DOCUMENT RESUME

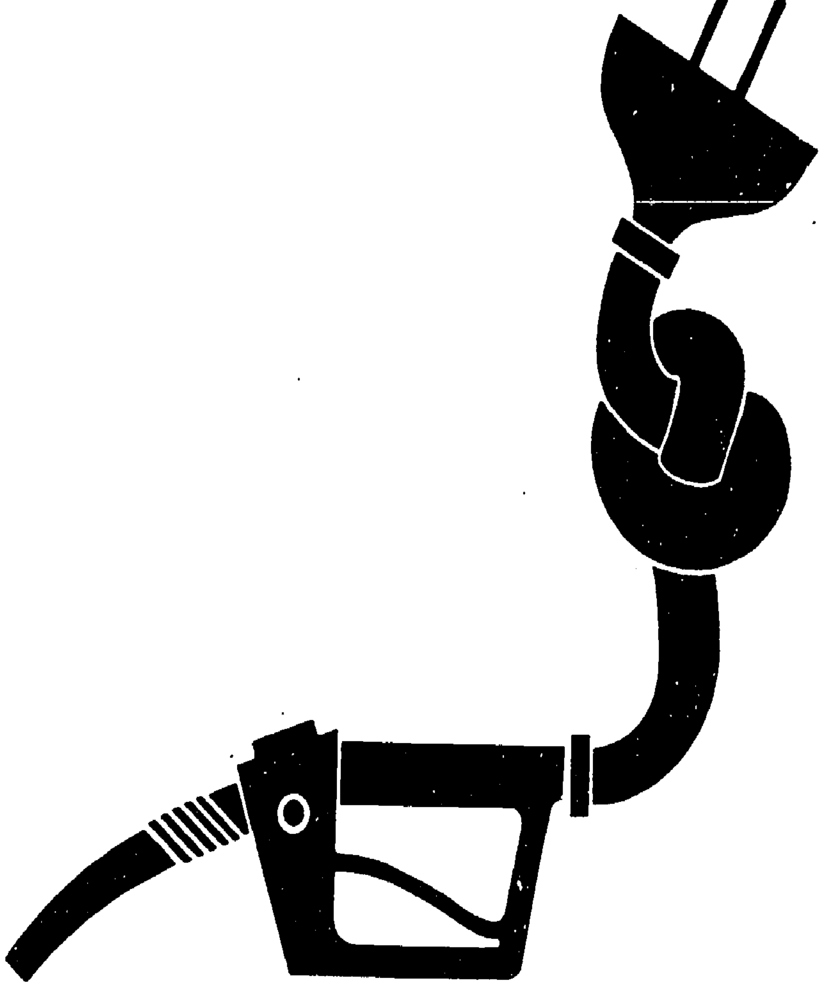
ED 197 998 SE 034 179

TITLE	Energy: What Can We Do Right Now? Easy Energy Reader, Book III.
INSTITUTION	Information Planning Associates, Inc., Rockville, Md.
SPONS AGENCY	Department of Energy, Washington, D.C. Office of Consumer Affairs.
REPORT NO	EDM-1139
PUB DATE	May 80
CONTRACT	EU-78-C-01-6497
NOTE	67p.: For related documents, see SE 034 177-180. Photographs may not reproduce well.
AVAILABLE FROM	Department of Energy, Technical Information Center, P.O. Box 62, Oak Ridge, TN 37830 (free).
EDRS PRICE	MF01/PC03 Plus Postage.
DESCRIPTORS	*Content Area Reading: *Energy: *Environmental Education: *Interdisciplinary Approach: Junior High Schools: Opinions: *Reading Materials: Science Education: *Social Studies

ABSTRACT

Highlighted in this collection of five articles on the nation's energy problems are the viewpoints of black people, environmentalists, consumers, and utility executives. Also included is a group of statements to help the reader develop a personal energy policy. Intended for junior high school language arts classes, this is the third in a series of four books on energy. Each article is rated for readability according to the Gunning Fog Index. By referring to these scores, a teacher can provide students with increasingly more challenging reading material. An energy glossary and list of related readings follow the articles. (WB)

EDM-1139
May 1980
U.S. Department of Energy



BOOK III
EASY ENERGY READER

ENERGY:
WHAT CAN WE DO RIGHT NOW?

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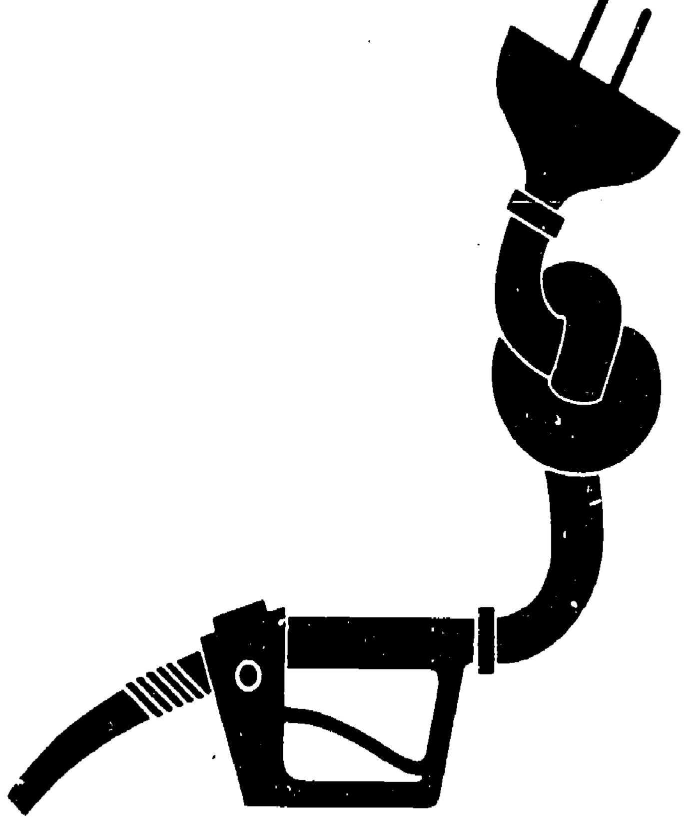

BOOK III

EASY ENERGY READER

ENERGY: WHAT CAN WE DO RIGHT NOW?

Prepared by
Information Planning Associates, Inc.
Under Contract No. EU-78-C-01-6497
for
The Department of Energy
Office of Consumer Affairs
The Education Programs Division
Washington, D.C. 20585

BOOK 3

ENERGY: WHAT CAN WE DO RIGHT NOW?

· panels being installed in the roof of an elementary school in Atl

PREFACE
TO THE INSTRUCTOR

As current issues have come to play a greater role in the language arts curriculum, the need for up-to-date materials on the technical and social foundations of these issues has increased. This has been a particular problem for the instructor of junior-high and middle school students, who may find that debate manuals and source books do not adequately consider the reading skills of the younger reader. Nowhere is this more evident than in the area of energy. The *Easy Energy Reader* has therefore been developed to help fill this information gap as well as to direct instructors and students toward other useful materials.

To facilitate reading, the *Reader* has been divided into four volumes. Book 1 discusses what energy is, where it comes from, how it is stored, and how it is transported; Book 2 talks about the history of energy and how it has come to play such an important role in our daily lives; Book 3 analyzes the causes of the nation's current energy-related problems and offers possible solutions; and Book 4 provides an insightful look at future energy technologies.

The readings in these books were selected on the basis of their currency, their importance to the student's understanding of energy issues, and their readability. The articles chosen provide a wide range of readability levels, which will accommodate the wide range of abilities found in middle school and junior high classrooms.

The Gunning Fog Index, with slight modifications, proved to be the most useful in scoring entries for the *Reader*. We elected to apply the index to a 300 word sample rather than the 100 word sample cited in the instructions to ensure the accuracy of the results. Also, certain three-or-more syllable words were not counted, as the formula suggests, because of their frequent recurrence and the obvious ease of the word, such as energy, conservation, etc. On occasion, it was necessary for the researcher to use his discretion in adding a point or subtracting a point because of the importance average sentence length plays. If it was noticed that sentences in certain articles were rather short but the text complicated, a point was added in most cases. Whereas if the reverse was true, i.e., long sentences but uncomplicated text, a point was then subtracted, thus producing a more accurate readability level for that article.

The formula that we used works as follows[1]:

1. Select a sample of 300 words.
2. Find the average sentence length.
3. Count the number of words of three syllables or over (Do not count proper nouns, easy compound words like "bookkeeper," recurring familiar words such

[1] Editor's Note: Adapted from *Toward World Literacy*, by Frank C. Laubach and Robert S. Laubach, Copyright © 1960, Syracuse University Press.

as "automobile" or "energy," or verb forms in which the third syllable is merely the ending, as, for example, "directed.") Divide by 3.

4. Add average sentence length to the number of "hard (three-or-more syllable) words."
5. Multiply the sum by .4 (four-tenths). This gives the Fog Index.

The equation for steps 4 and 5 is:

Number of "hard words"	= Average number of words per sentence	× .4	= The Fog Index

The table below lists in increasing order of difficulty the articles that are included in Book 3, *Energy: What Can We Do Right Now?*

TITLE	FOG INDEX*
We Can Produce Lots of Cheap Energy, If Only	6.0
Stop Taking Us for Fools	6.5
Let's Keep Our Energy Clean	9.0
Make Your Own Energy Policy	9.0
Energy Policy and Black People	11.0

*[illegible]d to nearest .5.

By providing an array of readings in the four books of this series, we hope to make the *Reader* more useful to the teacher who wishes to individualize instruction or to develop a curriculum of increasingly more challenging reading. Students can be encouraged to increase their energy vocabularies by studying the glossary at the back of each book.

Many of the readings lend themselves to problems in distinguishing between fact and opinion, and may be useful as background for mini-debates. Role-playing activities in which students represent the positions of consumer, environmentalist, or electrical utility executive could also be drawn from most of the articles, or current newspaper editorials might be analyzed according to whether the *Reader's* authors would agree or disagree. Students might also be encouraged to write their own letters to the editor in reply.

Simulated news broadcasts and interviews could be prepared using this material, or the readings could be used as preparation for interviewing people from the community, such as representatives of the solar equipment industry, utilities, alternate energy activists and school personnel responsible for reducing energy use.

There are of course many other uses for the *Reader*, both as part of the regular curriculum and as a resource for independent study. For example, it provides a number of good models of technical writing, a skill which is usually not taught until the student's senior year or college, if then. Yet educators have observed that the best time (the 'teachable moment') to help students communicate about a subject is while they are discovering their interest in it rather than after they have become immersed in its jargon and shorthand. We hope the *Reader* can help achieve that objective. We would appreciate your ideas and comments and those of your students. Please address them to:

Education Programs Division
Office of Consumer Affairs
U.S. Department of Energy
Washington, D.C. 20585

