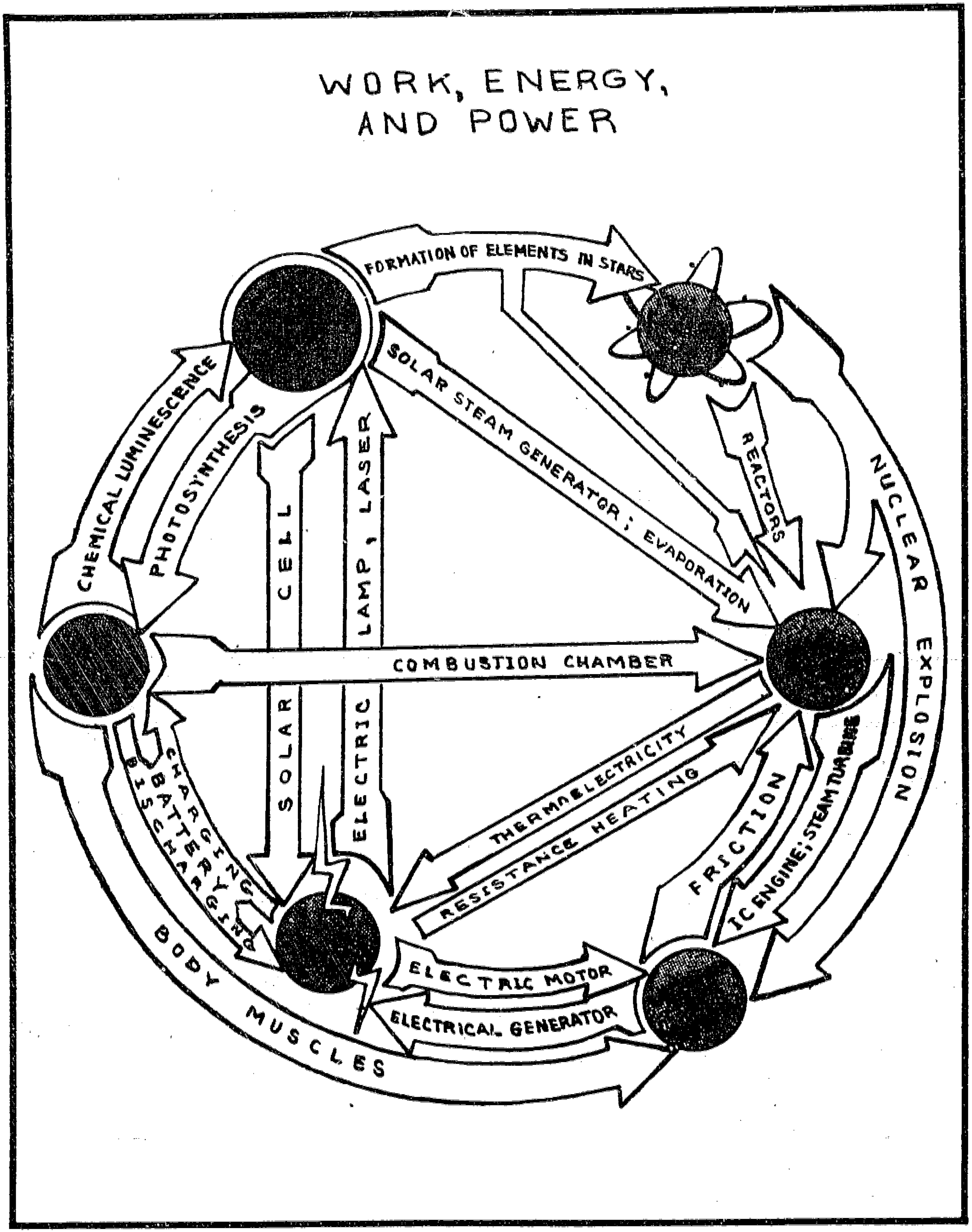
All substances have thermal energy, but all cannot be called thermal energy resources; that is, not all are good sources of heat energy. The sun, for example, is an excellent source of a vast amount of natural heat energy. At the present time, scientists and engineers know how to harness some of the sun's heat energy with solar collectors. They are also learning how to remove heat from water or air and convert it to electrical energy for residential and commercial purposes (heat pumps and annual cycle energy systems). In addition, scientists are learning how to harness some of the heat within the earth (geothermal energy) and turn it into electrical energy. These are all examples of energy conversion--a necessary concept in understanding energy utilization.

