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Synopsis of Proceedings:

Energy Research & Development Administration

Fourth Public Meeting on

A National Plan For Energy Research, Development And Demonstration

ERDA 76-1

Creating Energy Choices for the Future

Chicago, Illinois

June 21, 22, 1976

NOTICE

This synopsis of the public meeting held in Chicago, Illinois, June 21, 22, 1976, is being provided to all persons who have indicated an interest in obtaining a copy. The interested reader is encouraged to refer to the full transcript of the public meeting, the locations of which are listed at the end of this publication under the heading: ERDA Public Document Rooms.

The views summarized herein are those of the participants at the Chicago public meeting and do not necessarily reflect those of the meeting steering committee, workshop moderators and ERDA.

Synopses of other public meetings on the ERDA Plan are available by writing to ERDA, Office of Public Affairs, 20 Massachusetts Avenue, Washington, DC 20545.

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ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

PUBLIC MEETING,

"THE MIDWEST PERSPECTIVE"

June 21, 22, 1976
Palmer House Hotel
Chicago, Illinois

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PROGRAM OUTLINE

June 21, 1976

8:30 a.m.	Opening Sessions	Introduction--Robert H. Bauer, Manager, ERDA Chicago Operations Office
8:35 a.m.		Welcome--Honorable Richard J. Daley, Mayor, City of Chicago
8:50 a.m.		Introductory Remarks--Dr. Robert C. Seamans, Jr., Administrator, ERDA
9:10 a.m.		The ERDA Plan--Roger W. A. LeGassie, Assistant Administrator for Planning, Analysis, and Evaluation, ERDA
9:55 a.m.		The Midwest Energy Perspective--Robert H. Bauer, Manager, Chicago Operations Office, ERDA
10:15 a.m.		Questions and Answers
10:30 a.m.		Conservation Opportunities and Constraints
12:00 noon		Questions and Answers
2:00 p.m.		The Nuclear Fuel Cycle--Can We Fulfill the Promise of the Nuclear Option?
3:30 p.m.		Questions and Answers
4:00 p.m.		Workshops
		A. The ERDA Plan
		B. Conservation
		C. Nuclear Fuel Cycle
7:00 p.m.		Solar, Geothermal and Advanced Energy Systems--Seeking Infinite or Renewable Energy Resources
8:30 p.m.		Questions and Answers
9:00 p.m.		Workshops
		A. The ERDA Plan
		B. Solar, Geothermal and Advanced Energy Systems
10:30 p.m.		Adjournment

June 22, 1976

8:00 a.m.	Coal and Synthetic Fuels Utilization--The Challenge of Our Greatest Domestic Energy Resource
9:30 a.m.	Questions and Answers
10:15 a.m.	Biological and Environmental Risks--How Can the Adverse Effects of New Energy Technologies be Minimized?
11:45 a.m.	Questions and Answers
1:45 p.m.	Government, Industry and the Public Interest--Putting New Energy Technologies to Work
3:15 p.m.	Questions and Answers
3:45 p.m.	Workshops
	A. Coal and Synthetic Fuels
	B. Biological and Environmental Risks
	C. Government, Industry and the Public Interest
5:15 p.m.	Conference Summary
6:15 p.m.	Conference Close

INTRODUCTION

Shortly after the publication of ERDA-48, A National Plan for Energy Research Development and Demonstration: Creating Energy Choices for the Future, the Energy Research and Development Administration (ERDA) held two regional meetings to provide the public with an opportunity to exchange information and opinions about federal energy RD&D planning.

To obtain similar evaluation of and comments on ERDA 76-1 (an updated version of the plan), ERDA is holding a second series of regional meetings. The need for these meetings is based on the belief that the nation as a whole will make the ultimate decisions about the amount of energy to be consumed in the country and the technologies to be employed in the nation's energy future.

In June 1976, ERDA sponsored hearings in Chicago, Illinois.* The states involved were Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Ohio, West Virginia, and Wisconsin.

The agenda, which was drawn up with the aid of a regional steering committee to reflect the major concerns of this region, focused on the nuclear fuel cycle; coal and synthetic fuels utilization; biological and environmental risks; solar, geothermal, and advanced energy systems; energy conservation; and government, industry, and the public interest. Numerous issues were defined and discussed in each of these areas, and a range of important, and often conflicting, opinions was expressed on energy planning, funding priorities, and federal-regional coordination. These opinions and viewpoints are summarized in the remainder of this document.

* Earlier hearings were held in Atlanta, Seattle, and Denver; future metings will be held in San Francisco and Boston.

Generally, it was felt that information on this technology, to date, has not demonstrated the reliability of nuclear power. There was a great deal of discussion about the availability of uranium.

The ERDA representative stated that, presently, approximately 9 percent of the country's electricity is generated with nuclear energy. Nationwide, 60 plants are operating currently, 74 plants are under construction, and many utilities are applying for construction licenses. Within approximately 10 years, 180 plants will be generating about one-fourth of the nation's electricity.

Nuclear power ranks among the highest of ERDA priorities. Increasing the energy contribution of the present generation of reactors, the lightwater reactors, is a near-term objective; the next generation of reactors, the breeder reactors,is a long-term priority.

The liquid metal fast breeder, ERDA's largest project, transforms unfissionable uranium (i.e., U-238) into fissionable plutonium during the production of power. This breeder multiplies our nuclear fuel resources to the point where it can be classified as one of the essentially inexhaustible options. A small experimental breeder (EBR-II) has been operating since 1963, and a major experimental facility (the Fast Flux Test Facility), which is being used to examine breeder fuel and core materials, is nearing completion. Construction will soon begin on a demonstration breeder, a 350-foot megawatt (MW) plant located by the Clinch River in Tennessee. This demonstration plant will start up in 1983, and a decision on commercial deployment would be made as early as 1986. Not only will we learn a great deal through the development of this project, but the potential of the liquid metal fast breeder will also be defined.