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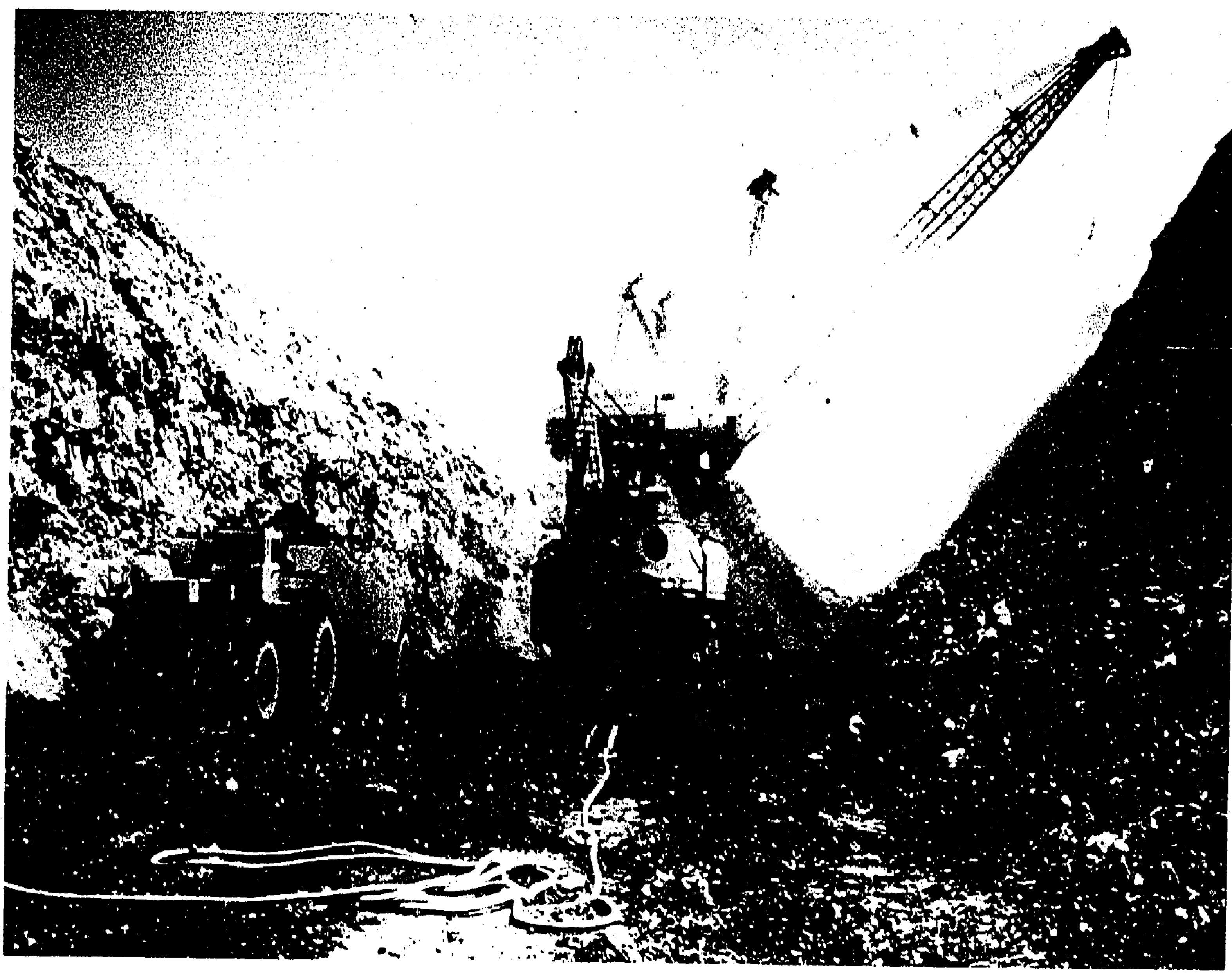


Coal fields in the western United States are near the surface and are mined in the manner pictured here.

INTRODUCTION

Just Imagine

Imagine that it is night, and everything around you that runs on electricity has stopped forever. The lights. The heating and air conditioning. The television and radio. The refrigerator. Street lights and stop lights and clothes washers and driers, stoves and toasters and hair driers and stereos. What else has stopped? Could you pick up the phone to call someone and find out why everything that uses electricity has stopped?

How would you see? How would you stay warm in winter and cool in summer? How would you send messages and be entertained at home? How would you wash and dry your clothes and cook your food?

You would look for other ways to do these things; you would look for other kinds and sources of energy. You might find that you could get along just fine without many machines. Just because your electric toothbrush wouldn't buzz any more would not mean you had to stop brushing your teeth. And you might discover that you could do without a clothes dryer by letting the sun do the drying.

Try to think of other ways to replace electricity in your daily life.

It Wouldn't Be The First Time

Just about everyone knows that there was a time when we had no electric heat for our homes. It simply didn't exist. Yet people stayed dry and warm by burning oil. Many homes are still heated that way.

What about the days *before* oil? We burned coal. Many homes in the world still do. A lot of factories do, too. And coal, like oil and gas, is now burned to make electricity. And how did we keep warm before coal? We burned wood.

In fact, all through history we have found ways to keep ourselves warm and dry and to cook our food and to make enough light to see by. We have used many, many sources of energy.

This Book Is About Energy

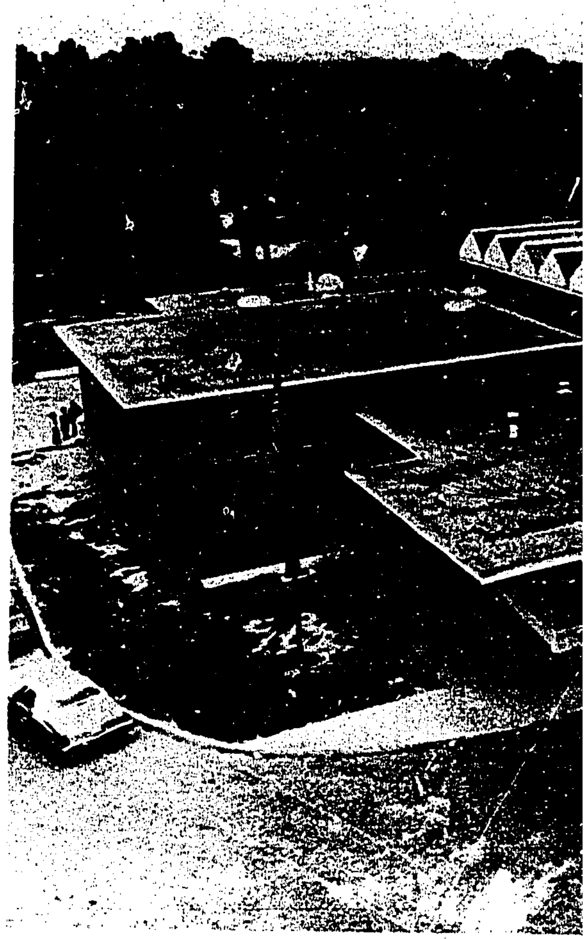
This book is about the energy that runs machines and lights and furnaces and electric blankets and automobiles. It is about how we get energy from many sources, and what we can do when one source or several sources begin to run out. This book will help you understand why it is important not to waste energy, as well as point out some of the things we can do to save it. It will help you think about what *you* want to do to help make sure there will always be plenty of energy for all of us.

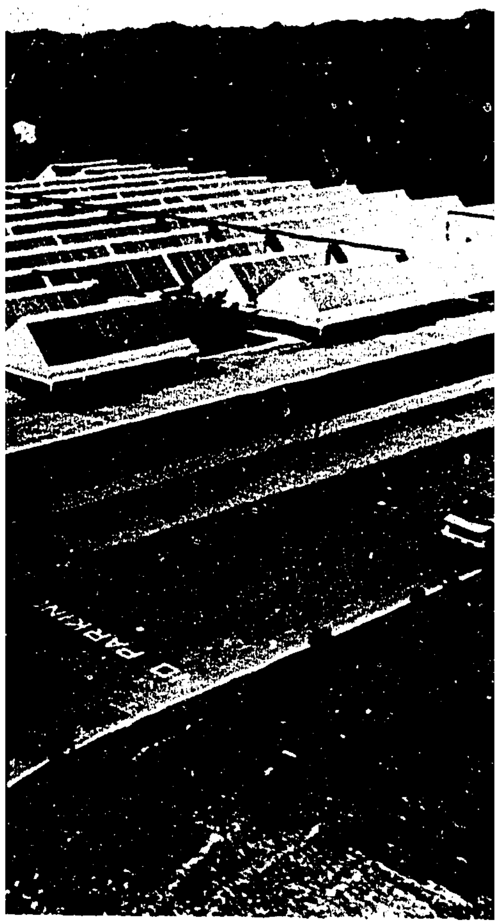
This Book Has Many Authors

The chapters of this book come from many different books and magazines. Each chapter is about a different part of the subject of energy: what it is, where it comes from, why some kinds are becoming very expensive, how different people feel about it, and many other topics. Remember, these are not official opinions of the United States Department of Energy. Instead, the chapters will give you an idea of what many different people are saying about energy. You will see that people disagree about how to make sure there will always be enough energy. But everyone agrees that each of us will have to make important choices about energy. That is why we hope you will find this book useful.

This Book Can Be Used In Many Ways

This book can help you learn to read about energy. Some chapters are harder than others, and your teacher can suggest the chapters to start with and the ones to read next. (There is also a list of energy words at the end of this book to help you build your vocabulary.) When you find a chapter you especially like, you may want to read the book from which it came. The first page of each chapter will tell you its source. Then look in the list of suggested reading for information that will help you find the original book or magazine. If it is not in your school library, your librarian may be able to help you get it from another library. Another way to use this book is to close it up every so often and look around you at what energy does. Think about which uses of energy are really necessary and which are not. Think about what you would be willing to give up for a gallon of gasoline or the comfort of an air-conditioned building. Then, when you are finished with this book, pass it on to a friend. By putting our energies together, we can help to assure a bright energy future for everyone.





in Atlanta, Georgia.

Energy Policy And Black People Participating In The Solutions

Rarely, if ever, has our nation been confronted with a major policy issue so little understood by so many people. Americans have been exhorted to respond to an energy crisis which many doubt exists, and which few pretend to comprehend. Many sectors of our society have advanced proposals, produced massive tomes of documents, and argued fiercely. But even after years of this, the public still has the feeling of giants groping in the dark.

And amid this confusion, black people and poor people have seen their fuel costs rise, their jobs endangered, and their interests ignored. It is only within the past few weeks that the media has paid any attention to the black stake in the energy debate, and public policy-makers have never shown even passing interest in the black role in energy policies.

Tonight I would like to talk about some of the major issues in the energy crisis and state some of the major factors the National Urban League believes should be part of national energy policies.

By way of preface to my remarks, I want to point out that the National Urban League has been active in proposing energy policies and speaking out on the impact of such policies on blacks and other minorities since the inception of the energy crisis back in 1974.

Just about everyone agrees on some basic principles governing energy discussions. It is recognized that our advanced industrial economy depends on an assured supply of energy sources; that there is a need to make our use of energy as efficient as possible; that development of renewable energy sources is desirable, and that lessened dependence on imported energy is vital.

How we reach those goals is a matter of debate, and while passions have been inflamed in the process of debate, we should remember that reasonable people may differ, and differ profoundly. Honest opinions may diverge, interests may clash, and legitimate social and economic considerations may be pursued. So let us recognize this at the outset, and let us also recognize that the interests of America's poor must be granted equal weight with those of other interest groups in the course of this national debate.

The energy crisis consists of the damaging effects caused by rising energy prices and of long-term depletion of non-renewable energy sources such as oil. The era of industrial development powered by cheap fuel is over. There is no free

Note: Delivered at the Northern States Power Company Consun[illegible]ty Conference, Minneapolis, Minnesota, January 20, 1978.

market for oil—the market is effectively controlled by the OPEC monopoly. Cheaper domestic resources are rising to meet artificially high world prices. At the same time, more intensive use accelerates their depletion. World energy resources are still enormous. No one knows for sure how much oil there is, but it is reasonable to assume that present reserves are vastly understated, and that new fields are certain to be discovered. Since the inception of the energy crisis in late 1973, massive fields have been developed in Alaska, Mexico and the North Sea. As one expert has said, "The crunch . . . is like the horizon—it recedes as you approach it."

But oil *is* a finite resource. Sooner or later it will be depleted. Sooner, if demand increases at the rate it has been—this nation uses twice as much oil today as it did in 1963. Clearly, that cannot continue.

Oil and gas prices have risen to the point where other energy sources have to be part of a national energy plan. Coal, nuclear energy, and others are most often mentioned. But traditional energy sources require immense amounts of capital for their development.

We all understand the higher prices we are paying for current supplies. But the glib expectations that drilling more oil fields, digging more mines, or building more reactors will mitigate this inflationary impact are false. The capital requirements needed for energy development are tremendous, both in physical costs and in the costs of the skills, labor, materials and other aspects of development.

Whether financed by private industry or by the government, traditional energy sources will impose unbearable financial burdens on our economy. They would create sharp inflationary pressures and would drain from other sectors of the economy the dollars and skills they need.

Industry seems prepared to cope with this. Calls for deregulation and for price rises as incentives to produce more oil, gas, and other energy sources treat energy as if it were a typical consumer item. If prices rise for, let us say, widgets, you and I could decide whether or not we want to buy widgets and act accordingly. Widget manufacturers would point to the highest prices as being an incentive to them to make more widgets, and if volume declines then their profit margins on those that are sold could well induce them to keep their prices high.

But energy is different. Most of us have no choice about heating our homes or driving our cars. Industry can't run its plants without energy. Higher prices—no matter how much people cut back—of necessity must work their way through the economy and affect all prices of all products.