Energy conversion means changing one form of energy into another. For example, when we switch on a television, electrical energy is converted into mechanical energy. The series of conversions which take place in the conversion of nuclear energy from the sun to electrical energy is a more complex example. Nuclear fusion reactions in the sun produce radiant energy which may cause water on the earth to evaporate. The evaporated water eventually condenses to form clouds which may then condense further to form rain. The rain may fall into a river which flows past a hydroelectric plant; the gravitational potential energy of the river is turned into electricity at the hydroelectric plant. The electricity may then be used to produce mechanical energy (e.g., to power a television) or it may be stored as chemical energy (e.g., in batteries used to operate the electrical starters in automobiles).

Of course, there are an infinite number of energy conversion examples. Some typical processes that convert energy are summarized in Figure 9. The series of energy conversions in a steam generating plant are shown in simplified form in the following diagram:

Fossil Fuel----------→Furnace---------→Turbine--------→Generator
*Chemical Energy------→Heat Energy--→Mechanical Energy--→Electric Energy*

Generally, coal, rather than oil or natural gas, is the fossil fuel used in a steam generating plant. Recall that all three fossil fuels contain chemical energy. The coal is loaded into a furnace. While it burns, it releases heat energy which sets water boiling and subsequently changes it into steam. The steam then flows through large pipes to the steam turbine where it turns the blades of the turbine to produce mechanical energy in the form of a rotating shaft.




*SOURCE: Adapted from* Jerry B. Marion, *Energy in Perspective* (New York: Academic Press, 1974), p. 22.

FIGURE 9. FORMS OF ENERGY AND THEIR METHODS OF CONVERSION.

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# GLOSSARY

## GLOSSARY

*Acceleration.* The time rate of change of velocity in either speed or direction.

*Alternating Current.* An electric current whose direction of flow is changed at periodic intervals (many times per second).

*Ampere.* A unit of measure for an electric current (a force of one volt and a resistance of one ohm).

*Aquifer.* An underground bed or stratum of earth, gravel, or porous stone that contains water.

*Atom.* The smallest particle of an element which can enter into a chemical combination.

*Atomic Energy.* (1) The constitutive internal energy of the atom which was absorbed when it was formed; (2) energy derived from the mass converted into energy in nuclear tranformations.

*Barrel.* Although seldom put in actual "barrels," crude oil is measured in a unit called the barrel, equal to 42 U.S. gallons. One barrel of crude oil has the same energy as 350 pounds of coal.

*Base Load.* The minimum amount of power demanded of a utility (electric or gas) over a given period of time.

*Blackout.* A situation in which all power is cut off from electrical generating facilities; or can be caused by storm damage, equipment failure, or overloaded utility equipment.

*Breeder Reactor.* A nuclear chain reactor in which a greater number of fissionable atoms are produced than the number of parent atoms consumed.

*British Thermal Unit.* The quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit at or near its point of maximum density (39.1°F).

*Brownout.* The deliberate lowering of voltage (and thus the power supplied to all users) by electric utility companies; employed when demand for power exceeds generating capacity.

*Calorie.* The amount of heat necessary to raise one gram of water by one degree Celsius.

*Capacity.* The maximum load for which a generator, transmission circuit, power plant, or system is rated.

*Celsius Scale.* The temperature scale using the ice point as 0 and the steam point as 100, with 100 equal divisions or degrees between.

*Chain Reaction.* A reaction that stimulates its own repetition. In a fission chain reaction, a fissionable nucleus absorbs a neutron and fissions, releasing additional neutrons. These in turn can be absorbed by other fissionable nuclei, releasing still more neutrons. A fission chain reaction is self-sustaining when the number of neutrons released in a given time equals or exceeds the number of neutrons lost by absorption in non-fissioning material or by escape from the system.

*Chemical Energy.* The kind of energy that may be released when a chemical reaction takes place.

*Circuit.* The complete path traversed by an electric current.

*Coal.* Solid, combustible, organic hydrocarbon formed by the decomposition of vegetable material under pressure and heat below the earth's surface.

*Coal Gasification.* The conversion of coal to a gas suitable for use as a fuel.

*Combustion.* Burning; technically, a rapid oxidation accompanied by the release of energy in the form of heat and light.

*Conductor (Electrical).* Body capable of carrying an electrical current.

