JOURNAL OF THE TENNESSEE ACADEMY OF SCIENCE
VOLUME 53, NUMBER 2, APRIL, 1978

ENERGY AND ENVIRONMENT*

GENERAL SESSION
TENNESSEE ACADEMY OF SCIENCES
87TH ANNUAL MEETING

INTRODUCTION

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Our concern of the energy future in the United States and the world has changed dramatically in the last few years. It used to be that our energy policy was based on unrealistic trends of continued growth. It was based on infinite growth requiring increased domestic oil and gas, nuclear reactors, domestic coal and rising imports to meet the demand. The possibility of curtailing demand was not one of the options considered. The Arab oil embargo of 1973 brought home the vulnerability of our energy dependence. It became obvious that we could not afford to depend on this source to satisfy our demand. Domestic oil and gas production had peaked in the early 70's and now seemed likely to decline steadily. A transition from oil and gas to alternative sources of energy was seen as the solution. But, in a nation where the public is increasingly aware of the environmental deterioration, every solution offered seemed to have environmental and sociological drawbacks. Increased stripmining of coal posed a threat to land; mining and using of high sulfur coal created the problem of acid rains which destroyed the crops and the streams; increase usage of nuclear power challenged us with questions of radioactive damage and terrorism; solar-energy is available in unlimited quantity, but its diffused distribution is not amenable to the centralized power generation and distribution we are accustomed to. Under these circumstances, our energy policy options need to be weighed carefully. Not only technological, environmental and economic problems need to be raised about the options. We, as a nation, need to determine the trade-offs implicit in each one of these technological complexities. We are at energy crossroads, and certain hard-hitting decisions have to be made now. To complicate the matter, we are burdened with the decision to make the transitional paths smooth, which will seriously demand changes in the lifestyles we are accustomed to. All these questions are addressed by the following speakers. Their presentations address themselves to issues such as "Can the National Energy Plan achieve its objectives by 1985?", "What should be the short- and long-term goals and how to reach them?" and "What are the social and environmental implications of the energy options we choose?" The energy and environmental crisis is here now, and the decisions we choose to make or not to make will decide the kind of world of tomorrow.

*Highlights of presentations made on the 1977 TAS theme of "Energy and the Environment" at the General Session of the Tennessee Academy of Science Annual Meeting, November 1977.

ENVIRONMENTAL ISSUES IN DOMESTIC ENERGY DEVELOPMENT

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In 1969 Stuart Udall wrote that the 1970's were going to be the age of ecology. This age lasted about 3-5 years, but it has since been merged into what I will call the Age of Multiple "E's". The energy-environment issue has a number of interface issues. Not only do we have energy and environment, but we have ecology, economics, ethics, equity and engineering. All of these social and scientific issues interact in our attempts to deal with the environmental problems. Now, as scientists, most of us are used to thinking in terms of resolving problems on the basis of technical data; but all of us are also citizens and we have to think of things in terms of costs, benefits and risks which gets us into the area of economics. We have problems of what is right and what is wrong which gets us into moral problems, and this get us into several legal problems. These are mentioned here to merely indicate that the issues discussed are complex and there are no easy linear, objective scientific answers in all cases.

The primary discussion here will be on fossil energy. Relatively little will be said about nuclear energy. The reason for this is because the environmental issues and technical issues of nuclear energy have been sufficiently well recognized. Regulations are so tight that we are at the point that if we set standards much tighter, we will be taking effluents and processing them to achieve levels of radiation less than natural background. Regarding fossil fuels, during the exploration phase of mining, there are a whole matrix of environmental problems. Another set of environmental problems are associated with both underground mining and surface mining. We have the problems of impact on soil, vegetation, underground and surface water, wildlife and fish. These problems can affect areas that are reasonably large, produce not only direct environmental problems, but also can result in social impacts.