So deregulation does not seem to me to be the route to go. Energy is different; its importance is manifest. It has to be treated differently. Deregulation and allowing domestic prices to rise to the OPEC monopoly levels would indeed provide more income—much more income—to oil and gas producers, but at an intolerable cost to the rest of us. And there is a healthy suspicion that present price levels offer enough incentives to industry. Gas and oil prices have risen sharply over previous levels and the companies engaged in resource production are doing well. Their claim that current profits are not high enough to meet future capital needs has to be taken seriously. But at the same time, we must realize that investment is never financed solely from profits. Profits need only be high enough to attract and cover debt and equity funds over the long term.

Therefore, I oppose deregulation, and further suggest that price controls and regulations be extended to all domestic gas and oil and to intrastate natural gas as well. Prices should be high enough to ensure reasonable profits and incentives for development of new fields, consistent with the public's need for reasonably-priced energy.

The Administration has attempted to meet national energy needs with a program that would encourage conservation, continue to regulate prices while imposing massive tax increases that would bring consumer prices to world levels, and then rebate those taxes to cushion their inflationary [illegible]ct.

This plan is flawed in that the specifics of its proposals on conservation and price are matched by the vagueness about the rebates—who would get them and how they would work. Nor has Congress adequately dealt with the issue. If we can be sure about anything in this unpredictable world, it is that the poor will suffer from whatever energy plan emerges from Washington in 1978.

I have already discussed how price rises and capital costs associated with development of traditional energy sources will inevitably lead to an inflationary spiral that would devastate the poor and minority community while crippling the economy. Unemployment would be likely to increase, especially for underemployed and unskilled workers.

Black people have a stake in national economic growth. Our piece of the pie has always depended to an unjust extent on the growth of the national economic pie. A shrinking economy inevitably means compounded black disadvantage.

Economic growth and sound energy policy are not incompatible. Economic growth and conservation are not incompatible. Economic growth and the development of renewable energy resources are not incompatible. Economic growth and measures to shield poor people from the negative effects of an energy policy are not incompatible.

Continued—and increased—national economic growth must be the central element of a national energy plan. There can be no compromise, no adoption of slower national economic growth as the cost of implementing energy policies.

And, in my view, the three pillars of a sound energy policy include conservation, development of renewable energy resources, and shielding the poor from negative fallout effects of energy policies. These three pillars must support the structure of continued economic growth with emphasis on including the poor and minorities in that growth.

The first pillar of a sound energy policy should be conservation. We are familiar with exhortations to save energy but often refuse to bite the bullet and implement programs that will lead to energy conservation. Distasteful as it may be to many of us, our cars and trucks will have to be made more fuel-efficient, our homes insulated, our transit systems improved, and our materials recycled. It is of relatively little importance whether deadlines to meet specific requirements are set for 1980 or 1983, or even 1987. The point is that such requirements are inevitable and they'll have to be implemented, the sooner the better. Where imposition of such requirements may be economically unsettling in short term, they should be delayed or compensated for in some fashion. But there is no [illegible] they can be totally avoided. The sooner administrators and industries come to grips with this, the better it will be for all.

Phasing in such regulations can be arrived at with a due understanding that industry needs assistance to readjust to an energy-scarce environment, and incentives to do so voluntarily. Above all, the national priority of economic growth must be central to our efforts to help industry's conservation efforts.

I disagree with those who say conservation must mean slower economic growth. Conservation means rational use of limited resources. It means using different forms of energy for uses to which they are best suited. It means eliminating waste. Per capita energy usage in the United States is typically several times that of other highly industrialized nations with high living standards. We as a nation must not fall into the trap of assuming that slower growth of energy usage means slower economic growth or no growth at all.

The major attraction of conservation is that it offers the greatest savings at the least cost. Some experts claim that conservation and application of low-cost technical aids could nearly double the efficiency with which we use energy. Changes in building design and modification of existing structures could save significant portions of our energy use while saving huge capital sums that would otherwise be expended on non-productive fuel costs.

In general, sound conservation policies could lead to efficient use of energy at no loss of jobs or major lifestyle compromises, while avoiding the inflationary impact on energy costs.

The second pillar of a sound energy policy should be massive development of non-renewable resources and nonconventional technologies.

There is plenty of gas, oil and coal in the ground and under the sea. But whatever the price and whoever develops them, they are finite and ultimately will be used up. The closer we get to exploiting the marginal wells and mines, the higher the cost. Present energy resources have to be seen as aids in the transition to renewable energy resources, and not as limitless ends in themselves.

Nuclear development has often been cited as eventually supplanting the more traditional energy sources. Ever since the first atomic bomb went off, nankind has been hypnotized by the possibilities of peaceful development of the atom, and nuclear breeder reactors have been looked upon as the long-awaited technical fix that will free us from dependence on finite gas, oil and coal.

But there are serious objections to nuclear nergy that should lead us to stress other energy ources. One of these is cost. Reactors are the most xpensive way to meet energy needs. Their construction and development impose price restraints hat must be considered. Expanded nuclear energy ar[illegible]th it capital costs that encourage inflation. There are also serious safety considerations: there is no known way in which radioactive nuclear wastes can be safely disposed. This is not an idle consideration; the health and safety of the nation are involved. Other objections to expansion of nuclear energy include international proliferation, terrorist attacks, health and safety risks, and the irreversibility of nuclear dependence once it is developed on a wide scale.

Other forms of energy also have serious drawbacks, but may be more amenable to technological solutions. Coal, for example, has been out of favor because of air pollution considerations. But there now exist technologies that can burn coal cleanly, use it more efficiently, and to raise steam and to power turbines, all at far lower costs than conventional power stations.

Co-generation is another major area of adapting technology to the needs of the economy. This is the term used for generating electricity as a by-product of the steam normally produced in many industrial plants. A study by industry economists estimates that half of the electricity needs of American industry could be met by co-generation within the decade. This is yet another example of how growth and jobs can be reconciled with sound energy use.

This also suggests that non-conventional energy sources utilizing new technologies can provide much of the nation's energy needs at only a fraction of the immense capital outlays required for oil exploration and for nuclear development.

The energy debate has largely ignored this. It has focused on traditional energy sources at the expense of solar, wind and other natural, renewable energy sources. Yet such sources do exist, the technologies required to develop them are either in existence already or would be with adequate research funds, and many are at the brink of commercial viability.

A national energy policy that stressed renewable energy resources, not for some distant future, but here and now, could well bring the potential of such sources to fruition.

I believe we should regard the claims of the active supporters of renewable energy with the same suspicions with which the claims of vested industry interests are regarded. Both groups tend to promise so much that we wonder if they really can deliver. But even looking at renewable energy conservatively, it is clear that the potential is impressive and should be supported by a massive research, development and implementation program.

A national energy pattern that uses energy sources based on their applicability to intended use is vital. More traditional, high-cost energy will still be needed for many uses. But for many other energy uses, low-cost renewable sources are more rational. This is especially so since fossil fuels are c[illegible]ed for low-grade purposes for which they are not suited. It has been said, for example, that electricity meets 13 percent of the nation's low-grade end use needs, and generating that electricity takes up 29 percent of our fossil fuels.

Black people have a major stake in the development of renewable energy sources, first because they would likely mean far lower fuel and heating costs, and second, because of their economic potential.

Development of renewable energy sources amounts to creation of a new sector of the energy industry, an industry in which black participation has been minimal. Adaptation of new energy technologies typically requires less capital, fewer skills, and are more labor intensive. Neighborhood-based heating installations, rooftop solar devices and community-based energy technologies are suited to small scale business development and to the training and employment of poor people and minorities. So too, are programs of insulation and of modifying existing structures to make them more energy-efficient.

Here again, it is clear that economic growth and sound energy policy are not mutually exclusive but mutually reinforcing.

The third pillar of sound national energy strategy has to be assistance to poor people. This means not only maintenance of economic growth and preservation of jobs, but assurance that energy considerations will not jeopardize jobs in industries with concentrations of minority workers. It also means that effective measures must be taken to shield the poor from the effects of high energy prices and shortages.

This relates directly to utility pricing practices. Various demonstration projects are now under way to determine the modification of rate designs to encourage conservation, shift usage patterns for more efficient use of power capacity and ameliorate the effect of utility prices on consumers. Such measures should move beyond the demonstration stage with all possible speed.

The poor spend a disproportionate percentage of their meager income on heating their homes. Typically, residential users pay more per unit of energy used than do large-scale users. Poor households paid an average of over seven percent more per unit for their oil and natural gas than did more affluent households, because rates decline as usage increases. Price structures operate to create hardships on those least able to afford them. In effect, poor people are penalized for using less energy.

The Federal Energy Administration reported in 1976 that a typical poor family of four consumed four times less energy than a smaller family with an income of $20,000. Only a quarter of the poor have clothes dryers; only four percent have air-conditioners; poor families use about a fourth of the gasoline used by more affluent families. So poor families don't have to be lectured about conservation; they're already forced to do without the energy-guzzlers regarded by most Americans as essential.

At the same time, poor families are forced to use their higher-priced energy in inefficient ways. Three-fourths of the poor don't have storm windows or doors and half have no insulation. The federal weatherization program is notorious for its failure to be effective in assisting poor families to insulate their homes. For many poor people in urban ghettos, there is no adequate heat and hot water, and rents reflect higher fuel costs, even when services are erratically supplied.

So it should be clear to all that massive federal assistance to meet the energy needs of the poor is a necessity. I have little confidence that any rebate system will effectively compensate lower-income families for the damage done by higher prices and taxes. It may well be that more innovative means are needed. A system of energy stamps may be required, or some other form of effective income transfer adopted. Vague promises of rebates have to be replaced with certain assurances of payments that fully cover increased costs.

Further, indirect means of assisting lower-income families to make their homes more fuel-efficient should be replaced by direct programs that train and employ community-based operations to do the job.

Energy is an enormously complicated issue touching on every aspect of our national existence. Decisions made now will affect us for generations to come. The central thrust of energy policy should be to foster economic growth. Continued reliance on non-renewable energy sources inevitably means high inflation and fewer job opportunities. A sound program of conservation, development of non-conventional technologies and renewable resources, and massive assistance to cushion low-income families and neighborhoods from negative effects of energy policies are essential elements of a sound energy program.

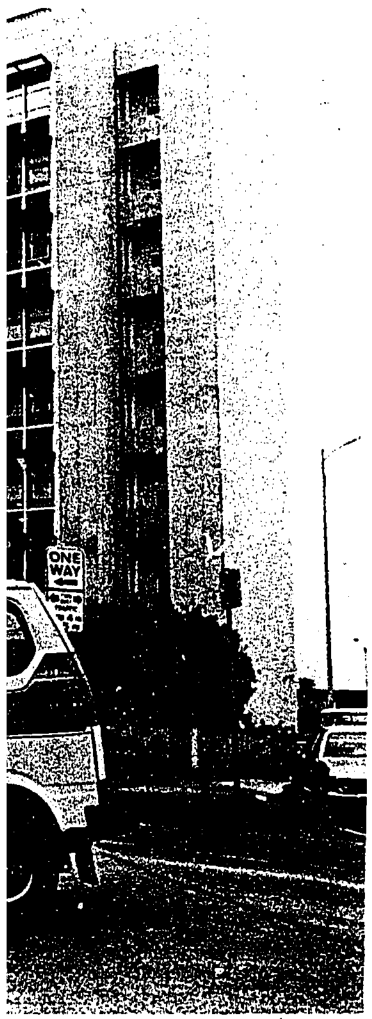
We should not allow ourselves to get locked into a stance that sacrifices growth for fossil energy. We should not get caught into sacrificing real long-term energy policy for short-term waste. We should avoid accepting as irreconcilable the need for jobs and the need for energy.

We should be pragmatic, and flexible. We should preserve the environment. Black people, the most urbanized group in the nation, have a stake in clean air and water too. We need jobs, but we also need to be healthy enough to hold those jobs, and that means adopting energy sources that will minimize pollution. And we need jobs, not only in the plants and factories of America, but at policy-making levels at the Department of Energy and environmental offices, where policies affecting our lives are set.

Above all, we must remember that a national energy policy cannot be framed in a vacuum. It cannot be shaped by powerful interests to the exclusion of groups traditionally left out of policy formulation. The President has called development of a national energy policy "the moral equivalent of war," and like war, we cannot be successful if a significant portion of our people are excluded from full participation in all aspects of that policy.