*Conservation.* The wise use of natural resources.

*Conservation of Matter and Energy (Law of).* Matter and energy are interchangeable; the total amount of energy and matter in the universe remains constant.

*Conservation of Mechanical Energy (Law of).* The sum of the potential and kinetic energy of an ideal energy system remains constant.

*Convection.* The transfer of energy by moving masses of matter.

*Conventional Hydroelectric Plant.* A hydroelectric power plant that utilizes streamflow only once as the water passes downstream, as opposed to a pumped-storage plant which recirculates all or a portion of the streamflow.

*Cooling Tower.* A device used to cool power plant condensor water before it is returned to a lake, river, or ocean; intended to prevent thermal pollution.

*Coulomb.* The amount of charge delivered by an electrical current of one ampere flowing for one second.

*Crude Oil.* Liquid fuel formed from the fossils of animals and plants at the bottom of ancient seas; petroleum as it comes from the ground.

*Current (Electric).* The rate of movement of electricity.

*Curtailment.* Cutting back the use of energy resources in an emergency as opposed to conserving or wisely using energy resources.

*Density.* Concentration of matter, measured by the mass per volume.

*Direct Current.* An electric current that flows in only one direction through a circuit.

*Direct Energy Conversion.* The process of changing any other form of energy into electricity without machinery; for example, a battery which changes chemical energy into electricity.

*EER.* Energy efficiency ratio; Btu's divided by wattage.

*Electrical Energy.* The energy associated with electric charges and their movement; measured in kilowatt-hours.

*Electron.* A small particle, orbiting about an atom's nucleus, having a unit of negative electrical charge, a small mass, and a small diameter.

*Energy.* The capability of doing work. Potential energy is energy due to position of one body with respect to another or relative parts of the same body. Kinetic energy is due to motion. Mechanical energy is released to make objects move.

*Entropy.* A measure of the unavailability of energy to do useful work; every spontaneous process in nature is characterized by an increase in the total entropy of the bodies concerned in the process.

*Environment.* The sum of all external conditions and influences affecting the life, development, and ultimately the survival of an organism.

*Evaporation.* The change from liquid to gas in which molecules escape from the surface of the liquid.

*Feedstock.* Energy resources used as raw materials in the production of products rather than as fuels for burning.

*First Law of Thermodynamics* (also called the *Law of Conservation of Energy*). Energy can neither be created nor destroyed.

*Fission.* A nuclear reaction in which the atom is split into two approximately equal masses. There is also the emission of extremely great quantities of energy since the sum of the masses of the two new atoms is less than the mass of the parent atom.

*Flywheel.* A method of energy storage based on the principle that a spinning wheel stores mechanical energy.

*Force*. That property which changes the state of rest or motion in matter measured by the rate of change in momentum; the force ($F$) required to produce an acceleration ($a$) in a mass ($m$) is given by $F = ma$.

*Fossil Fuels*. Coal, oil, natural gas, shale, peat; originating from geologic deposits of ancient plant and animal life under millions of years of heat and pressure.

*Frequency*. Number of vibrations or cycles per unit time.

*Frictional Force*. Force required to move one surface across another.

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

*Fuel Cell*. A device in which fuel and oxygen are combined to produce chemical energy that is converted directly into electricity.

*Fusion*. A nuclear reaction involving the combination of smaller atomic nuclei or particles into larger ones with the release of energy from mass transformation; also called a thermonuclear reaction because of the extremely high temperature required to sustain it.

*Gas*. A state of matter in which the molecules are practically unrestricted by cohesive forces; a gas has neither definite shape nor volume.

*Gasoline*. A mixture of hydrocarbons obtained from petroleum.

*Generator*. A device that converts heat or mechanical energy into electrical energy.

*Geothermal*. When applied to power generation, it is the use of heat energy obtained through the medium of hot water or steam coming from beneath the earth's surface.

*Geothermal Energy*. The heat energy available in the earth's subsurface, believed to have been produced by natural radioactivity; the temperature increases by about 1°F for each 100 feet of depth.

*Gram*. A unit of mass in the metric system; there are about 30 grams in one ounce.

*Gross National Product (GNP)*. A measure of economic activity; the total market value of all goods and services produced in a country (depreciation and other allowances for capital consumption are not deducted).

*Heat*. Energy possessed by a substance in the form of internal kinetic energy; transmitted by conduction, convection, or radiation.