Recently, the Congress has passed a surface mine and

reclamation act. Research in reclamation is needed to assure long-term successful revegetation of strip-mine areas. Research requirements differ between the eastern and western United States because of differences in climate, topography and soils. The President's National Energy Plan has posed the challenge to shift to conservation and conversion to coal by 1985. Coal is to be used increasingly for direct generation of electricity. Our experience with coal has identified a number of environmental problems. The emissions from plants burning coal include SO_x and NO_x. In addition, there is a variety of trace elements, radioactive elements and organic materials are byproducts of coal combustion and can be released to the environment are subject to further long-distance transport in atmospheric, terrestrial, and aquatic systems.

Sulphur dioxide is one of the compounds that is of major concern. One environmental concern is the effect of SO_2 directly on plants and animals. Another environmental issue is that of "acid rain." Environmental data collected over the past 20 years clearly demonstrates a major area of concern—an increasing acidiferation of rain in the eastern United States. In Tennessee in 1955-56, the pH of rain ranged from 5-5.7. In the early 70's, it dropped to 4.3 and at times has decreased to 3.5.

Coal burning also produces trace elements, such as arsenic, selenium, cadium, and mercury. The trace-element problem is another environmental issue because of the potential for these elements to move through ecological food chains and undergo biomagnification.

A part of the President's program calls for utilization of coal to produce gas and perhaps oil over the next few decades. The technological processes for converting coal have the potential for production of quantities of complex organic substances, many of which may be carcinogenic. It is extremely important that environmental research programs are established to provide for rapid testing of these substances for development of environmental control.

The CO_2 question will be one of the major problems of the next decade. Our concern over CO_2 stems from the evidence that CO_2 concentrations are building up in the atmosphere as the result of our increased utilization of fossil fuels. Scientists are concerned that should CO_2 levels exceed certain levels, there will be induced changes in the earth's climate—possibly a warming of the polar regions with attendant drastic shifts in local rainfall and climate patterns. A further intensification of use of coal globally could result in a relatively rapid building up of CO_2 in the atmosphere. We need, therefore, to know a great deal more about the global carbon cycles, the capacity for the terrestrial biosphere to absorb CO_2 and the relative budgets and shifts in budgets of CO_2 that can be expected to take place.

The environmental issues briefly discussed here are merely representative of a larger number that must be dealt with in order to assure an energy technology that is compatible with the environment. The complexity of these issues means that all of us have the responsibility to grapple with them as citizens as well as scientists. The challenge is great and the time is short.

THE CHANGING ENERGY EPOCH

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Today, the world is in the midst of a momentous transitional storm between two great energy epochs—the fossil-fuel age and a future energy era. The impact of this dramatic episode is being felt throughout the world. Historically, the transition from one fuel epoch to the next has always been accompanied by a marked improvement in human living conditions. It will certainly be the same, when, eventually, the present transition is completed. But in the meantime, one essential difference between this transition and all those that have preceded it must be dealt with. Today, the fossil-fuel epoch and the next age are not interlocking. There is some overlap, but there is also a large supply-demand gap, and we call this gap a "transitional storm"—you've heard it called an "Energy Crisis."

Coal was the dominant U. S. source of fuel energy from 1885 until World War I. Its production almost doubled during this period. Natural gas was used commercially for the first time in this country in 1921, mainly as a lighting fuel. It was not until the mid-1930's that gas could be transported over long distances of 1,000 miles or more. During the 1930's advances in technology provided the know-how to use natural gas as a source of energy. Let's not despair with the notion that the world will go out of business when the last barrel of oil is pumped. Thermodynamics teaches us that *unlimited* energy exists; what is missing is a practical way to use this energy efficiently. The shortage is not of energy or of fuel, but of conversion technology.