The ERDA representative cited the safety record of nuclear power plants. The nation has accumulated approximately 174 reactor years of safe operation, and 100 ships have logged 1,400 reactor years of accident-free reactor performance.

ERDA's plan calls for increased emphasis in six areas:

1. We need to take stock of our uranium resources: how much, where, how accessible, and what the quality is. We should also improve exploration and extraction technology. ERDA's program to meet these needs, the National Uranium Resource Evaluation Program, has been underway for 2 years, and the continental United States will have been systematically and extensively surveyed by fiscal year (FY) 1981. In addition, the Nuclear Regulatory Commission (NRC) is currently deciding whether the spent fuel should be reprocessed and plutonium and unfissioned uranium should be recycled.

2. We need to construct new uranium enrichment facilities, either of the present gaseous diffusion kind or the proposed gas centrifugation type. The Nuclear Fuel Assurance Act, which is intended to encourage the private sector in this field, also provides for a new government back-up plant in the event that private ventures are unable to proceed.

3. We need to help industry resolve problems associated with commercializing fuel reprocessing and recycling. If spent fuel is reprocessed, demands for mined uranium could be reduced by approximately 30 percent, and demands for enrichment capacity, by some 25 percent.

4. ERDA plans to begin storage demonstration in the early to mid-1980s and to recommend specific criteria for converting radioactive waste into a solid form. Exploratory drilling has begun to define those stable underground geologic formations that can be developed as terminal depositories for storing radioactive wastes. Within several hundred years, the initial level of radioactivity will have decayed to the point where it equals the activity of naturally occurring deposits of high-grade uranium ore. Although the level of radioactivity in the small fraction of plutonium contained in the waste will not disappear for several hundred thousand years, the surrounding impermeable geological formation will serve as a natural container. In addition, ERDA is supporting detailed investigations of the 2-billion year old natural nuclear reactor in Gabon, West Africa, to learn more about the behavior of reactor waste products.

5. We need to reduce the time required to bring nuclear plants on stream and to achieve better reliability. To this end, ERDA has a program of engineering standard support that includes standardization design studies, improved construction technology development, and special siting studies. Although nuclear plant reliability is about the same or better than that of comparably sized fossil-fired plants, its improvement will mean more energy production.

6. We must ensure the safety of nuclear plants and satisfy safeguards criteria. Therefore, ERDA is coordinating the development of cost-effective conceptual designs to identify system performance requirements for physical protection, accountability, and materials controls.

The discussion of ERDA's nuclear policy involved the following issues:

- Costs and Benefits of Nuclear Power
- Nuclear Fuel Cycle
- Funding Priorities
- The Merits of the Plan.

COSTS AND BENEFITS OF NUCLEAR POWER

The costs and benefits of nuclear power are argued in detail. One speaker asserted that there is no clear, visible, and consistent economic benefit resulting from the production of nuclear power.

It was also pointed out that more than 22 years have passed since the President of the United States announced a program for the peaceful harnessing of the atom, and we are still debating whether nuclear reactors might bring some cheaper form of energy to the American people. In addition, the nation does not know the costs entailed in fuel reprocessing, nor has it stored anything for 2000 years. One day, we will be faced with the consequences of this ignorance. Another speaker denounced

the nuclear industry as technology's latest Titanic and contended that the industry had run afoul of the laws of physics and the geologic facts.

It has recommended that instead of spending 49 percent of the FY 77 energy research and development (R&D) budget on nuclear fission, the nation ought to consider phasing nuclear fission plants out as soon as possible, which would not adversely affect the economy. One critic mentioned that the use of nuclear power yielded a net addition to the nation's energy budget of only .25 percent. It will not even reach the 1 percent level until 1980.

One critic stated that the absorption of so much investment capital by one industry is detrimental to the economic health of the nation. The cost of building an atomic plant has jumped in 7 years from $200 million to $1,485 million. It was considered doubtful that the financial community would be willing to risk such large investments or that the electric industry can afford ERDA's plans. In fact, 13 plant orders were recently cancelled, and 33 more postponed.

Another stated that rate setting is virtually impossible, and the promise of low fuel cycle costs to compensate for higher capital costs may be a figment of the imagination of nuclear power promoters. Unless the industry makes firm commitments, it will be the consumer who pays the price. Atomic power was an albatross around the neck of U.S. energy independence.

Another speaker discussed the benefits of nuclear power. He stated that the energy choice is toward electrification, or a combination of nuclear and coal-fired generation, which appears to be the nation's best option for the following reasons:

1. Even with strict conservation measures, U.S. electric power needs are expected to grow. Unless we are prepared to settle for a lower standard of living and high unemployment, we must develop our domestic energy resources (i.e., coal and nuclear power) in a rational manner.

2. While solar energy, as well as geothermal, wind, and fusion power represent long-term energy supply possibilities that should be pursued, they cannot provide a significant portion of our energy needs in this century.

Consequently, according to this speaker, the only way to ensure an adequate supply of electricity is to expand both nuclear and coal-fired generation. Neither is sufficient alone. The required lead time for licensing and building power plants is 10 years: thus, those nuclear power plants that are not already in the design stages will not be available until the mid to late 1980s. On the other hand, even if coal production is doubled within the next decade it is unlikely that it alone can meet the growing need for electric power. In addition, regulatory and environmental constraints impede coal development.

It was pointed out that, although the cost of new capacity is bound to be high compared to existing capacity, the record clearly shows that nuclear power is more economical for base-load generation. The kilowatt hours produced by nuclear power cost about 20 percent less than the next least expensive alternative, i.e., western low sulfur coal.

NUCLEAR FUEL CYCLE

According to one speaker, the viability of the nuclear program is dependent on the fuel cycle. Several commentators felt that the vital links in the nuclear industry (e.g., uranium supply, processing recycle, and waste management) were not working as planned. These areas are discussed below.