*Heat Capacity.* That quantity of heat required to increase the temperature of a system or substance one degree Celsius.

*Heat Energy.* Energy that causes an increase in the temperature of an object; it may change the object from solid to liquid or from liquid to gas.

*High-Sulphur Content.* Generally, coal or oil that contains more than one percent of sulphur by weight.

*Horsepower.* The rate at which energy is produced or used; a man doing heavy manual labor produces energy at the rate of about .08 horsepower; a one-horsepower motor consumes about 750 watts of electricity.

*Hydroelectric Plant.* An electric power plant in which the turbine-generators are driven by falling water.

*Insulation.* A substance that can slow down the flow of heat or sound from one material to another.

*Internal Combustion Engine.* Energy is supplied by the controlled burning of a fuel which is directly transformed into mechanical energy.

*Isotope.* A variation of an element having the same atomic number as the element itself, but having a different atomic weight because of a different number of neutrons; different isotopes of the same element have different radioactive behaviors.

*Joule.* A metric unit measure of work; the energy produced by a force of one newton operating through a distance of one meter (joule = newton-meter).

*Kilocalorie.* Heat energy equal to 4190 joules; a Calorie--the basic measure of energy in food.

*Kilowatt (kw).* A unit of power equal to 1,000 watts, 3,410 Btu's, or 1.341 horsepower.

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

*Light.* Visible radiant energy.

*Liquefied Natural Gas (LNG).* Natural gas that has been changed into a liquid by cooling to about -160°C at which point it occupies about 1/600 of its gaseous volume at normal atmospheric pressure, thus reducing the cost of shipping and storage.

*Liquid.* A state of matter in which the molecules are relatively free to change their positions with respect to each other but restricted by cohesive forces so as to maintain a relatively fixed volume.

*Low-Sulphur Content.* Generally, used to describe coal or oil which is one percent or less sulphur by weight.

*Mass.* A measure of the weight of matter in an object. The weight of an object depends on its mass. The United States standard measure is the avoirdupois pound as defined by $\frac{1}{2.20462}$ kilograms.

*Matter.* Anything which is solid, liquid, or gaseous.

*Megawatt (MW).* A unit of power equal to 1,000 kilowatts or one million watts; usually used to describe the capacity of power plants.

*Methane.* Colorless, nonpoisonous, and flammable gaseous hydrocarbon ($CH_4$); emitted by marshes and by dumps undergoing decomposition; the principal constituent of natural gas.

*Molecule.* The smallest unit or quantity of matter which can exist by itself, yet retain all the properties of the original substance.

*Momentum.* Quantity of motion measured by the product of mass and velocity.

*Motion.* Continuous change of location or position of a body.

*Natural Gas.* Mixtures of hydrocarbon gases and vapors occurring naturally in certain geologic formations, usually associated with oil.

*Neutron.* A constituent particle of all nuclei of mass number greater than 1.

*Newton.* The force necessary to give acceleration of one meter per second squared to one kilogram of mass.

*Nonrenewable Resources.* Near-term depletable energy resources, such as the fossil fuels (coal, gas, and oil).

*Nuclear Electric Power Plant.* One in which heat for creating steam is provided by fission rather than combustion of fossil fuel.

*Nuclear Fuel.* Material containing uranium of such composition and enrichment that, when placed in a nuclear reactor, will support a self-sustaining fission chain reaction and produce heat in a controlled manner for process use.

*Nuclear Power.* Electric power produced from a power plant by converting the energy obtained from nuclear reaction.

*Nuclear Power Plant.* Any device, machine, or assembly that converts nuclear energy into some form of useful power, such as mechanical or electrical power; in a nuclear electric power plant, heat produced by a reactor is generally used to make steam to drive a turbine that in turn drives an electric generator.

*Nuclear Reaction.* A change in an atomic nucleus, such as fission, fusion, neutron capture, or radioactive decay, as distinct from a chemical reaction, which is limited to changes in electron structure surrounding the nucleus.

*Nucleus.* The dense central core of the atom in which most of the mass and all of the positive charge is concentrated.

*Off-peak Power.* Energy supplied during periods of relatively low system demands.

*Ohm.* The basic unit of electrical resistance in a conductor.

*Oil Shale.* A sedimentary rock containing solid organic matter (kerogen) that yields substantial amounts of oil when heated to high temperatures.