The nation depends on its least abundant energy resources, oil and natural gas, to provide most of its energy needs. The result has been a growing dependence on imported energy, the availability and price of which are controlled by a few Middle East countries. Petroleum demand grew at an annual rate of 4.6 percent during the 1960's and 1970's, in response to low prices, air pollution restrictions on coal use, and the growing use of automobiles. In 1975, the U. S. consumed about 73 quadrillion Btu (quads). In the 20 years before the OPEC embargo of 1973, energy demand grew at a rate of 3.6 percent. Electricity consumption grew at twice the rate of all energy demand (about 7 percent per year). Electricity is expected to grow about twice as fast as overall energy demand.

How Will the Nation Meet It's Growing Energy Demands by 1985? Total domestic supply is forecast to increase by 40 percent between now and 1985, with all major fuels playing a large role. Coal production could increase to over 1 billion tons. If Outer Continental Shelf (OCS) leasing is strongly pursued and market prices prevail, oil production could reach 13.9 MMB/D (including natural gas liquids). Natural gas production could be increased if "new" gas prices are deregulated. Although nuclear power has experienced significant delays it could grow from current levels of 9 percent

(1976) to about 26 percent of electricity generation by 1985. Emerging technologies such as conversion of coal to oil or gas, solar and geothermal energy, will be important in the post-1985 period, but will not produce much energy in the next eight years. Where will new oil supplies come from. More intensive use of secondary and tertiary recovery in current fields and new discoveries onshore can keep onshore production about constant. If current OCS leasing and development schedules are followed, OCS production could about double by 1985, to about 2.3 MMB/D. Alaska will be the greatest new source of production, increasing to about 2.4 MMB/D by 1985.

The major contribution from solar, geothermal, and synthetic fuels will not be felt until after 1990 and more than likely after the year 2000 when they may contribute 7 percent of the total. Today, these resources are not readily available in the amounts needed. And, if environmental considerations and social costs are factored in, the days of low-cost energy are over. The fossil-fuel epoch is coming to an end. While some oil and natural gas will probably always be available with increased cost, they will be too expensive to be burned as fuels. Promises of solar energy, fusion, geothermal and wind power sources just won't provide us with enough power in the future to satisfy our energy needs. All of these forms of energy, even optimistically, likely could supply only 7 percent of our total energy needs by the year 2000.

To summarize: We must conserve every form of energy in order to remain a self-sufficient nation. Having more money to spend doesn't mean there is more energy to use. We must stop energy waste; consider other enrgy sources; and carefully plan for their use. If we don't, the well will run dry in our lifetime and not in some future generation.

IN THE IMMEDIATE FUTURE—1977 to 1985: Oil and natural gas will satisfy the bulk of our energy needs. As long as oil export countries supply us with the oil we need, and we prepare for the next phase, we should make it through this period. BUT, construction lead time dictates that we work toward higher coal production and nuclear power now, as well as the conversion of coal into synthetic gas and oil.

IN THE INTERMEDIATE FUTURE—1985 to 2000: Coal AND nuclear power will supply most of our energy needs, but only if we have chipped away at the lead time during the previous period.

THE FUTURE BEYOND 2000: With coal resources properly developed, they could last several centuries . . . and nuclear reactors can well be on the way to helping us out of the energy dilemma. At the same time, solar, wind, tides, geothermal, biomass and fusion should all be working to produce electricity on a rather large scale.

Our most important role . . . before it is too late, is to heed the warning and take advantage of the time we have . . . and stretch that time by saving our present oil and natural gas supplies through common sense conservation by supporting efficient and practical methods of mining our huge coal resources and by developing additional nuclear power plants. We have time . . . but we don't have time to waste.