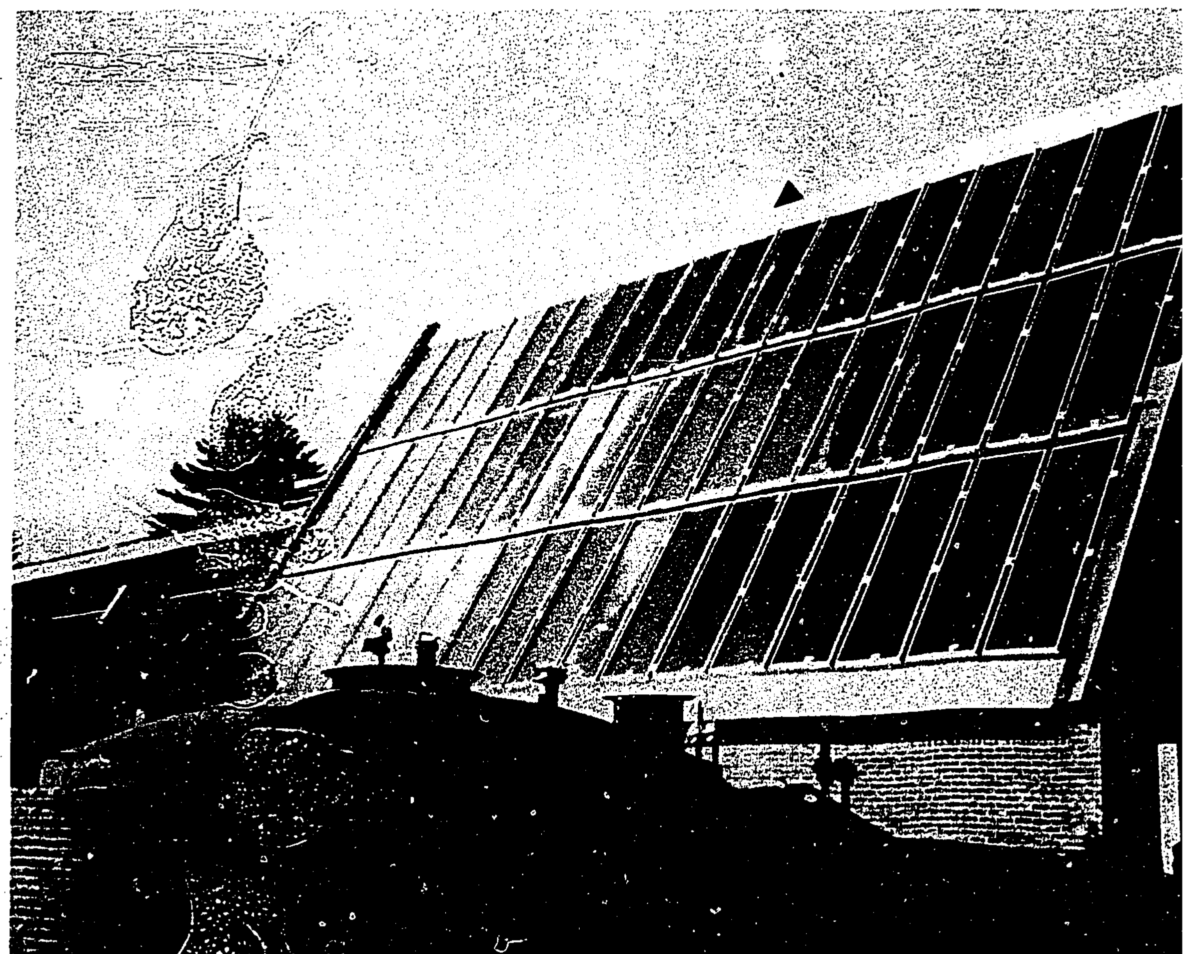
To date, black people and low-income families have been allowed to participate to the extent of bearing the burdens of energy prices. It is now for those groups to participate in framing the policies as well, so that their interests, their concerns, and their needs may be honored.

:red extraction project.


ONE WAY

Viewpoints

Consumer



"Stop Taking Us For Fools"

My name is Charlie Simmons. I'm 42 and the father of a 15-year-old girl and a 13-year-old boy. I work as an insurance salesman. I own a nice house on a quiet street in a suburb of New York City. If you want to call me an "average American," it's OK by me. I'm proud of it. I've worked hard to get where I am.

What's my view of the country's energy problems? First, let me tell you what I want and what I think every American deserves. I think every citizen is entitled to a guaranteed supply of energy at the lowest possible price. It's just as important as having a police or fire department or a school for your kids.

Now, as to my idea of what's going on. All right, I know that the price of imported oil has risen by 400% in the last four years. Boy, do I know it! My heating bill was $110 last month. That's more than double what I paid last year, but my salary hasn't gone up that much. Don't get me wrong; I'm willing to pay my fair share. The point is, I get that sinking feeling that I am paying more than my share. I have the feeling I am being taken for a sucker, a fool.

You want an example? Oil company profits in the third quarter of 1977 were the highest they've been in years. That's profits, mind you, not just the gross amount of money taken in. After they paid all of their workers, plus all of th[illegible]ons of dollars in other expenses, they still made record profits. You don't have to be a math genius to figure out that those oil companies must be charging more for their products than they really need to. As I see it, it's not just the Middle East oil nations that are squeezing money out of us consumers. Our own companies seem to be doing the same.

But whoever is at fault, the consumer is caught in the middle. Energy is like food, clothing, or housing. You can't live without it.

"I'M STUCK"

But, in one way, energy is very different from other necessities. If I don't like the quality or the price of lamb chops at one store, I can go to another store. If I need a new coat, I can look around for an after-Christmas sale. But what choice do I have when it comes to heating or lighting my home? The utility company has no competition. And they don't have "bargain sales." So I'm stuck.

You think I'm exaggerating? Well, do you remember one of the things President Carter said about energy? He said that his government was going to see to it that there would be no "excess profits" made as a result of putting a national energy plan into effect. But it looks to me as though that has already begun, even before a national energy plan has gone into effect.

There are already reports from around the country of people getting cheated by fly-by-night insulation salesmen. Every time you turn around you hear the familiar message: "insulate your home, save energy, save money." People are doing that. But what is happening? Shady operators are selling inferior materials. There are reports from all over the U.S. of home fires resulting from cheap insulating materials. There should be strong federal laws preventing this sort of thing. But, no, once again it is the consumer who gets hit.

Another thing: There seems to be no coordination in this whole energy mess. You look one way and you are told to save energy, you look the other way and you see energy being wasted.

Last winter, for example, we went out to visit my brother and his family in Ohio. Well, it was just about a year ago that they had a horrible energy crisis in Ohio. My niece and nephew were out of school because the schools were closed—no heat. Tom, my brother, was out of work for two weeks because the factory where he works had the same problem.

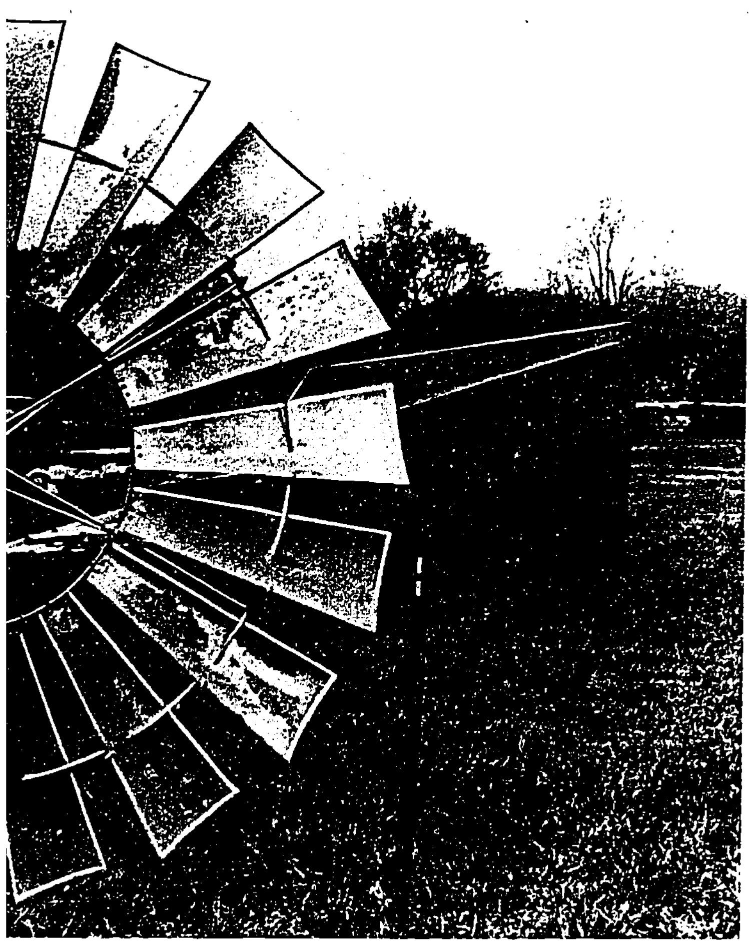
But you know what you saw on TV and in the newspapers? Ads for gas-guzzling cars, electric carving knives, dishwashers and loads of other energy-eaters. Okay, I know everything can't be done overnight. But if there is a crisis, let's start acting like there is.

But you haven't heard the last yet, friend. Let me tell you what happened to about eight million of us consumers here in the New York City area.

For years, the electric company here in New York spent piles of money to tell people to use more electricity. You couldn't open a newspaper without seeing an advertisement from the electric company telling you to buy air conditioners, electric heaters, blenders, dishwashers, and dozens of other "conveniences of modern life."

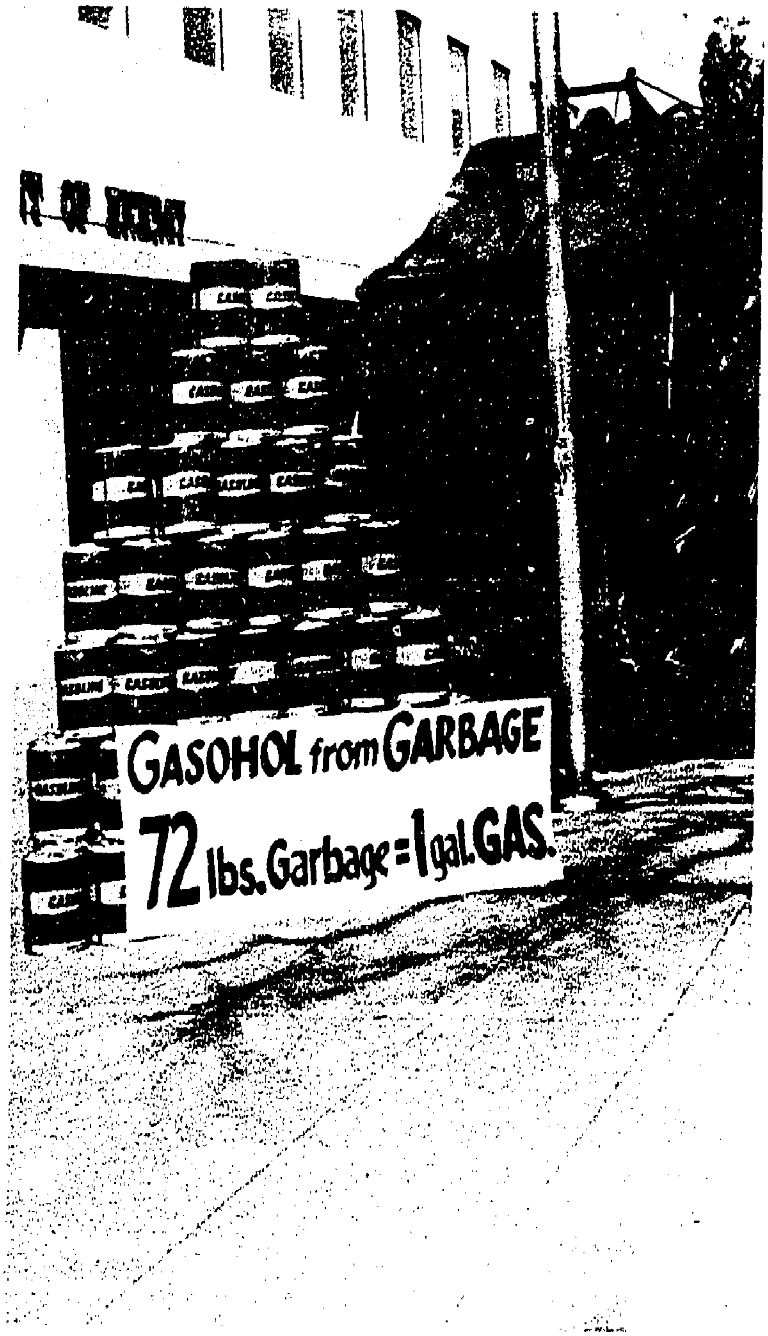
Then, out of the blue, they stop all the ads. They say we've got to save energy. It worked. People did as they were asked. They cut energy use. Guess what happened? The power company said that, *because* people had cut their energy use, bills had gone down. The company wasn't making enough money. So they raised the rates!