*OPEC.* The Organization of Petroleum Exporting Countries; an organization of countries in the Middle East, North Africa, and South America which aims at developing common oil-marketing policies.

*Oxidation.* A chemical reaction in which oxygen combines with another element.

*Peaking.* Power plant operation required to meet the highest portion of the daily or seasonal demands.

*Peaking Capability.* The maximum peak load that can be supplied by a generating unit, station, or system in a stated period of time.

*Plutonium.* A fissionable element, artifically produced by neutron bombardment of $U^{238}$.

*Power.* The time-rate at which work is done; units of power are the watt (one joule per second) and the horsepower (33,000 foot-pounds p minute or 746 watts).

*Pressure.* The force applied to a unit area.

*Proton.* A particle of the atom having a positive charge equivalent to the negative charge of the electron, but possessing a mass approximately 1,837 times as great; the proton is the positive nucleus of the hydrogen atom.

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

*Pumped Storage Plant.* A hydroelectric power plant which generates electric energy for peak load use by utilizing water pumped into an elevated storage reservoir during off-peak periods.

*Radiation.* The emission and propagation of energy through space or through a material medium in the form of waves.

*Reclamation.* Act or process of leveling and replanting strip-mined land.

*Renewable Resources.* Nondepletable resources.

*Reserves.* The amount of a natural resource which can be recovered by present-day techniques and under present economic conditions.

*Reservoir.* A pond, lake, tank or basin, natural or man-made, used for the storage, regulation, and control of water.

*Resources.* The estimated total quantity of natural resources, including prospective undiscovered mineral reserves.

*Second Law of Thermodynamics.* One of the two laws which govern the conversion of energy; sometimes called the "heat tax," it can be stated in several equivalent forms, all of which describe the inevitable passage of energy from a useful to a less useful form in any energy conversion.

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

*Solar Energy.* Radiant energy from the sun which reaches the earth's surface.

*Solid.* A state of matter in which the relative motion of the molecules is restricted and they tend to retain a definite fixed position relative to each other with a definite shape and volume.

*Solid Waste.* Unwanted or discarded material with insufficient liquid content to be free flowing.

*Sound Energy.* A kind of energy carried by molecules that vibrate so that waves are formed.

*Static Electricity.* Electricity at rest.

*Steam-Electric Plant.* A plant in which the turbines connected to the generators are driven by steam.

*Stockpile.* A storage pile or reserve supply of an essential raw material.

*Storage Cell.* An electrochemical cell in which the reacting materials are renewed by the use of a reverse current from an external source.

*Stored Energy*. Potential energy.

*Strip-mining*. A process in which rock and topsoil strata covering ore or fuel deposits are scraped away by mechanical shovels.

*Supertankers*. Extremely large oil tankers that can hold up to four million barrels (170 million gallons) of oil.

*Temperature*. The condition of a body which determines the transfer of heat to or from other bodies; or a manifestation of the average translational kinetic energy of the molecules of a substance due to heat agitation.

*Thermal Efficiency*. The ratio of the electric power produced by a power plant to the amount of heat produced by the fuel; a measure of the efficiency with which the plant converts thermal energy to electrical energy.

*Thermal Energy*. The total potential and kinetic energy associated with the random motions of the particles of a material.

*Thermal Plant*. A generating plant which converts heat energy to electrical energy by burning coal, gas, or oil, or using nuclear energy.

*Thermal Pollution*. Degradation of water quality by the introduction of a heated effluent; primarily a result of the discharge of cooling waters from industrial processes, particularly from electrical power generation.

*Thermodynamics*. The science and study of the relationship between heat and mechanical work.

*Transformer*. A machine which can increase or decrease the voltage of an alternating current of electricity.

*Transmission*. The act or process of transporting electrical energy in bulk from a source of supply to the distributors.

*Transmission Lines*. Wires or cables by which high voltage electric power is moved from point to point.

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

*Volt*. The difference in potential required to make a current flow through a resistance; V = joules/coulombs.

*Voltage*. The amount of force employed to move a quantity of electricity.

*Watt*. A unit of measure for electric power equal to the transfer of one joule of energy per second; watt = volts x amperes.

*Weight*. The measure of gravitational force acting on a substance; W = Fgrav = Mg.

*Work*. A force acting against resistance to produce motion in a body is said to do work; Work = force x distance or W = Mgh.

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