We must *conserve energy resources*—especially oil and natural gas, we must *develop coal and uranium* more rapidly and we must open up *Alternate Resources for the Future.*

ENERGY VERSUS SOCIETY: PROFITEERING FROM SCARCITY

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From an environmentalist perspective, the key ingredients to an energy plan are conservation and efficiency. It is important that we realize that conservation is not just a means to save on energy resources, but that it can also substantially help to reduce the economic and social costs which society uses up in producing this energy. Efficiency and conservation also go the farthest in protecting the environment. The dichotomy of coal versus fission is a false one. Neither of them is desirable environmentally or in terms of efficiency, and furthermore they are only being considered transitional energy sources. If a commitment to safe and renewable sources is made today as seriously as the commitment to fission was made yesterday, we could reach the 1990's with far better prospects for a cleaner environment and cheaper energy. Furthermore, if conservation is induced by policy rather than price and is given a real priority rather than a rhetorical one, the transitional period can be travelled at a zero energy growth rate thus bypassing the problems associated with coal and nuclear power. The choice of energy strategies should, of course, have been made 20 years ago which we failed to do.

The production of electricity is a prime example of a wasteful process. Not only is the process of generating electricity very inefficient since for instance two-thirds of the fossil fuel energy is lost as waste heat in the conversion, but also it is ecologically harmful in terms of the heat pollution as well as chemical or radioactive pollution. Therefore, attempts at minimizing the need and the use of electricity should become a primary goal.

This can be accomplished through a rational conservation program and by implementing the more efficient end-use technologies available today such as solar collectors for heating as well as the numerous other technical fixes such as cogeneration in the industrial sector. Such an environmentally oriented program need not be a cause of loss of jobs. On the contrary, a number of studies, including one by McCracken for the National Science Foundation, have shown how a conservation program would not only create more jobs than are created in labor intensive areas, but would also save billions of dollars in investments.

What I want to analyze now is the economic and

political environment surrounding the tnergy problem areas that we find the underlying motivations for the important decisions being made today which will affect our future. Probably some of the most revealing trends of the last few years have been the huge profits generated in the energy sector of the economy. Oil companies attempt to justify their profits by a-guing that massive investments are required for research, development and exploration. But it is hard to see how Mobil Oil's purchase of the Montgomery Ward retailing chain is going to help produce more gasoline for transportation! It is clear that the oil conglomerates are, in effect, increasing their cont-ol over the economy by acce'erating, to their advantage, the concentration of capital and businesses. Oil firms have also been acquiring a large controlling sha-e of the other energy sources as well. The 500 percent increase in the price of uranium yellowcake ore over the last four years is a very good indicat'on of this monopolization where an international cartel including major oil companies has been charged by Westinghouse of price fixing.

The sun as an energy source cannot be owned and therefore cannot in general be monopolized, especially when it is used through solar collectors or wind mills on a decentralized neighborhood basis. Unfortunately, this thinking may be too naive. A recent ERDA report issued last spring recommended that public utilities be given exclusive monopoly franchises to provide solar heating and cooling systems for individual consumers. This would then be just like renting a telephone from the local phone company. In this way the energy industry can continue to be guaranteed control over the national energy supply.

Negative redistribution of wealth would probably take place under President Carter's plan for higher regulated oil and gas prices coupled with a tax rebate scheme. Walter Heller, economist at the University of Minnesota, recently remarked that complete decontrol of oil and gas prices would cost consumers $25 billion per year while President Carter's Crude Oil Equalization tax scheme and a gas price ceiling of $1.75 per thousand cubic feet would cost consumers $14 billion per year. As a result, instead of progressing toward an increasingly egalitarian society, we will be heading towards greater inequalities aggravated by the approach taken to deal with the scarcity of traditional energy sources.

It is a welcome sign that public concern over energy options is increasing. An example is the astonishing growth of the anti-nuclear movement across the country. The Catfish Alliance itself has now over a thousand active members of widely different political persuasions and diverse backgrounds including scientists, lawyers, workers and students. We should also note that this citizens' movement is quite international. Large organizations exist in most European countries as well as in Japan and Australia. At this time such citizens' movements have the major responsibility of educating the public. But we are faced with a sizeable handicap as was clearly shown during the statewide initiatives and referenda last year. The Catfish Alliance and other similar environmental and consumer organizations will be pursuing a broad spectrum of strategies to challenge the energy industries and the utility companies. Exposing the dangers of nuclear power is the first step in educating the public. Petitions and endorsements are being used to influence elected officials at the local, state and federal levels. Legal interventions during the licensing process will be pursued at every possible step even though the heavy financial burden this requires has generally yielded minimal results. In this way, the energy debate will become increasingly democratic in that it will involve a larger and larger segment of the population.