Uranium Supply

One participant stated that the nation was running out of uranium at the front end of the nuclear cycle. Until recently, the nuclear industry had assumed that uranium would be inexpensive and plentiful. However, in 1973, the price rose from approximately $7/lb. to a current price of $50/lb.

Another suggested that today's high uranium prices reflect OPEC oil prices, uncertainty about the future of recycle, and pressure from utility commissions for longer term commitments. On the other hand, he stated that utilities can currently buy all the uranium they need at $40/lb. for delivery 5 to 10 years from now.

Another mentioned that all the low-cost uranium reserves have been contracted for, and the known medium-cost reserves that exist in the United States will not be sufficient to supply the demands for the nuclear plants planned for the 1980s. Furthermore, the government has changed the operating tail assay of the process from 0.20 percent to 0.29 percent, which increases the required amount of uranium by 20 percent. The utilities are already protesting that they cannot obtain this extra uranium.

One speaker asserted that the nation must discover new uranium supplies equal in extent to 9 new Colorado Plateaus or 20 new Wyoming Basins to provide for our domestic uranium requirements to the year 2000. However, it is highly questionable whether facsimiles of these two regions can be found even once, much less 9 or 20 times in the United States. It was pointed out that most of the predicted reserves are founded largely on statistical analyses that have accorded the eastern half of the United States with the same degree of favorability for uranium discovery as the western half. Such evidence appears contrary to available geological evidence.

One speaker felt that the nation would soon be importing uranium from such countries as Gabon, Niger, Zaire, the Central African Republic, Zambia, and South Africa. According to one federal plan, up to 10 percent of uranium may come from a foreign source in 1977. Another participant mentioned that the Uranium Institute in London, which already includes all the uranium-producing countries, will probably emerge as a uranium cartel. Another remarked that, instead of depending on oil imports, we will depend upon uranium imports. If ERDA was not solving the nation's energy problem, it was contributing to it.

ERDA replied that when known reserves and probable reserves are combined, we have sufficient ore to supply 300 thousand MW of reactor capacity. (This amount is more than is necessary for those reactors in current operation or expected by 1985.)

Milling Capacity

By 1990, according to one speaker, uranium demand will increase to 80,000 tons/year from the existing mining and milling capability of 19,000 tons a year. This 400-percent increase means the opening of 200 to 300 new mines and 60 to 70 milling facilities.

According to this speaker, the lead time to produce a mining facility is approximately 8 years. In addition, this 400-percent increase requires that 1.8 million tons of additional uranium be found by 1990. To achieve this goal, an average of 120 million feet per year must be drilled over the next 15 years, or an increase of 600 percent per year. This amount of drilling would be similar to mining 16 Ambrosia Lake Districts in New Mexico, or 10 times the total production in this country in the equivalent span of less than 25 years.

Uranium Enrichment

According to one spokesman, the nation's three uranium enrichment plants are operating at close to full capacity and lack the capacity to meet our needs beyond the middle 1980s. Even if we began constructing a new gaseous diffusion plant, it probably would not be operating until 1985 at the earliest.

Each utility planning to build a nuclear plant must deliver sufficient uranium to these plants so that it can be enriched to the higher percentages of U-235 required to fuel the reactors. It was pointed out that the utilities are already complaining that the extra uranium required for the operating tails assay cannot be obtained. However, the government believes that the change from 0.20 percent to 0.29 percent will make the plants operate more efficiently.

Fuel Utilization

According to one participant, we are using approximately 1 percent of the potential energy in the uranium with our present system. Another participant stated that the actual average fuel performance has been considerably lower than the 33,000 MW(+)D/MTU (thermal megawatts days per metric ton of uranium) assumed in environmental impact statements for presently-operating plants. For example, the first fuel cycle at Zion Station, the largest Westinghouse reactor in operation, was only 16,650 MW(+)D/MTU; the average burn-up at General Electric (GE) plants has been only 11,000 MW(+)D/MTU. In total, the Westinghouse and GE plants, which represent 85 percent of the nation's operating nuclear plants, have produced only 49 percent of the energy they were designed to provide. The largest Commonwealth Edison plants, which are supposed to be operating at 80 percent of capacity, have been operating at capacity rates of 39.3. As a result, these plants would have to be doubled to supply the amount of energy that they were designed to produce. It was felt that, at these burn-up rates, approximately double the amount of uranium assumed by ERDA will be required to produce the amount of electricity projected for future needs.

Fuel Reprocessing

Presently, the nation has two nuclear fuel reprocessing plants, one inoperative and the other inoperable. Consequently, according to one speaker, neither can recover the unfissionable U-235 that is not being consumed.

One attendee commented that a factor in the ability of the oil cartel to hold strong is the slow pace and the lack of long-term assurance that the United States will achieve commercial uranium and plutonium recycle.

One participant was concerned that the NRC may decide against the reprocessing of fuels. However, the industry feels that it is not economical to reprocess just for the U-235; it wants to recover the plutonium also.

Nuclear Wastes

Over the years, a large inventory of nuclear wastes has been accumulated. Several participants mentioned that the ERDA's schedule for the development of a commercial waste depository was reasonable as long as there were no delays.

Other participants declared that the burial of atomic waste materials was totally unacceptable. The changes over a time span of this length cannot be reliably predicted and 10,000 generations cannot be exposed to the dangers.

It was pointed out that all individuals annually receive 140-150 millirem of environmental radiation, depending on such factors as where they live and whether they live in a house that has radiation emitters (e.g., a television set). In contrast, the normal release of radiation from nuclear power is less than 1 millirem per year, even in close proximity to the reactor.

One participant stated that if the nation turns to a plutonium-based economy, we will produce insoluble halogenetic radiation; by 1985-2400, 600,000 lbs. of plutonium will be in the fuel cycle. That amount of plutonium would produce fatalities, even if the leakage rate is 1/1000 of 1 percent. Another commentator mentioned that the U.S. Transuranium Registry, located in Washington State, has 800 to 1,2000 registrants who were exposed to plutonium as far back as the development of the Manhattan Project. To date, not so much as one cancer has been attributed to the ingestion of plutonium. The ERDA representative stated that, over any period of time, the radiation levels are orders of magnitude below the levels that can cause health hazards.