I'll tell you what it all boils down to. Consumers *will* do their part. But there has got to be a pay-off. People *will* cooperate, but they must know what it is they are going to receive in return for their sacrifices. We are not going to be made fools of.



Viewpoints

Environmentalist



"Lets Keep Our Energy Clean"

My name's Carrie Sandusky. When I tell people I'm an environmentalist, I watch their faces. I may see anger or admiration, friendliness or distrust. Sometimes, I'm accused of being "anti-people." Other times, I'm praised for trying to save the human race.

I can remember the afternoon in 1969 when I became an environmentalist. I picked up a copy of a magazine, and what I saw forever changed my thinking. The photographs showed birds and beaches caked with thick black oil. An oil well had burst off the California coast. Masses of black slime spread onto the beach. To me, the lesson was clear. In its hunger for more energy, the United States was not giving enough thought to the dangers of ruining the environment.

What scares me most is that it looks as if things will get worse. The government is trying to reduce our use of oil and natural gas. That's good. I'm all for it. The less oil we import or drill, the less oil we'll have to clean up from spills. And the less oil and natural gas we refine, the less air pollution we'll have.

What I don't like, however, are the proposed alternatives to oil and natural gas. The Carter administration says that, for the next 25 to 30 years, we'll have to use more coal, nuclear power, and hydroelectric power. I say, if we do that, we'll be trading some forms of environmental mess for other, possibly more harmful, ones.

The coal people point out that we have an abundant supply of coal, and we know how to extract and use it. But I object.

Surface (strip) mining destroys the land and everything that grows on it. At best, restoring surface-mined land is a long and costly job.

Underground mining is bad for other reasons. Thousands of miners each year are injured in the underground mines. Many die. Countless others suffer from black lung disease caused by years of breathing coal dust. When high-sulfur coal is burned to produce energy, it gives off sulfur-dioxide pollution that can harm humans.

Nuclear power is probably our greatest threat. Nuclear plants might leak radioactive chemicals, endangering our health. And researchers haven't invented a safe way to dispose of nuclear waste, which also is radioactive. Nuclear plants discharge heated water. In some places, the discharge water has caused huge fish kills.

The hydroelectric-power people like to point out that the dams they build are great because they create lakes—which provide recreation for a lot of people. But creating a lake also drowns whole environments of plants and animals.

What would *I* do?

We should launch an all-out campaign to develop clean energy sources. Solar energy is the ideal source. It's clean to produce, clean to use. Unfortunately, it will be a while before solar-energy technology can be widely used.

The answer is *conservation.*

This means we'll have to tighten our belts—use our cars less, cut down on energy-guzzling items such as air conditioners, turn more to energy savers such as insulation.

On a large scale, we can promote conservation by building fewer highways and more mass transit systems, which use energy more efficiently. We can plan cities that provide shopping areas within walking distance of most homes, thus reducing the need to waste gasoline in driving to shops. We can ban, or curb, unnecessary packaging that takes a lot of energy to produce—and often ends up as litter, anyway. We can recycle solid wastes and use them to provide more fuel.

While scientists develop clean energy sources, and consumers conserve, energy suppliers can take some responsibility, too. Electric utilities should be forced to switch, even more, from burning high-sulfur coal to low-sulfur coal. Or, they should install the very best sulfur-scrubbing equipment that reduces pollution. Nuclear plants should cool waste water before discharging it into nearby streams and lakes.

From what I've said, you can see why the energy people might oppc me. They want government to relax the antipollution laws that exist, and to block further environmental regulations. They complain such regulations cost too much.

If we don't stop the pollution of our air, water, and land, the costs will be great. I'm not just talking about wilderness and wildlife. I'm talking about the cost in human lives.

Already, pollution has taken its deadly toll. We spew out 360,000 tons of gaseous waste into the air each day—from industries, as well as from motor vehicles. Most of this waste is invisible and odorless. But it can be harmful. Studies show that Americans spend, each year, from $122 million to $244 million on health problems due to smog. The National Academy of Sciences suggests that, each year, auto exhaust may cause 4,000 deaths.

In the most practical terms, air pollution can be a "business expense." Up to four million of the sick days Americans take each year may be due to air pollution.

Sure, let's decrease our dependence on oil and natural gas—and *all* other polluting energy sources. Let's step up research on solar and other clean forms of energy. In the meantime, let's stop wasting energy, and clean up our energy-producing process. In the long run, we'll be saving our environment—and our health. That will be good for people—and our natural heritage.

Deep mining near Marissa, Illinois, is once again attract
needed to increase the nation's future coal production.

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ɔung miners will be

A turtle is fitted with a heartbeat sensor and radio transmitter as part of waste heat from electric generating facilities.

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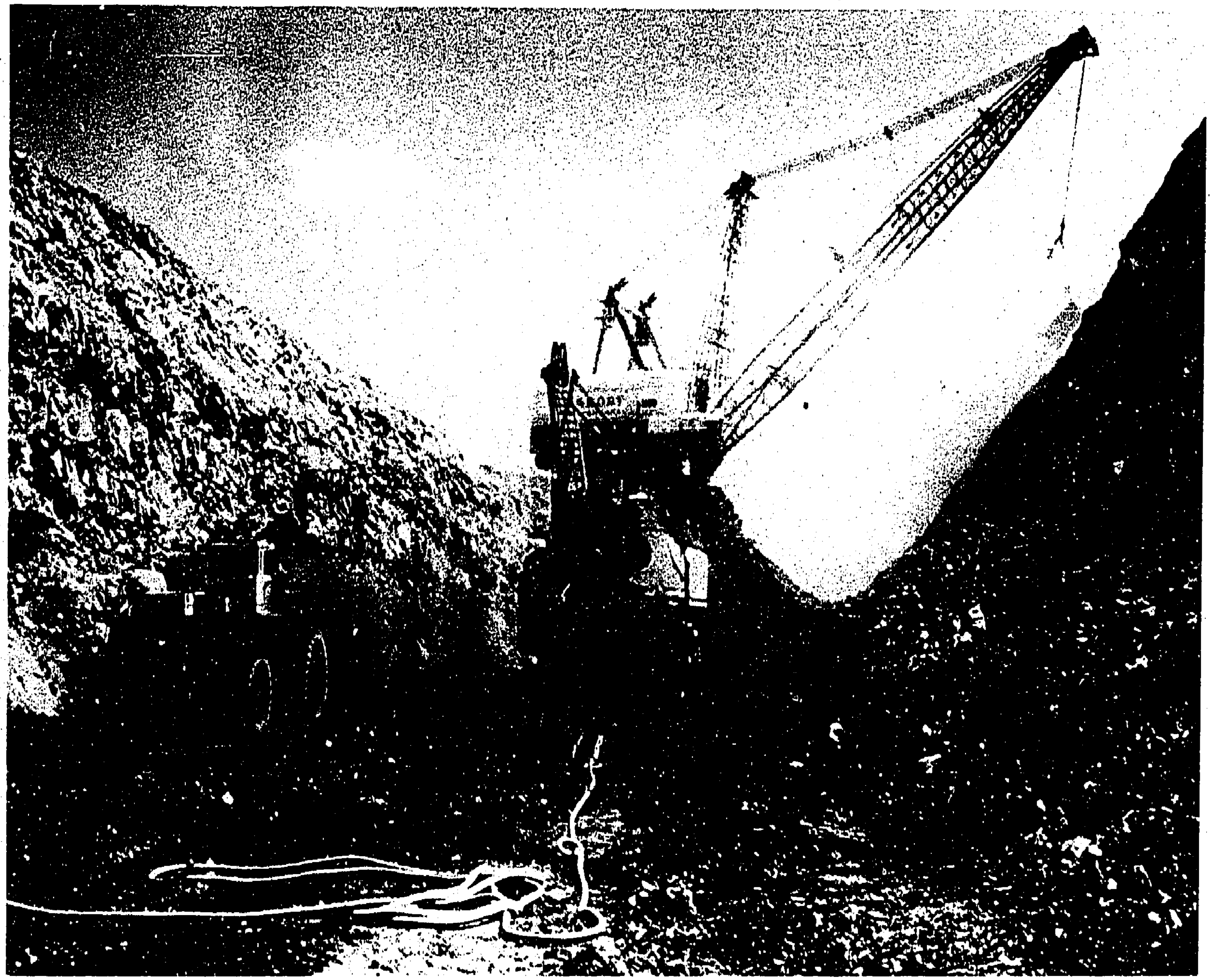


"We CAN Produce Lots of Cheap Energy, If Only . . ."

I'm Dr. Elizabeth Barlow. But just call me Beth. All my friends do.

I'm a vice-president of an electric-utility company called NRG Electric Power and Light. My job is to keep up with R&D. That stands for *research* and *development* of future energy programs.

People are always asking me, "Is there an energy crisis?" And my answer is always *yes*. You can call it anything you want—a crisis, challenge, problem, or dilemma—but it all amounts to the same thing. And it could cause very serious problems for everyone, much sooner than they may think.

The National Electric Reliability Council, whose members represent the nation's electric companies, have just made a report. It warns that electrical utilities could be forced to make big cutbacks of power as early as 1979. If so, I think everybody will agree that blackouts and brownouts are a "crisis."

The funny thing is that we electric-power companies have been warning about possible energy problems for at least 10 years. We have also been calling for a sensible national energy policy. Warnings have been coming from the other energy suppliers, too—the oil, coal, and natural gas people, for example. But it seems nobody has wanted to listen to us energy people. They'd rather hinder than help us.

It seems that no matter what we've wanted to do in research and development—or in planning and building for the future—the government has hit us with rules and regulations, red tape, and know-nothing bureaucrats who couldn't care less.

Back in the 1950's, price controls were clamped on the natural gas producers. Those controls ate away at profits. A lot of us pointed out that if the gas producers couldn't make a fair profit, they wouldn't be able to attract investors. Without investors' money, they couldn't afford to seek out sources of more gas. And that would mean shortages. Well, you saw what happened last winter. Some cities were almost shut down completely for lack of natural gas. People were out of work for days or weeks. It all goes back to those price controls!

Natural-gas companies have to pay higher and higher wages to workers, higher and higher prices for equipment and maintenance. They have to plan ahead. But they can't charge the fair price for the energy they give the consumer. Is that fair?

Price controls are just part of it. We're told to shift to coal, our most abundant natural energy resource. But we're hindered all along the way. The coal people have so many rules and regulations to follow that deep coal mining—mining way below the earth's surface—is barely profitable. Surface mining—strip mining—is often a "no-no" because of environmental concerns about the landscape and nature. If you do somehow manage to get the coal, you have to make sure, when you burn it, you don't violate very rigid air-pollution standards. There's an urgent need for coal-burning electric-power plants—but all these regulations can cause a 10-year delay in building a new one. And meeting regulations, plus delays, costs a lot of money.

Nuclear plants? They can build one in three years or so in Japan. But in the U.S., the regulations can cause delays of up to 14 years.

Clearly, something or somebody has to give. Conservation of energy by everyone is fine and necessary. But it doesn't solve the problem, it only keeps delaying it. During the delay, the energy suppliers must be as free as possible to pursue R&D, to build for the future. You can't do that if you can't raise the money and get some kind of incentive—or if the consumer isn't paying a fair share. You can't do that if anti-pollution laws are so strict.

Up to now, the government rules for us have mostly boiled down to: *You can't.* My hope is that the new Department of Energy will start saying: *You can.* Then, we'll produce lots of energy as cheaply as we can.

MAKE YOUR OWN ENERGY POLICY!

By Elizabeth Dowling

Consumers. Environmentalists. Energy suppliers. Each has different viewpoints on the energy problem—and different suggestions to solve it. Where do *you* stand? What do you think should be done?