What can the scientific community do to contribute meaningfully to the energy debate? Although policy decisions affecting the environment are generally made at managerial or governmental levels, the decisions are in large part based on technical information furnished by scientists and engineers employed in and out of government. When the technical information is freely available, the professional employees working inside the company or laboratory are usually in the best position to offer a critical analysis of the technical basis for the policy decisions or of other related health and safety questions. It should therefore be in these situations that dissenting views be expressed without being subjected or threatened with retaliation. This conflict has indeed been borne out by a number of recent polls of engineers. While some 60 percent of the members of the National Society of Professional engineers polled believe there are valid reasons for the public to be worried about nuclear plants, as many as 40 percent of them felt restrained from criticizing their employer's products or activities. Although many aspects of a particular problem may not be grasped on the technical level by the public, an average citizen can certainly readily understand the social and political aspects. It is here that the scientific community can lose a great deal of credibility in the eyes of the public as was happening during the Vietnam War. Sooner or later, the fallacies behind the decisions become too obvious to be covered up. A more adversarial role on the part of scientists and enegineers is a fundamental requirement for the advancement of clean and safe energy technologies in a democratic society.

OUR ENERGY FUTURE

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Our national debate on the energy field reflect a great deal of ambivalence in the social and environmental values. Our ambivalence is reflected in contradictions between governmental stated energy goals and actual programs, in congressional reactions, and in public attitudes. Before we can make coherent and consistent practical plans for our energy future, we need to go back to some simple basics, to try to understand these ambivalences, and to come to grips with underlying environmental realities. The governmental energy scenario for the future seems to assume that we are on a road moving ahead in terms of energy—that will take technologies and fuels of the past and gradually alter these so that we use more carefully the oil and gas we still have, expand greatly the use of coal, and carry through on the use of nuclear technology developed over the past 20 years. Conservation of energy fits into the plan as an important near-term goal. We must consider some revision of our lifestyles, in order to make them more energy effiicient—at least until some limitless source of energy is developed. The road we have been traveling in fact, may be coming to an end, because it assumed cheap and plentiful energy as a base for a comfortable sophisticated society that has thrived on waste. We have more cars and still deteriorating mass transit systems. We have homes that leak heat. We have a lifestyle that is filled with all kinds of unnecessary energy-consuming gadgets. In our economy, for every million dollars for gross domestic production, we consume 1,513 tons of oil or oil equivalent, while in Sweden, with comparable standard of living, the consumption rate is 865 tons.

The change in value and planning is not just the government's responsibility. How many of us have reevaluated or altered any of our habits? How many of us drive at speeds of 55 m.p.h.? How many of us walk a couple of blocks instead of driving? Not only have we failed to do these, but we are educating our children by the examples we set. If we accept the fact that a real transfer to another road is needed, then there are a number of areas in which substantial change will have to be made.

The first area we should consider involves our individual lifestyles. Even though conservation is viewed as a short-time effort, in a world of limited resources, conservation will be a permanent new way of living. This will demand developing a sustainable and harmonious relationship with our environment—feeling a part of it and not just the user of it. An energy conserving lifestyle will necessitate a renewed stress on our intellectual growth, on recreational activities that compliment nature, on linking instead of snowmobiles, on sailboats instead of motorboats, etc. If we must change, I'd like to suggest we consider the possible benefits of a real jolt rather than gradual change. Because, for people and institutions, it may be harder and annoying to make tiny changes over years. For example, if the government decontrolled oil and gas prices, many of us would begin making changes in significant ways in a hurry. And if we allowed prices of dwindling fuels to rise rapidly, we would also greatly encourage a market for alternative, more environmentally sustainable sources, such as solar heating and cooling, and trash-to-energy systems.