Presently, according to ERDA, the wastes are being handled in a responsible fashion. A great deal of attention is being paid to storage, the unpermeable quality of the sites, and monitoring devices. In addition, ERDA has cooperative programs with other nations on the management of radioactive waste. For example, the United States has a detailed agreement with the Federal Republic of Germany on solidification and handling of low- and high-level wastes and is working jointly with them on saltbed storage of radioactive wastes.

FUNDING PRIORITIES

Many participants felt that the plan represents an incorrect allocation of resources. One questioned when ERDA would stop deluding the nation and wasting tax dollars on nuclear power, a costly and inefficient energy source. Another stated that, in spite of ERDA's professed interest in providing the public with economic, safe, and socially acceptable energy sources for our future energy needs, the ERDA plan is significantly pro-nuclear biased. For example, in the ERDA budget for FY 1977, energy conservation is of highest priority, equal to that of fission power, yet it receives only 1/10 the amount of R&D funding.

The expenditures of $8.15 billion for nuclear energy by ERDA and its predecessor, the Atomic Energy Commission (AEC), were questioned. It was pointed out that this investment amounted to 15.9 mills for every killowatt of commercial nuclear power generated and equaled about 85 percent of the total capital spent by private industry. Another participant questioned the sensibility of implementing an energy system that depends on low-cost uranium, which will no longer be available in the next 20 to 30 years and has residual problems which will last several thousands of years.

One attendee quoted the survey on the cost of 19 steam stations in Electric World; this survey concluded that nuclear plants were coming on line at a significantly higher cost than coal-fueled plants. He found it ridiculous that $12.8 billion will be spent on the liquid metal fast breeder reactor and stated that the fast breeder budget is five times greater than that of solar energy.

It was proposed that all forms of solar research be greatly expanded at the expense of nuclear power, if necessary. Another participant supported this proposal with the statement that too much was being spent proportionately on the development of nuclear power generation devices, and insufficient funds were being spent on renewable resources, e.g., solar, wind, and biomass.

THE MERITS OF THE PLAN

There was a good deal of discussion about the general merits and negative aspects of ERDA 76-1. Although the ERDA plan was considered well suited to dealing with the uncertainties and complexities of the issues, several commentators thought that it was based on a simultaneous pursuit of a wide range of options and on a more rapid transition to new energy sources than before. One critic felt that the plan misleads the public by fostering the notion that we can have a wide range of energy options.

According to one participant, individual occupational and living styles are more dependent on energy supply patterns than in the past. Yet the legislative and regulatory constraints to change are more influential today than previously, and the present political climate suggests a conservative trend rather than a trend that fosters change.

Another attendee suggested that the nation has a limited capacity to develop new energy systems and bring them into widespread use. It was suggested that the next plan should be more selective in its goals and that, when technologies are selected for priority treatment, they should be chosen on the assumption that the transition to new systems may proceed more slowly than in the past.

It was mentioned that the plan might better serve its objective, especially in terms of education and discussion, if it were less optimistic in tone. For example, the plan suggests the maximum benefit from shale might be 7 quads per year by the year 2000, which would require the mining of almost 2 billion tons of shale per year. Several felt that the presentation of such numbers was misleading and that the problems should be outlined more clearly and more completely.

COAL AND SYNTHETIC FUELS UTILIZATION

Generally, the participants in this session were in favor of ERDA's synthetic fuels program. One of the major points made was that the nation should proceed in a rapid manner to initiate this program because of the lengthy lead times required and the associated costs.

ERDA's major objectives are to ensure that the nation's coal, petroleum, natural gas, and oil shale resources are developed efficiently, economically, and in a socially and environmentally acceptable manner. Its primary emphasis is the development of the technological capability to convert coal and oil shale into more acceptable forms of energy. ERDA hopes that the improved technology will be available for commercialization by the 1980s.

Currently, ERDA is developing processes for obtaining liquid fuels from coals in four liquefaction plants. ERDA is also developing synthetic natural gas (SNG), suitable for existing pipelines and equivalent to natural gas, and a lower Btu gas, suitable for industrial heating and electric power generation.

In addition, ERDA is studying underground (i.e., in situ) processing and assessing various methods for using coal directly. It is also examining the use of a fluidized limestone bed for controlling sulfur dioxide emissions from coal conversion. Furthermore, ERDA is analyzing magnetohydrodynamics (MHD), a process that can be used to increase the efficiency of the direct use of coal.

In the oil and gas field, ERDA is working on increasing the recovery rate. Approximately 30 field tests in cooperation with industry are currently underway or planned by the end of the year. Approximately 4 billion barrels of oil are potentially recoverable from the flushing method. ERDA is also studying means of increasing our gas capture rate through explosive or hydraulic fracturing. In addition, it is examining underground and surface strip mining of oil shale and the associated environmental problems, e.g., disposal of spent shale.

ERDA extensively analyzes the affect of these technologies on the environment, and, where required, it develops appropriate solutions. Since many of the pilot synthetic fuel plants are located in the western United States, the agency is particularly concerned about the water requirements of these processes. As a possible solution, ERDA is considering the use of the region's abundant saline water supplies for these technologies.

The discussion in this session covers the following issues:

- Coal Development
- Oil and Gas Development
- Socioeconomic Implications of Energy Development
- The Role of ERDA.

COAL DEVELOPMENT

Generally, it was felt that the coal conversion program, as currently planned, was inadequate and that provisions must be made for greater coal development. However, the attendees were also concerned about the environmental acceptability of increased coal use.