To find out where you stand, look at the statements below. Each statement is *most likely* to have been made only by one of three speakers—consumer, environmentalist, energy supplier. Decide if you agree or disagree with each of the statements. [Pull out a sheet of paper and] ... write A (agree) or D (disagree) after [the number for] ... each statement. Then turn to page 28 to find which speaker made the statement. Which speaker did you agree with most?

From the statements you agree with, write your own view of the energy crisis. Propose moves that might relieve or solve some of the problems....

1. My greatest concern is staying free of government regulations, so that I can provide services for my customers and make a profit.

2. My greatest concern is getting all the energy I need, at a reasonable cost.

3. My greatest concern is preserving our land, which provides us with irreplaceable beauty and is our major source of food.

4. Energy suppliers use the crisis as an excuse to raise prices.

5. Suppliers use energy shortages as an excuse to try to avoid meeting safety standards, which increase the suppliers' costs.

6. Finding energy sources for human use comes first, then wildlife.

7. The cost of energy to consumers should be carefully controlled. Otherwise, suppliers will charge consumers as much as they can.

8. Suppliers should be allowed to charge as much as they need in order to expand their energy-producing capacity, and step up the search for new sources. They can't do this if they don't make profits.

9. Suppliers raise consumer bills not because they need the money, but because they greedily want more profits.

10. Consumers should conserve—but I doubt it will do any good.

11. Conservation is only part of the solution. We need to produce more energy.

12. Conservation is essential. If we conserve, we'll need less energy, and we'll have less waste and pollution.

13. Businesses should pay for anti-pollution equipment, because they are responsible for cleaning up their own pollution.

14. Suppliers should be allowed to perform as any business does—to make profits without

having to apologize, and to raise prices when their costs for labor and raw materials rise.

15. Because they are a monopoly, suppliers have consumers in an unfair bind and can charge whatever they want to.

16. Suppliers are in a bind. Their costs rise due to inflation and anti-pollution regulations, but the government forbids them to raise prices.

17. It's more important to preserve the natural beauty of the land than it is to increase energy production, which might lead to pollution.

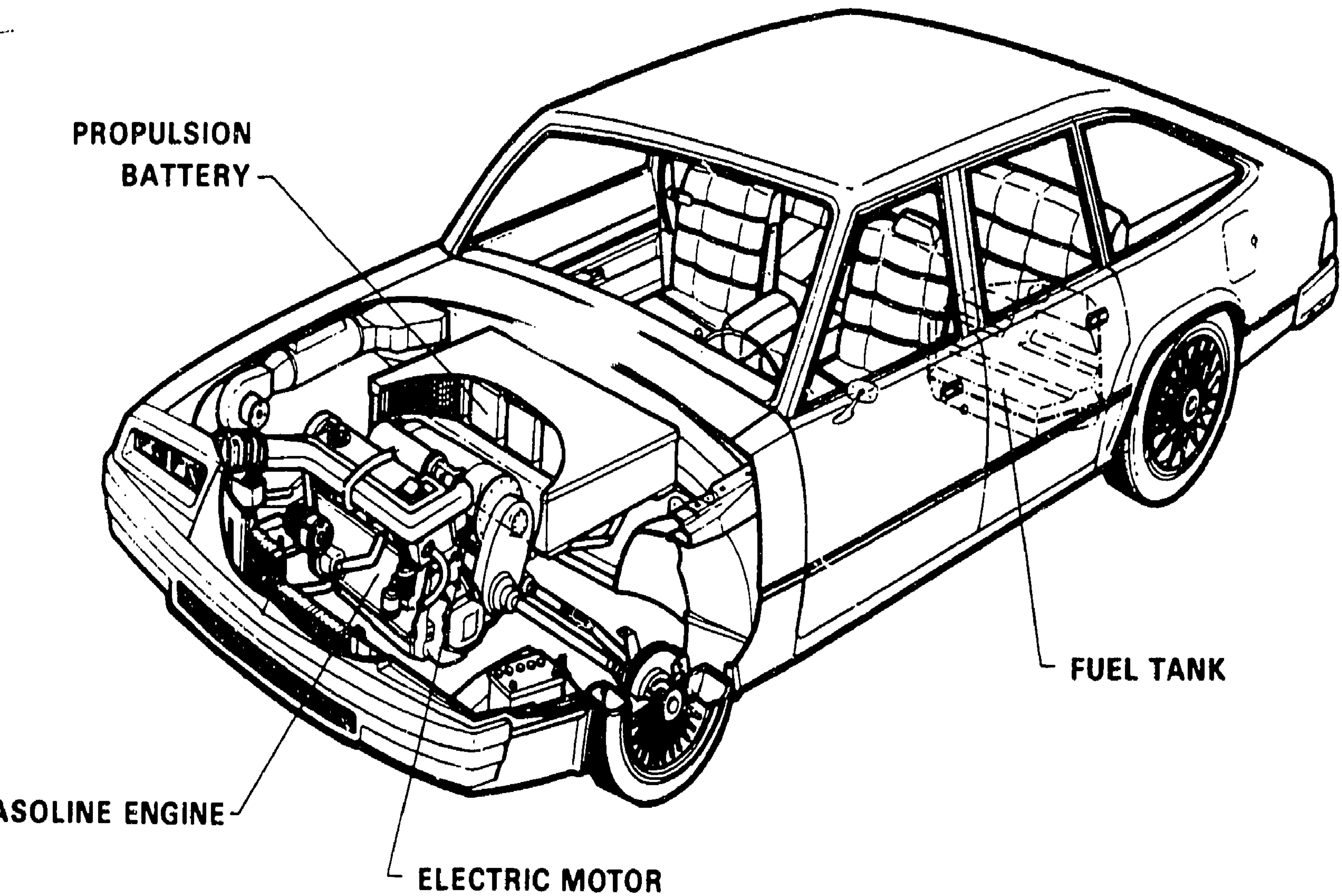
18. Businesses should have to prove that what they produce is more important than the damage they do to the environment.

ANSWERS

The statement was most likely made by a consumer (c), an environmentalist (e) or an energy supplier (s): 1-s; 2-c; 3-e; 4-c; 5-e; 6-s; 7-c; 8-s; 9-c; 10-c; 11-s; 12-e; 13–e; 14-s; 16-s; 17-e; 18-e.

CHECK YOUR ENERGY VOCABULARY

John M. Fowler and King C. Kryger


PROPULSION
BATTERY
FUEL TANK
ASOLINE ENGINE
ELECTRIC MOTOR

A GLOSSARY OF TERMS

amperage—A measure of the volume of flow of an electrical current.

anthracite—"Hard coal," low in volatile matter, high in carbon content, with a heat value of 6.40 million Calories/ton.

atom—Consists of a heavy center or nucleus, made up of protons and neutrons, around which revolve blurs of energy called electrons.

atomic number of an atom–The number of protons in the nucleus.

atomic oven—Another name for atomic furnace. Sometimes called a uranium pile or a nuclear reactor.

atomic pile—A nuclear reactor, arranged to get energy out of the nuclei of atoms. The energy appears as heat.

barrel (bbl)—A liquid measure of oil, usually crude oil, equal to 42 gallons or about 306 pounds.

base load—The minimum load of a utility (electric or gas) over a given period of time.

bioconversion—A general term describing the conversion of one form of energy into another by plants or microorganisms. It usually refers to the conversion of solar energy by photo- :hesis.

biomass—Plant materials in any form from algae to wood.

bituminous coal—Soft coal; coal that is high in carbonaceous and volatile matter. It is "younger" and of lower heat value than anthracite or "hard coal." Heat value, 5.92 million Calories/ton.

black lung—A respiratory ailment, similar to emphysema, which is caused by inhalation of coal dust. Identified as a contributing cause in the deaths of many underground coal miners.

bottoming cycle—A means of using the low-temperature heat energy exhausted from a heat engine, a steam turbine, for instance, to increase the overall efficiency. It usually employs a low-boiling point liquid as working fluid.

breeder reactor—A nuclear reactor so designed that it produces more fuel than it uses. Uranium 238 (92 U^{238}) or thorium 232 (90 Th^{238}) can be converted to the fissile fuel, plutonium 239 (94 Pu^{239}) or uranium 233 (92 U^{233}), by the neutrons produced within the breeder reactor core.

[1] Editor's Note: This material was produced in part by the National Science Teachers Association under contract with the U.S. Energy Research and Development Administration, now a component of the Department of Energy. The facts, statistics, projections, and conclusions are those of the authors.

British Thermal Unit (Btu)—A unit of energy commonly used to measure heat energy or chemical energy. The heat required to raise the temperature of one pound of water 1°F, it is usually written Btu, and is equal to 778 foot-pounds of work or energy.

Calorie—The amount of heat required to raise the temperature of one gram of water one degree celsius.

capacity factor—A measure of the ratio of the electrical energy actually produced at a generating plant to the maximum design capacity of the plant.

capital intensive—Requiring heavy capital investment. The energy industry, for example, is said to be capital intensive rather than labor intensive because it employs relatively more dollars than people.

carbon dioxide (CO_2)—A compound of carbon and oxygen formed whenever carbon is completely burned (oxidized).

carbon monoxide (CO)—A compound of carbon and oxygen produced by the incomplete combustion of carbon. It is emited by automobiles and is, as far as total weight is concerned, the major air pollutant.

carcinogen—A substance or agent producing or [illegible]ing cancerous growth.

catalyst—A substance which changes the speed of a chemical reaction without itself being changed.

catalytic converter—A device added to the exhaust system of an automobile that converts the air pollutants carbon monoxide (CO) and hydrocarbons (HC) to carbon dioxide (CO^2) and water. A similar conversion also removes nitrogen oxides (NO_x).

Celsius—The metric temperature scale in which the temperature of melting ice is set at 0°, the temperature of boiling water at 100°. One degree Celsius is 9/5 of a degree Fahrenheit. The Celsius scale is also known as the Centigrade scale.

Centigrade—See Celsius.

chain reaction—A reaction that stimulates its own repetition. In a fission chain reaction a fissionable nucleus absorbs a neutron and splits in two, releasing additional neutrons. These in turn can be absorbed by other fissionable nuclei, releasing still more neutrons and maintaining the reaction.

char—A porous, solid, nearly pure carbon residue resulting from the incomplete combustion of organic material. If produced from coal, it is called coke; if produced from wood or bone, it is called charcoal.

chemical energy—A kind of energy stored inside the molecules of matter, which may be released or absorbed as their atoms are rearranged.

coal gasification—The conversion of coal to a gas suitable for use as a fuel.

coal liquefaction—The conversion of coal into liquid hydrocarbons and related compounds, usually by the addition of hydrogen.

coal tar—A gummy, black substance produced as a by-product when coal is distilled.

coke—Degassed coal (see char).

commutator—A set of electrical contacts that can convey electrical current between stationary and rotating devices.

conduction—(of heat) The transmission of energy directly from molecule to molecule.

confinement time—(in fusion) The time during which the reacting materials (deuterium and tritium, for instance) are physically confined at proper density to react.

convection—(of heat) The transfer of energy by moving masses of matter, such as the circulation of a liquid or gas.

converting energy—Changing energy from one ...n to another.

cooling towers—Devices for the cooling of water used in power plants. There are two types: wet towers, in which the warm water is allowed to run over a lattice at the base of a tower and is cooled by evaporation; and dry towers, in which the water runs through a system of cooling fans and is not in contact with the air.

critical mass—The smallest mass of fissionable material that will support a self-sustaining chain reaction under stated conditions.

crude oil—A mixture of hydrocarbons in liquid form found in natural underground petroleum reservoirs. It has a heat content of 1.46 million Calories/barrel and is the raw material from which most refined petroleum products are made.

current—The flow of electricity, comparable to the flow of a stream of water.

cyclotron—A machine for splitting atoms on a small scale and under controlled conditions, so that the process can be studied.

declining block rate—A method of charging for electricity wherein a certain number of kilowatt hours (the first block) is sold at a relatively high rate and succeeding blocks are sold at lower and lower rates. Thus the charge for energy decreases as the amount consumed increases. (See "inverted block rate.")

deuterium—A non-radioactive isotope of hydrogen whose nucleus contains one neutron and one proton and is therefore about twice as heavy as the nucleus of normal hydrogen, which consists of a single proton. Deuterium is often referred to as "heavy hydrogen"; it occurs in nature as 1 atom to 6500 atoms of normal hydrogen.

efficiency of conversion—The amount of actual energy derived, by any technique in relation to the total quantity of energy existing in any source being tapped; expressed as a percentage.

elastic energy—The energy involved in the change of a piece of matter from its original shape which tends to restore this shape—as when a spring is stretched or a ball is compressed.

electrical energy—A kind of energy that arises because of electrical forces between particles of matters such as electrons.

electrolysis— The decomposition of a substance by means of an electric current as in the production of hydrogen and oxygen from water.

electron—An elementary particle with a negative charge that orbits the nucleus of an atom. Its mass at rest is approximately 9×10^{-31} kg, and it composes only a tiny fraction of the of an atom. Chemical reactions consist of the transfer and rearrangement of electrons between atoms.

electrostatic precipitator—A device that removes the bulk of particulate matter from the exhaust of power plants. Particles are attracted to electrically charged plates and the accumulation can then be washed away.

energy—A quantity having the dimensions of a force times a distance. It is conserved in all interactions within a closed system. It exists in many forms and can be converted from one form to anther. Common units are Calories, joules, Btus, and kilowatt-hours.

energy intensiveness (EI)—A measure of energy utilization per unit of output. For passenger transport, for example, it is a measure of Calories used per passenger mile.

enrichment—A process whereby the percentage of a given isotope present in a material is artifically increased, so that it is higher than the percentage of that isotope naturally found in the material. Enriched uranium contains more of the fissionable isotope uranium 235 than the naturally occurring percentage (0.7%).

exothermic reaction—A reaction which releases more energy than is required to start it. The combustion reaction (burning) is an example as are fission and fusion reactions.

external combustion engines—An engine in which the fuel is burned outside the cylinders.