The second area deals with government planning and choice. It relates to dealing with systems we have a real stake in, but may need to move away from. There are real limits to the technological risks. Let us consider nuclear power as an example. Regarding the government subsidized nuclear power technology, in addition to the recent economic disappointments, the multiplicity of environmental and social risks surrounding the industry operations remain. As reactors age and become larger and as various new parts of the nuclear cycle are tackled, nuclear power seems to increase rather than decrease in complexity thus increasing the prediction difficulties. Reprocessing plants and the breeder are the key links in completing the nuclear cycle and making available nuclear fuel in the coming decades. Neither type facility is close to realization. No matter what type of nuclear power plants we operate, eventually the radioactive wastes generated will have to be permanently disposed of, which will certainly pose ethical and environmental dilemma.

Knowing what we do about resource scarcity, will we actively discourage new towns being built where energy, land and water resource don't exist and try instead to begin adjusting our human activities and dwelling patterns to harmonize with the requirements and sustainable capabilities of regional environments? Turning away from a number of habits, technologies and attitudes of the past decades will be feasible only if we are actively pursuing other habits, technologies, and attitudes to replace them.

And so we arrive at a third area of choice. Despite the fact that very few of us have any economic stake in new technologies, are we willing to bite the bullet and make the investment needed to reorient our energy supply system? The U. S. industry has the capability to develop and market all kinds of new technologies, depending on what our values call for. At INFORM we completed a three-year research study of energy alternatives. We found that of 17 new kinds of energy sources, a number were actually technologically available and commercially usable, including a range of solar and renewable resource-based alternatives. Many corporations are eager to find a market for their systems. A central barrier to broad and commercial use of their products was price; they could not compete at present against the controlled prices of oil and gas. One quarter of the energy used in the U. S. goes for space heating and cooling, a burden that can be very easily carried by the solar technology. Were the market demand to suddenly increase greatly, the economics of mass production could make it advantageous. This also applies to trash-to-energy systems. Geothermal steam for power production, cogeneration for efficient combined production of electricity and steam from one source, and bottoming cycles capable of recycling industrial waste heat, are all poised on the starting line waiting for the economic incentives to ring the bell and start the competition.

In closing, the choices we make in all three of the areas are still in our hands. In the past five years, we have taken one important step in acknowledging that the notion of infinite resources, the infinite capacity of man to build technological systems that produce limitless energy has been illusory. Now that no realistic ideas have emerged as to our own and the environment's capabilities what we do about today's energy crisis and tomorrow's energy future depends on whether and how soon we choose to act on this knowledge.

NATIONAL ENERGY PICTURE

ROBERT MCFARREN

Department of Energy
Washington, D. C.

The thinking that the energy crisis is a passing phenomenon on the national scene is coming to a fast stop. Even though a consumer's immediate interest in the price of gasoline at the pump for his automobile or the price of oil and gas for his furnace, from the point of view of government's planning and action, the energy picture is extremely complex. There are many ways of looking at the energy crisis, which include price, federal regulation, ODEC, balance of payments, foreign dependence for resources among others. Regarding the price structure of energy, if we let the market place rule, the distribution of energy may become inequitable. To make it equitable for all the people and to control to some extent the supply and demand, government regulations are imposed. Since a great deal of our oil is imported, many of the energy and environment decisions we make are dependent on the pricing policies of the exporting nations, which invariably creates balance of payments problem. Because of the increased interdependence of nations for the energy resources, the decisions we make invariably influence our foreign policy decisions.

Energy Crisis is a multiple transition we all are going through. In this, oil was the first major commodity to change from a buyer's to a seller's market. We have really come to a point of recognizing how small we are, how insignificant we are in the big picture. This demands a need to get along with each other on this small island called earth. No longer can one turn to a "Go West Young Man" philosophy. Third world countries are challenging the right of fourteen nations to divide among them the Antarctic.