According to one speaker, the United States has more than 4000 billion tons of coal. Although coal has been estimated to constitute 86 percent of our national energy resource base, it only represents 18 percent of our annual energy usage. One representative claimed that our national coal resources contain more energy, in terms of Btus, than all of the oil in the Middle East. Not only are we rich in natural resources, but we generally have the water, labor, knowledge, and the market required for a successful coal development program.

One speaker indicated that if the nation intends to have a full fledged high-Btu gasification industry by the 1990s, the current level of the coal conversion program is inadequate. Another remarked that the coal conversion program, which is geared to produce the equivalent of 350 thousand barrels of oil per day by 1985, is insufficient in terms of the national energy consumption. The projected increase in coal demand will require that domestic coal production be doubled by 1985.

To ensure timely commercialization, the coal gasification technologies, currently being tested in pilot plants, should be demonstrated in the near future. One attendee contended that it is vital to the national prosperity and security that RD&D activities for environmentally safe sources, such as synthetic fuels, be given the greatest possible emphasis in our national plan. Without an expedited demonstration of these projects, the resulting data and experience will be unavailable for future decision makers. By building and operating coal gasification plants, the nation can determine the true economic, environmental, and social costs and benefits associated with synthetic fuel production.

However, another critic warned that coal conversion technology should be developed in an orderly fashion applicable to all regions. The vitality of all energy-producing areas should be promoted, and no one regional area should be jeopardized.

It was also believed that methane recovery from underground coal seams must be given high priority in the national energy plan. According to one representative, the natural gas situation dictates the prompt development of this potential energy source.

Several participants addressed the barriers facing the coal industry, e.g., unsophisticated reclamation techniques, substantial water requirements, and strict sulfur dioxide regulations. According to one critic, such barriers lead to tremendous costs and delays. In addition, the number of coal-mining engineers is dwindling. It was felt that ERDA should assess such problems as the restrictions imposed on the industry by water use regulations.

The health, safety, and environmental impacts of coal conversion were also discussed. According to one participant, synthetic oil and gas from coal gasification produce polycyclic aromatic hydrocarbons, which are a potential source of cancer, and trace metals, such as mercury, nickel, lead, solenium, and arsenic. The representative emphasized that these various emissions and trace metals must be analyzed during the design and implementation phases. It was felt that the safety threshold for such pollutants must also be determined.

Another critic proposed that ERDA work jointly with the Environmental Protection Agency (EPA) to develop a sound energy and environmental plan. ERDA should assume the responsibility for desulfurization and stack cleaning, while EPA should develop a well-balanced environmental energy and economic policy. It was also suggested that ERDA develop more effective scrubbers and assess means of waste disposal, as well as coordinate the R&D efforts of other agencies. Another declared that the nation must find an environmentally acceptable means of removing sulfur either from the coal or the stack gases directly or during the combustion process.

One participant remarked that, although many critics of coal development have cited environmental degradation as the reason for their opposition, West Virginia, which produced 100 million tons of coal worth $2.6 billion in 1965, has been able to reclaim its mined areas. The natural beauty of its land has not been preserved, but it has been useful for agricultural purposes. Another noted that the abundance of the water supply in West Virginia makes it easier to reclaim land than in the northern Great Plains. One attendee asserted that the costs of reclamation will be passed onto the consumer.

The ERDA representative mentioned that it currently has an environmental development plan for all possible aspects of environmental and safety problems created by a technology.

OIL AND GAS DEVELOPMENT

One representative stated that natural gas supplies nearly 30 percent of the nation's annual energy consumption and represents about 40 percent of domestic energy production. Participants in this session felt that a variety of actions must be initiated to alleviate the natural gas shortage and to ensure that high Btu gas (i.e., natural gas) will be a significant energy source in the long term. Actions that were mentioned include decontrol of wellhead prices and commercialization of coal gasification. Others declared a need for aggressive industry and government RD&D program on gaseous fuels.

One participant noted that the gas industry has committed $50 million to testing improved second-generation processes for making high-Btu gas. However, ERDA's requirements of equal cost sharing for the construction phase of these second-generation coal gasification demonstration projects were criticized. According to this participant, it is unlikely that industry sponsors can raise the requisite funds. In addition, the technical risks are great and there is no assurance that a demonstration plant can be expanded to commercial size and that significant quantities of economic gas can be provided to customers.

Another critic questioned the basis of ERDA's rationale in requiring that 50 percent of the capital for prototype coal, gas, and liquefied plants be provided by industry, when ERDA assumes almost 100 percent of the costs for nuclear development. In response, ERDA noted that, although the government bears most of the costs for the liquid metal breeder projects, it is still a cost-shared nuclear project. Currently, ERDA is seeking similar cost sharing in the geothermal and solar areas.

Another pointed out that the nation presently uses 70 billion cubic feet of natural gas per day and that our supplies are declining at a rate of 6 percent per year, or 4 billion cubic feet per day in capacity. One representative

advocated an acceleration of ERDA's program for enhancement of natural gas recovery from eastern and western tight formations and urged that program expenditures be increased from the current $10-$15 million per year to $30-$50 million per year. It was felt that this type of program would provide the necessary information to the gas industry to embark on commercial ventures, resulting in increased availability of natural gas.

ERDA was also urged to continue its efforts to determine the technical and economic feasibility of several other technologies. Oil shale was viewed as a logical alternative to coal, while the conversion of biomass from ocean farms or land plantations to methane-based gas was also viewed as a feasible alternative. For example, hyrogen produced from water was considered a rational means of supplementing high-Btu gas.

SOCIOECONOMIC IMPLICATIONS OF ENERGY DEVELOPMENT

Participants in this session felt that the energy industries and the government are not respecting the basic social and cultural values and aspirations of the public. Several questioned whether inhabitants of one region should be forced to alter their lifestyles and change their values because of energy development activities in their region so that inhabitants of other regions can maintain their same lifestyles.