Fahrenheit—A temperature scale in which the temperature of melting ice is set at 32° and the temperature of boiling water at 212°. One Fahrenheit degree is equal to five-ninths of a Celsius degree.

fertile nucleus (or "fertile materials")—A material, not itself fissionable by thermal neutrons, which can be converted into a fissile material by irradiation in a reactor. There are two basic fertile materials, uranium 238 and thorium 232. When these fertile materials capture neutrons, they are converted into fissile plutonium 239 and uranium 233 respectively.

First Law of Thermodynamics—Also called the Law of Conservation of Energy. It states: Energy can neither be created nor destroyed.

ission—The splitting of atoms.

luidized bed—A furnace design in which the fuel is buoyed up by air and some other gas. It offers advantages in the removal of sulfur during combustion.

ossil fuels—Fuels such as coal, crude, oil, or natural gas, formed from the fossil remains of ...ic materials.

fuel cell—A device for combining fuel and oxygen in an electrochemical reaction to generate electricity. Chemical energy is converted directly into electrical energy without combustion.

fuel reprocessing—A recycling operation. Fissionable uranium and plutonium are recovered from uranium fuel rods which have undergone intense neutron bombardment in a nuclear reactor and fission products are removed.

fusion—The formation of a heavier nucleus by combining two lighter ones. In the reaction under study as a source of energy hydrogen (or helium 3) nuclei combine to form helium 4 with a subsequent release of energy.

gasoline—A petroleum product consisting primarily of light hydrocarbons. Some natural gasoline is present in crude oil but most gasoline is formed by "cracking" and refining crude oil. It has a heat value of 1.32 million Calories/barrel.

generating capacity—The capacity of a power plant to generate electricity. Usually measured in megawatts (Mw).

geopressured reservoir—Geothermal reservoir consisting of porous sands containing water or brine at high temperature or pressure.

geothermal energy—The heat energy in the Earth's crust whose source is the Earth's molten interior. When this energy occurs as steam, it can be used directly in steam turbines.

greenhouse effect—The warming effect of carbon dioxide, CO_2, and water vapor in the atmosphere. These molecules are transparent to incoming sunlight but absorb and reradiate the infrared (heat) radiation from the Earth.

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

heat—A form of kinetic energy that flows from one body to another because of a temperature difference between them. The effects of heat result from the motion of molecules. Heat is usually measured in Calories or British Thermal Units (Btu's).

heat engine—Any device that converts thermal heat energy into mechanical energy.

heat pump—A device that transfers heat from a cooler region to a warmer one (or vice versa) by the expenditure of mechanical or electric energy. Heat pumps work on the same general principle as refrigerators and air conditioners.

heat value—The energy released by burning a given amount of the substance; also energy equivalent.

Helium 3 (${}_2He^3$)—A rare, non-radioactive isotope of helium.

Helium 4 (${}_2He^4$)—The common isotope of helium.

horsepower—A unit of power equal to 550 foot-pounds of work per second.

hot rock reservoir—A potential source of geothermal power. The "hot rock" system requires drilling deep enough to reach heated rock then fracturing it to create a reservoir into which water can be pumped.

hydrocarbons—Molecules composed of carbon and hydrogen atoms in various proportions. They are usually derived from living materials.

hydroelectric—Producing electrical power by the extraction of energy from the force of moving (usually falling) water.

hydroelectric plant—An electric power plant in which the energy of falling water is converted into electrical energy by a turbine generator.

hydrogenation—The addition of hydrogen to an organic molecule to increase the ratio of hydrogen to carbon, for instance in the production of oil from coal or from organic waste.

hydrothermal reservoir—One of the forms of geothermal reservoir systems. Consists of naturally circulating hot water or steam ("wet steam") or those which contain mostly vapor ("dry steam"). The latter type of hydrothermal reservoir is the most desirable type with present technology.

inertial confinement—One of two major techniques used in nuclear fission experimentation. (See "Magnetic Confinement".) A frozen pellet of deuterium and tritium is bombarded from all sides by an energy source—a laser beam of charged particles. The resulting *implosion* of the pellet results in high temperature and density which allows ignition of the fusion reaction and the pellet *explodes.*

internal combustion engine—An engine in which power is generated within one or more cylinders by the burning of a mixture of air and fuel, and converted into mechanical work by means of a piston. The automobile engine is a common example.

in situ—In the natural or original position or location. In situ conversion of oil shale, for instance, is an experimental technique in which a region of shale is drilled, fractured, and set on fire. The volatile gases burn off, the oil vaporizes, then condenses and collects at the bottom of the region, from which it can be recovered by a well. There also has been some experimentation with in situ conversion of coal.

inverted block rate—A method of selling electricity wherein a first "block" of kilowatt hours is offered at low cost and prices increase with increased consumption.

ionization—Removal of some or all electrons from an atom or molecule, leaving the atom or molecule with a positive charge, or the addition of one or more electrons, resulting in a negative charge.

ions—Atoms or molecules with electric charges caused by the addition or removal of electrons.

isotope—Any of two or more species of atoms having the same number of protons in the nucleus, of the same atomic number, but with differing numbers of neutrons. All isotopes of an element have identical chemical properties, but the different nuclear masses produce different physical properties. Since nuclear stability is governed by nuclear mass, one or more isotopes of the same element may be unstable (radioactive).

joule—A metric unit of work or energy; the energy produced by a force of one newton operating through a distance of one meter. One

Btu = 1055 joules, and one Calorie = 4.185 joules.

kerosene—A petroleum distillate with a heat value of 1.43 million Calories/barrel presently used in gas turbines and jet engines.

kilocalorie—See Calorie.

kilowatt (kw)—A unit of power, usually used for electric power, equal to 1,000 watts, or to energy consumption at a rate of 1,000 joules per second.

kilowatt-hour (kw-hr)—A unit of work or energy. Equivalent to the expenditure of one kilowatt in one hour, about 853 Calories.

kinetic energy—The energy of motion. The ability of an object to do work because of its motion.

land subsidence—The sinking of a land surface as the result of the withdrawal of underground material. It results from underground mining and is a hazard of the development of geothermal fields.

langley—The amount of energy from solar radiation that, falling on an area of one square centimeter facing the sun on a clear day, equals one calorie of heat.

laser—A device for producing an intense beam of coherent, sharply focused, light. The name is an acronym for Light Amplification by Stimulated Emission of Radiation.

Law of Conservation of Energy—See First Law of Thermodynamics.

Lawson Criterion—A rough measure of success in fusion. For a self-sustaining fusion reaction to take place, the product of the confinement time (in seconds), and the particle density (in particles per cm^3) must be about 10^{14}.

life cycle costs—The total cost of an item including initial purchase price as well as cost of operation, maintenance, etc. over the life of the item.

lithium—The lightest metal; a silver-white alkali metal. Lithium 6 is of interest as a source of tritium for the generation of energy from a controlled fusion reaction. Molten lithium will also be the heat exchanger.

liquified natural gas (LNG)—Natural gas that has been cooled to approximately −160°C, a temperature at which it is liquid. Since liquefaction greatly reduces the volume of the gas, the costs of storage and shipment are reduced.

load factors—The percentage of capacity actually utilized. For example, the average number of passengers for a certain size car divided by the passenger capacity of that size car.

magnetic confinement—A confinement technique used in nuclear fusion in which electrons are stripped from the reacting nuclei (deuterium and tritium, for example) forming a "plasma" which can be controlled by a magnetic field. There are several different types of magnetic confinement systems under development. (See "Tokamak," "magnetic mirror," and "magnetic pinch device.")

magnetic energy—A kind of energy that arises when electrons or other charged particles move.

magnetic mirror—(See above) Consists of linear tubes in which the magnetic field confining a "plasma" is shaped so as to turn particles around at each end, as a mirror does a light beam. The most successful of these devices is the 2X-IIB at the Lawrence Livermore Laboratory of the University of California.

magnetic pinch device—(See above)—An interior space is filled with plasma which is then "pinched," or compressed by a magnetic field. This is accomplished by increasing the strength of the field and forcing the plasma toward the center of a tube. The Scyllac at Los Alamos is the major pinch device.

magnetic storage—A futuristic concept in which energy can be stored in a magnetic field around a superconducting material.

magnetohydrodynamic (MHD) ***generator***—An expansion in which electricity is generated from the combustion of fuels without going through an intermediary steam turbine. Hot, partially ionized gases move through a magnetic field, and are separated by charge, generating a current that is then collected by electrodes lining the expansion chambers.

mechanical energy—One form of energy. It is observable as the motion of an object.

megawatt (mw)—A unit of power. A megawatt equals 1,000 kilowatts, or 1 million watts.

Methane Gas (CH_4)—A light hydrocarbon; an inflammable natural gas with a heat value of 257 Calories/cubic feet. Forms explosive mixtures with air. It is the major part of marsh gas and natural gas but can be manufactured from crude petroleum or other organic materials. (See coal gasification.)

Mev.—One million (or 10^6) electron volts—a unit of energy. It is equivalent to 1.6×10^{-13} joules.

MHD generator—See magnetohydrodynamic generator.

mill—A tenth of a cent. The cost of electricity is often given in mills per kilowatt hour.

moderator—A material used in a nuclear reactor to slow the speed of neutrons and thus control the rate of fission. Common moderators are graphite, water, deuterium, and beryllium.

molecule—Atoms combined to form the smallest natural unit of a substance. For example, the water molecule is composed of two atoms of hydrogen and one atom of oxygen.

neutron—An elementary particle which is present in all atomic nuclei except for the most common isotope of hydrogen. Its mass is approximately that of a proton, but it has no electric charge. Neutrons are released in fission and fusion reactions.

Nitrous Oxides (NOx)—Compounds formed whenever combustion occurs in air (in the presence of nitrogen). An air pollutant and component of "photochemical smog."

nuclear converter reactor—A reactor in which the major process is the conversion of fissionable fuel into energy as distinguished from a "breeder reactor" which produces more fuel than it uses. A converter reactor also "converts" some fertile material into fissionable fuel but produces less fissionable fuel than it consumes.

nuclear energy—The energy released during reactions of atomic nuclei.

nuclear reactor—A device in which a fission chain reaction can be initiated, maintained, and controlled.

nucleus—The extremely dense, positively charged core of an atom. It contains almost the entire mass of an atom, but fills only a tiny fraction of the atomic volume.

ocean thermal energy conversion (OTEC)—A process of generating electrical energy by harnessing the temperature differences between surface waters and ocean depths.

"off-peak" power—Power generated during a period of low demand.

oil shale—A sedimentary rock containing a solid organic material called kerogen. When oil shale is heated at high temperatures, the oil is driven out and can be recovered.