Because of the ever increasing global consumption of energy, insignificant environmental issues have become problems at levels we never thought would be of concern to us. The problems are so suddenly upon us that we don't know what degree of controls is necessary. More important than anything else is the recent public awareness of complex scientific issues such as CO_2 threat to the atmosphere. When we consider new technologies to combat the energy crisis, the electric utilities will be increasingly scrutinized, which will have a hard time changing. Some of these changes will be inherent in the technological change, but others will be forced upon them by the public and governmental regulations.

The extent of such changes will depend on the public participation in the resolution of conflicts. The extent to which the public participated in energy and environmental issues, a decade ago was small and insignificant. With the increased activity by the public in environmental issues, we will be seeing more of sunshine laws, open meetings and public forums. To reach rational decisions under such circumstances, we all have to become knowledgeable on the problems at hand. We will be called upon to change our lifestyle to fulfill our obligations to govern a nation which will have to make some difficult decisions in the energy field.

Such a changing picture will thrust upon us more and more decentralization. Since the Roosevelt administration of the thirties, the nation has been seeing more and more of centralization of decision making in Washington. Even though it served well in the past, with the anticipated enhanced participation of the 'man in the street', the future trend will be moving away from this. What is going on is a forcing function on a lot of the ways we do things, and this forcing function is the energy shortage. Such an issue cannot be easily resolved unless we actively seek and debate each other's views.

Sixty percent of the citizenry does not realize (or accept) that there is an energy crisis. The number of motorists who refuse to maintain a 55 m.p.h. speed-limit on our illustration is an example of this. The Department of Energy will assume the responsibility to increase communication with the citizenry and help educate them on the energy crisis. In recent years, we have seen every state in the Union formulating its own plan in the field of energy to satisfy its special interests. The Carter administration is very much interested in coordinating our national plan with the state plans. It is surprising that many of the states are simply not aware of their own energy needs, expected growth rate, etc. Part of the reason for such a gap in information is that in the past they were not required to collect, maintain and interpret such information. The Department of Energy will have plans to change these.

This nation has more coal than all of the oil in the Middle East. Our biggest problem in the past has been the safe utilization of this resource. There are strict laws against stripmining; there are laws that restrict the burning of high sulfur coal. We have got the technology to get the coal out of the ground, but using it in large quantities in the safest way with least environmental disruption is a challenge to our technology. In DOE, one of our main interests is to find ways to put coal to use quickly and in such an endeavor, increasing emphasis is being given to synthetic gas and fluidized bed processing of coal.

The economic factors, uncertainty in regulatory procedures, and environmental concerns are having an impact in power plant construction in the past decade. If we were to maintain the rate of growth we are accustomed to, then the new power plants that are going on line at present, will not be able to meet the demand. At present, it takes 10-12 years lead time to put a nuclear power plant in operation. To make them operative in the year 2000, we have to start planning now. The general public cannot understand this unless they have technical training to do so, and the willingness to access the risks of not understanding such issues.

President Carter is in opposition to the Clinch River Breeder Reactor which is based on the plutonium cycle. This is not necessarily the same as his opposition to the breeder concept itself. It is the administration's feeling that it is time to examine alternative fuel cycles, because the Clinch River Breeder Reactor will be obsolete by the time it becomes operational. An alternative to consider here is the thorium cycle, which will have fewer drawbacks from weapons standpoint. We have an obligation to prevent weapons proliferation, but reprocessing of breeder is not the only way that can happen. The breeder may one day become a major world power source; in such a case, the breeders might be confined to a few countries to produce fuels to be used by different kinds of reactors in less developed countries.

Politicizing of complex issues can be good, but it can carry with it some agonizing problems. But in a democratic set-up as we have in the U.S. unavoidable. When public awareness of the energy issues is increased, it will become increasingly easier for us to solve them, and we all will have to do it together.

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