One participant stated that ERDA, as other agencies, believes that technology, regulations, and economic support will solve present problems and overcome opposition. Current federal plans were criticized for their naivety and myopic viewpoint concerning the attitudes of the residents and local and state governments in the coal areas and other regions. For example, Wyoming is challenging the reclamation standards of the Department of the Interior for federal lands. Although Wyoming has a progressive coal policy, the Federal Energy Administration (FEA) and industry coal plans are seen as a direct threat to local decision making. According to this critic, the proliferation of enormous coal proposals by government and the energy industry is increasing litigation, delays, and costs, and is leading to a states' rights battle.

One participant contended that, to compound the existing problems, ERDA is planning to subsidize the development of synthetic fuels from coal. It was felt that these subsidies might be acceptable if the net result would be a significant contribution of synthetic fuels to the total energy supply and if substantial efforts were made to ensure greater energy efficiency. However, the loans, loan guarantees, and outright grants for synthetic fuels development were considered to be economically unsound.

According to one participant, it would cost $1.5 billion for a single SNG plant to produce 90 billion cubic feet of high-Btu gas annually, a volume that is only a little more than 0.3 percent of total U.S. energy consumption in 1974. In comparison with the investment costs, total output from an SNG facility is miniscule. Even with the deregulation of new natural gas supplies, there is no indication that the gas industry can or will finance synthetic gas production; furthermore, the price of the finished product to the consumer will still be too high. According to the critic, large SNG plants are undesirable from an environmental and socioeconomic viewpoint; in addition, the water charges and the severance taxes have not been calculated. Finally, SNG production is much less efficient than natural gas production. The critic asserted that SNG operations are a near-term technology, which will be unnecessary in the long term.

Another suggested that the gas industry has influenced the ERDA plan far more than the ERDA plan will ever influence the gas industry. It was considered incongruous that, on one hand, the gas industry fights for deregulation and, on the other, it lobbies for subsidies and grants to increase supplies.

One representative felt that ERDA 76-1 complements the gas industry goal of selling more gas and maintaining its market share. However, the national energy goal should be one of using all energy forms efficiently and of freeing the marketplace from the constraints that inhibit energy development, accelerate it artificially, or that continue to subsidize those costs that should be borne by ultimate consumers.

One critic remarked that ERDA 76-1 is geared to overcoming basic limits through technological innovation and economic incentives; however, it ignores the more critical "social limits." Controversies over such technical and regulatory issues as mining, reclamation, and air quality can be viewed as outward manifestations of deep-seated beliefs pertaining to the quality of life and freedom of choice.

Another attendee felt that a disproportionate share of the benefits of regional energy development goes to people who do not live in that area; in other words, those regions that bear most of the costs usually do not recoup many of the benefits. Another noted that we should understand that the "lowest cost" option may not be acceptable to the most directly affected consumers. We can no longer rely on the technical and/or economic feasibility of an energy system, particularly when most analyses fail to recognize the social costs.

It was felt that if the government plans relating to coal development are to become reality, we must gear the public for at least three things:

1. Significant increase in the size, cost, complexity, and inefficiency of the governmental regulatory processes

2. Increasingly difficult decisions about the allocation of funds, during a period in which plans are to develop inefficient energy systems that would never be developed by the private sector

3. Significant loss of personal freedom and potential chaos.

Even if the primary physical and economic constraints to increased coal utilization can be overcome, people may not be willing to accept the necessary changes to sustain their chosen lifestyles and values. It was felt that our economic and energy problems will not be solved unless we first resolve our basic social, cultural, and institutional problems. These problems should be analyzed and quantified, where possible, and included in the nation's basic technical and economic forecasting and planning. Beyond understanding the costs and benefits of energy development and knowing exactly where they occur, we must develop mechanisms for more adequately distributing them.

One participant observed that, although ERDA may not be the agency to undertake the basic research to solve these complex social issues, a substantial portion of its budget should be directed to their resolution. We need to develop those systems that will monitor shifts in values, balance tradeoffs, and produce results.

THE ROLE OF ERDA

Generally, it was felt that the nation must use all existing energy sources (e.g., coal), while working to develop or create new sources of energy (e.g., biomass) for the future. As one critic remarked, energy is no longer a smorgasbord from which we can select the desired items.

One participant expounded on ERDA's priorities and suggested that ERDA systematically evaluate its technological alternatives based on national and regional needs. ERDA's efforts and priorities, which are directed to long-term choices, must be defined and rank ordered so that alternatives can be developed in time to alleviate the short-term need. Concurrently, other technological alternatives can be developed to solve our longer term needs. This ordering of priorities, in conjunction with a quantitative timetable, will enable the nation to systematically evaluate the funding and commitment to the plan.

This participant felt that ERDA was preoccupied with nuclear and coal gasification and liquefaction, probably because of the rapid depletion of our natural gas and oil supplies. It was believed that the nuclear program should be eliminated, and that the plan should include an aggressive plan to increase the efficiency of existing systems.

The funding for natural gas and oil extraction technologies was considered to be out of proportion to that for the other R&D activities. This speaker maintained that ERDA should reorder its priorities and support an expanded effort in the oil and gas extraction area, which is more responsive to our present needs than some of the more sophisticated and advanced concepts.

Several participants were concerned about the interaction between state and federal government. One person stated that the basic precepts of federalism require that the role of the federal government lies in assimilating the interests of the states and coordinating their involvement to ensure a better union. It was recommended that ERDA consider the implementation of a formal procedure to ensure that state energy plans are fed back into the federal planning process. Another voiced a need for the involvement of the state and local interests, as well as the private business sector and public interest groups. However, the public meeting was felt to be an important step toward reaching the public awareness required for a comprehensive national energy plan.

SOLAR, GEOTHERMAL, AND ADVANCED ENERGY SYSTEMS

The need for research into the more low technology energy systems (e.g., changes in building design, biomass) was stressed in this meeting. It was felt that the plan emphasizes those systems which were more oriented toward high technology. To determine the best energy source or sources for the long term, ERDA is currently pursuing a number of energy sources in parallel. Although solar and geothermal are two of the more attractive energy sources, they are undergoing development; therefore, they cannot be considered options.