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.

particulates—The small soot and ash particles produced by combustion.

peak demand period—That time of day when the demand for electricity from a power plant is at its greatest.

peak load—The maximum amount of power delivered during a stated period of time.

peak load pricing—Charging more for the delivery of power during the daily period in which demand is the greatest. (See "peak demand period".)

petroleum— (or oil) an oily, flammable liquid that may vary from almost colorless to black and occurs in many places in the upper strata of the Earth. It is a complex mixture of hydrocarbons and is the raw material for many products.

photoelectric—Pertaining to electric effects produced by light.

photon—A quantum (the smallest unit) of electromagnetic radiation. It has no rest mass or electric charge, but behaves like both a particle and a wave in its interactions with other particles.

photosynthesis—The process by which green plants convert radiant energy (sunlight) into chemical potential energy.

Photovoltaic—Providing a source of electric current under the influence of light.

Photovoltaic generation—Direct and continuous generation of electrical energy by a material whenever it is illuminated by light; this is accomplished without breakdown of the material.

plasma—An electrically neutral, gaseous mixture of positive and negative ions. Sometimes called the "fourth state of matter," since it behaves differently from solids, liquids and gases. High temperature plasmas are used in controlled fusion experiments.

Plutonium (Pu)— A heavy, radioactive, man-made, metallic element with atomic number 94. Its most important isotope is fissionable plutonium 239 (94 Pu^{239}), produced by neutron irradiation of uranium 238. It is used for reactor fuel and in weapons.

potential energy—"Stored" energy. Energy in any form not associated with motion such as that stored in chemical or nuclear bonds, or energy associated with the relative position of one body to another.

power—The rate at which work is done or energy expended. It is measured in units of energy per unit of time such as Calories per second, and in units such as watts and horsepower.

power gas—A mixture of carbon monoxide and hydrogen which has a low heat value (25-75 Calories/cubic feet) and is of most use as power plant fuel.

primary energy—Energy in its naturally-occurring form—coal, oil, uranium, etc.—before conversion to end-use forms.

proton—An elementary particle present in all atomic nuclei. It has a positive electric charge. Its mass is approximately 1,840 times that of an electron. The nucleus of a hydrogen atom.

PSI—Abbreviation for "pounds per square inch." A measure of pressure.

pumped storage—An energy storage system in which reversible pump turbines are used to pump water uphill into a storage reservoir. The water can then be used to turn the turbines when it runs downhill.

Pyrolysis—Heating in the absence of oxygen. Also called "destructive distillation"; pyrolysis of coal produces three fuels: high Btu or pipeline gas, a synthetic crude oil (syncrude), and char, a carbon residue. Also used in the conversion of organic wastes to fuel.

radioactive decay—The spontaneous transformation of an atomic nucleus during which it changes from one nuclear species to another with the emission of particles and energy. Also called "radioactive disintegration."

reactor years—One year's operation of a nuclear reactor.

recoverable resource—That portion of a resource expected to be recovered by present-day techniques and under present economic conditions. Includes geologically expected but unconfirmed resources as well as identified reserves.

regenerative braking—Braking in which the energy is recovered either mechanically, in a flywheel for instance, or electrically. This energy can then be used in subsequent acceleration.

reserve—That portion of a resource that has been actually discovered but not yet exploited which is presently technically and economically extractable.

secondary recovery—Recovery techniques used after some of the oil and gas has been removed and the natural pressure within the reservoir has decreased.

Second Law of Thermodynamics—One of the two "limit laws" which govern the conversion of energy. Referred to sometimes as the "heat tax," it can be stated in several equivalent forms, all of which describe the inevitable passage of some energy from a useful to a less useful form in any cyclic energy conversion.

Second Law of Efficiency—The ratio of the minimum amount of work or energy necessary to accomplish a task to the actual amount used.

solar cells—Photovoltaic generators that yield electrical current when exposed to certain wavelengths of light.

solar energy—The electromagnetic radiation emitted by the sun. The Earth receives about 4,200 trillion kilowatt-hours per day.

solvent refined coal (SRC)—A tar-like fuel produced from coal when it is crushed and mixed with a hydrocarbon solvent at high temperature and pressure. It is higher in energy value and contains less sulfur or ash than coal.

Stirling engine—An external combustion engine in which air (or hydrogen in the newer versions) is alternately heated and cooled to drive the piston up and down. It is claimed to be non-polluting and more efficient than the internal combustion engine.

stratified charge engine—An engine in which the amount of charge, fuel plus air, is adjusted to engine conditions, directed to the area where it will burn best and fired at just the precise instant.

Strontium 90 ($38Sr^{90}$)—A hazardous isotope produced in the process of nuclear fission. Strontium 90 has a "half-life" of 28 years. Thus it takes 28 years to reduce this material to half its original amount, 56 years to one quarter, 84 years to one eighth, and so on. Strontium 90 typifies problems of radioactive waste storage which are faced in producing power by means of nuclear fission.

ulfur smog (classical smog)—This smog is composed of smoke particles, sulfur oxides (SO_x), and high humidity (fog). The sulfur oxide (SO_3) reacts with water to form sulfuric acid (h_2SO_4) droplets, the major cause of damage.

uperconductor—A material which at very low temperatures, near absolute zero, has no electrical resistance and thus can carry large ...ical currents without resistance losses.

synthetic natural gas (SNG)—A gaseous fuel manufactured from coal. It contains almost pure methane, CH_4, and can be produced by a number of coal gasification schemes. The basic chemical reactions are $C + H_2O + heat \longrightarrow CO + H_2; 3CH_2 + CO \longrightarrow CH_4 + H_2O$.

tar sand—A sandy geologic deposit in which low grade, heavy oil is found. The oil binds the sand together.

tertiary recovery techniques—Use of heat and other methods to augment oil recovery (presumably occuring after secondary recovery).

thermal storage—A system which utilizes ceramic brick or other materials to store heat energy.

thermodynamics—The science and study of the relationship between heat and other forms of energy.

thermostat—A temperature-sensitive device which turns heating and cooling equipment on and off at set temperatures.

Thorium (Th)—A naturally radioactive element with atomic number 90, and as found in nature, an atomic weight of approximately 232. The fertile thorium 232 ($90Th^{232}$) isotope can be transmuted to fissionable uranium 233 ($_{92}U^{233}$) by neutron irradiation.

Tokamak— (toroidal magnetic chamber) The Russian adaptation of the toroidal or "doughnut" geometry. The plasma is confined in the central region of an evacuated doughnut-shaped vessel by a magnetic field provided by current-carrying windings around the outside. A separate set of windings produce a heating current in the plasma. American examples are the PLT (Princeton Large Torus) and the ORMAC (Oak Ridge Tokamak).

topping cycle—A means to use high-temperature heat energy that cannot be used in a conventional steam turbine. A gas turbine, for instance, might operate as a topping cycle on furnace gases of 2000°F and its exhaust could then heat steam for a turbine operating at 1000°F.

total energy system—A packaged energy system of high efficiency, utilizing gas fired turbines or engines which produce electrical energy and utilize exhaust heat in applications such as heating and cooling.

Tritium—A radioactive isotope of hydrogen with a half life of 12.5 years. The nucleus contains one proton and two neutrons. It may be used as a fuel in the early fusion reactors.

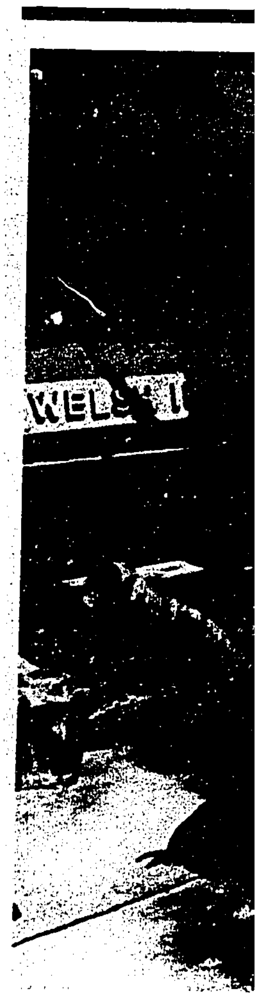
voltage—A measure of the force of an electric current.

watt (w)—A metric unit of power usually used in electric measurements which gives the rate at which work is done or energy expended. One watt equals one joule of work per second.

work—Energy that is transferred from one body to another in such a way that a difference in temperature is not directly involved. The product of an external force times the distance an object moves in the direction of the force.

working fluid—The material, usually a gas or a liquid, whose absorption of heat and subsequent expansion drives a heat engine. Steam is the "working fluid" of a steam engine.

yellowcake—The material which results from the first processing (milling) of uranium ore. It is sometimes called "artificial carnotite" and is about 53% uranium, a mixture of UO_2 and UO_3.



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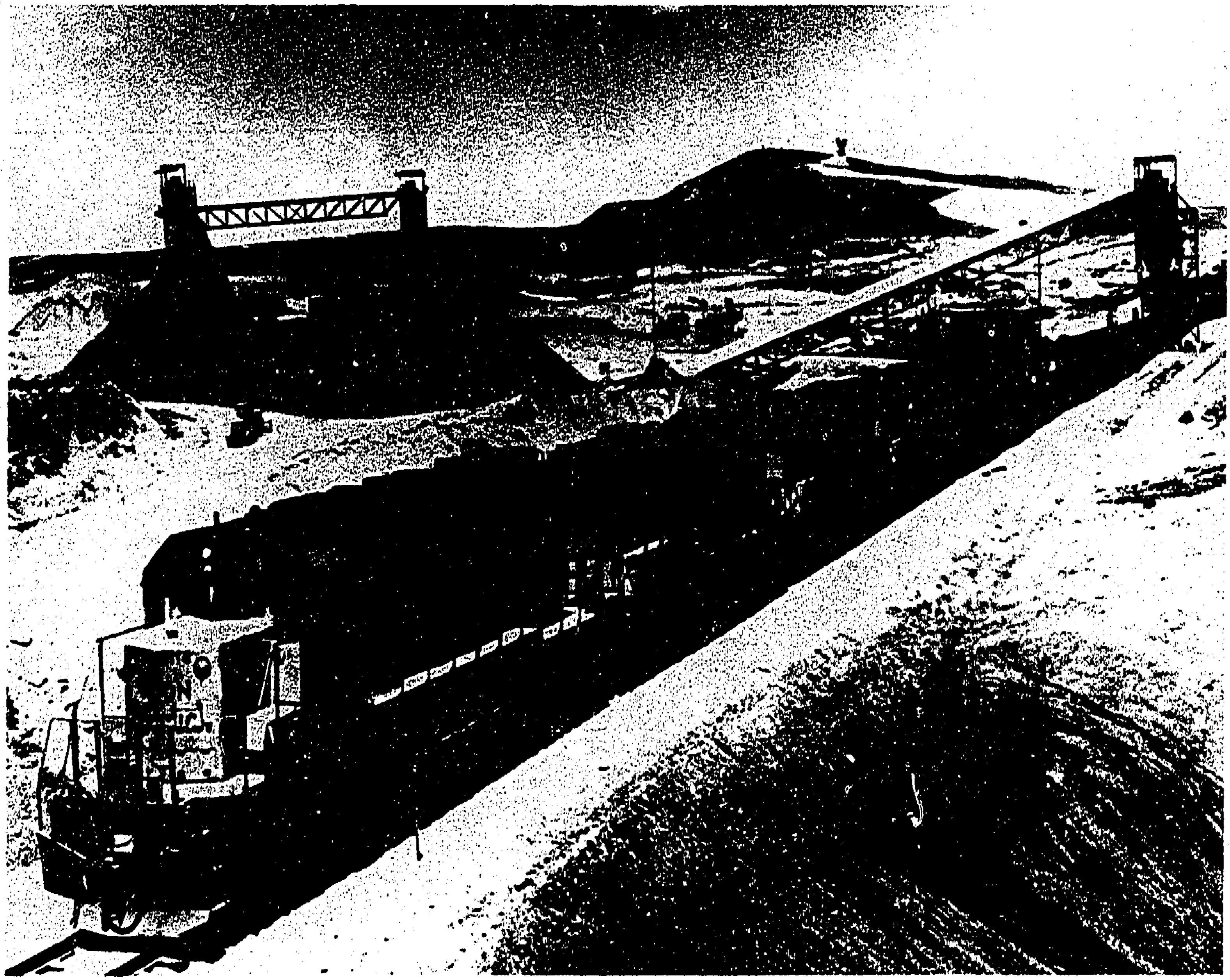

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