ERDA's program in solar/geothermal has many different components.

In the geothermal area, ERDA is analyzing the potential environmental impacts (e.g., land subsidence, water pollution) and the associated cooling of the brine before injection and hydrogen sulfide problems resulting from geothermal development. The different types of geothermal resources include: hot dry steam (e.g., The geysers in Northern California are currently supplying 500 MW); hydrothermal resources, which are found in the western United States and could produce a significant amount of energy; and geopressure resources, which contain a certain amount of dissolved methane that could be used to supplement our national gas supply.

Currently, ERDA is analyzing the engineering problems associated with fusion power systems. Although these systems are inherently safe, have few adverse environmental impact, and offer an infinite fuel supply, their capital costs are significant. In addition, ERDA is presently reorienting its physical research program on materials, chemistry, and atomic phenomena to reflect the agency's mission.

In the solar field, ERDA is funding programs to examine the direct use of solar energy to produce hot water, heating, and cooling. It is hoped that by 1980 the private sector will assume responsibility for the direct solar thermal applications areas. ERDA is also concerned with solar electric technologies and the associated problems of cost and energy storage. The costs of the photovoltaics technology, which is also under study, have been brought down by a factor of 10.

In addition, ERDA is conducting research on wind energy and the ocean's thermal energy system. These technologies still have several major problems, i.e., cost, energy storage, and vulnerability.

The discussion of ERDA's solar/geothermal program is divided into the following categories:

- Alternative Energy Sources
- Building Design and Lifestyle Changes
- Funding Priorities
- Future R&D Needs.

ALTERNATIVE ENERGY SOURCES

Several participants felt that there was a lack of interest with respect to agriculture as a means of conserving energy or improving energy efficiency and questioned whether the current ERDA plan capitalized upon the opportunities in agriculture that relate to energy.

One spokesman thought it was time to invest in the further improvement of plants as a renewable energy source for food, fiber, and fuel. There are considerable opportunities for increasing the production of these resources and improving their utilization. For example, a breakthrough such as the one in high lysine corn and sorghum that occurred at Purdue University can change the amount of foodstuffs necessary to produce the required amounts of fuel and fiber and increases the capacity of an existing land base to feed more people. This type of breakthrough, which effectively improves productivity, should be of primary concern to the United States with its fixed or declining land base and dwindling fossil fuel resources.

It was pointed out that approximately 17 percent of the nation's energy is used for the growing, processing, and delivery of food and like products to the final consumer. Only 2 to 3 percent of the nation's energy usage is concentrated in the actual production of agricultural commodities. The nation should be concerned with increasing the energy efficiency of agriculture, i.e., how much product do we get out for the amount of energy expended in its production.

According to one speaker, opportunities for improving the energy productivity of agriculture are often expressed in specific terms, e.g., improved nitrogen utilization, low energy grain drying, low energy irrigation, and low energy field operations. However, these opportunities must be considered in relation to such factors as timeliness of planting, biological control of diseases, and efficient double cropping. One participant asserted that if such energy practices as double cropping were introduced to the grain-producing fields of Minnesota, energy crops grown on existing cropland could supply all of the state's energy requirements through wellknown technologies for gasifying crop materials. It was also mentioned that the residue from increased farm production is the best feedstock for making synthetic hydrogen of all candidates considered.

Currently, ERDA and other agencies are investigating the use of solar systems for crop drying. In the short run, however, the economic cost of ground drying is such a small proportion of the total cost of crop production that farmers are unlikely to shift to any radically different system or impose any new risks upon their crops for a savings of a few cents a bushel.

Another area that must be pursued actively is plant nutrition, including more efficient manufacturing processes and utilization of these chemical products. Several participants thought that investment in nitrogen fixation and the improvement of its use have the greatest potential to improve energy efficiency in agriculture.

It was felt that various heating processes in agriculture could use solar energy such as grain drying, specialty crop curing (e.g., peanuts and tobacco), livestock and poultry shelter heating, and farm and green houses. Solar cooling could be used in farmhouses and for environmental control in livestock buildings. Solar

energy could also be used to power irrigation pumps. One attendee recommended that ERDA refer to the National Science Foundation report prepared by the Maryland Agricultural Experimental Station, which suggests that the U.S. Department of Agriculture Land Grant University system be used to implement the adoption of solar energy in agriculture and establish solar energy demonstration farms at the state agricultural experiment stations.

Another speaker discussed the application of digested sewage sludge to stripmined lands. For example, one mine spoil field had received 40 tons of sludge solids over a 4-year period; in 1975, it produced 60 bushels of shelled corn per acre on land that previously could only be used for forage production. If 10 thousand acres were reclaimed in this manner, yielding an average 60 bushels of corn per acre, 600 thousand bushels of corn would be contributed to the nation's granary. This amount of corn would satisfy the minimum protein and caloric requirements of 24 thousand people for 1 year, without consuming any energy in synthesizing nitrogen.

The production of methane by sludge was also mentioned. Not only can the methane be used as an energy source, but the digested sludge can be used as a soil amendment and fertilizer. At a sanitary treatment plant in Chicago, 300 tons of sludge are digested anaerobically per day and the resulting fuel gas is used to augment the natural gas supply. The nitrogen content of the digested sludge (11 tons per day) represents a potential use of 539 to 682 million Btu's, if it were produced synthetically. This energy has a value of approximately $340 to $430 per day; however, the actual market value of digested sludge as a fertilizer depends on various factors.

One speaker mentioned that agriculture, to some extent, is a net energy producer. In fact, it is the nation's largest, most successful, and oldest solar collector. However, the agricultural industry is widely dispersed and susceptible to the weather and timing; thus, its potential as a collector is difficult to use.

Agricultural biomass itself can also be used as an energy source. One attendee mentioned that the residue from corn production could provide the equivalent of 1.3 million barrels of petroleum a day.

BUILDING DESIGN AND LIFESTYLE CHANGES

Several participants spoke about the need for reasonable architectural design from an energy-efficient viewpoint. It was felt that part of the solar answer is not using devices at all but learning how to live with nature.

For example, windows should be treated differently for each compass direction. The fact that the sun is high in the summer and low in the winter is a magnificent design opportunity. Horizontal overhangs over windows would permit the winter sun to come in and warm the space in the winter, but would exclude the summer sun. Underground buildings, which capitalize on the warmth of the ground in the winter and its coolness in the summer, offer another opportunity for conserving energy.

One representative stated that the age of energy conservation would generate a new architecture on two grounds:

1. Learning how to live with the natural environment

2. Incorporating new technology as it emerges and develops.

Good architects would respond to the need for aesthetically pleasing buildings and would design solar equipment as an integral part of the structure. In addition, most of the costs of solar collectors can become a part of the building shell, ductwork, and fans, which are necessary even if solar energy is not used. Another stated that simple flat plate collectors could be used to produce 60 to 65 percent of our heating and domestic hot water.

It was also mentioned that simple collectors can be built on the premises and that every sheet metal shop in the United States makes solar components, although they are not aware of that fact.

The ERDA spokesman mentioned that it is most economical to build solar heating and cooling devices into the building structure at the design stage. Retrofitting buildings is too expensive.

One attendee spoke out in favor of encouraging lifestyles and community designs that are less dependent upon the use of private automobiles. One study, prepared by the Real Estate Research Corporation for the Council on Environmental Quality, the Department of Housing and Urban Development, and the EPA, noted that the energy use for a high-density planned community is only 56 percent of the energy used for a low-density sprawl community. New community designs and new lifestyle changes could be a significant way to achieve lower per capita use of energy.

FUNDING PRIORITIES

Several participants felt that more money should be spent wisely and rapidly on renewable resources. It was suggested that our allocation to atomic power development should be cut severely, and the resulting large sums of money should be spent on the development of other safe forms of potential energy sources, e.g., fusion, fossil, geothermal, and wind power development.

Several found a low commitment on the part of ERDA toward the use of solar energy for heating or cooling. One attendee remarked that the plan does not sufficiently emphasize solar energy in relation to its potential use. When one considered man is presently using only approximately 1/13000 of the sun's energy, the ERDA budget of $2 million allocated to improving hydrogen storage seemed highly disproportionate. All forms of solar research should be greatly enlarged at the expense of nuclear power. It was also suggested that funds should be allocated for research on efficient fireplace-type systems to feed directly into the solar storage system, thereby eliminating unnecessary duplication of heating modes.

The administrative requirements and the cost involved in ERDA's request for funding of a demonstration project were also criticized. If residential solar systems are to be cost effective, residential contractors should be given direct grants or tax incentives on the basis of reputation and a performance guarantee. In the case of a commercial and institutional solar system, an architect can spend several thousand dollars preparing a request for funding with only 1 chance in 30 of receiving the project. Projects could be selected on the basis of need and reputation of the owner, contractor, and architect/engineer team; periodic reports and calculations could be submitted to ERDA.

Another spokesman was concerned about the solar demonstration phase and the possibility that it might decimate all our resources. ERDA replied that we must demonstrate to the nation and the world the viability of these technologies.

Another attendee complained that solar photovoltaic had one of the smallest budgets in the whole ERDA program although the silicon power cell had powered most of our space missions. Furthermore, solar cells were the only product in the plan discussed in terms of dollars per kilowatt of generated power. The ERDA spokesman stated that the photovoltaic budget is the largest of any of the items in the solar electric budget. The majority of the ERDA budget is going to R&D; actual hardware production is only a small item. ERDA's objective is to lower the cost of solar photovoltaic so that it is competitive with other solar approaches.

It was pointed out that, in the worst case, the energy regained from the manufacture of a photovoltaic battery is about 13 years. The payback in terms of today's dollars with current photovoltaic systems is probably closer to 30 to 50 years. If ERDA's objective is obtained, by 1985 the cost of solar photovoltaic should be in the area of $500 per kilowatt for peak-generating power. If the current figures of $500 to $1,000 per kilowatt for nuclear-generated power are correct, photovoltaics would be competitive with nuclear plants.

ERDA was also urged to increase the allocated research budget and shorten the assigned timetable to biomass. Research and development should include imaginative approaches to developing better processes for utilizing plants and trees, and creating devices that would permit rural people to obtain energy from biomass.

Another complained that the utilization of geothermal energy to any significant degree seems to be decades in the future. To another, it seemed as if nothing had been spent on wind power, ocean tides, or other forms of energy that would furnish at least a minor percentage of our energy needs.

FUTURE R&D NEEDS

Several attendees questioned the need to develop so many long-range energy sources (e.g., plasma, fusion, solar electric). If each of these sources has unique features, its role in the national energy mix should be defined. R&D should be incorporated into the present ERDA programs to achieve such goals and the critical path of the research should be precisely defined in order to avoid the consequences of making a wrong decision.

One participant stated that we must be willing to try, study, experiment, and evaluate a variety of solar heating and cooling methods. Another commented that never in our history has a society been asked to invest so much money so far in advance of the expected return and that the risks should be stated more clearly. It was also mentioned that while solar energy sources involve an initial investment, people presently have no means of assessing the benefits that can be derived from solar energy.

One participant considered fusion to be one of the idea long-term energy sources and felt that ERDA had a well-conceived approach to the achievement of controlled fusion. However, if the unique feature of fusion is inexhaustible fuel supply, more effort should be devoted to the development of such advanced technologies as deuterium reactors. It was suggested that perhaps this energy form can be used for chemicals or materials processing or even fission fuel breeding.

Another representative called for a subdivision of the inertial confinement program, which is currently coordinated by the military. In this way, that part of the program aimed at commercial power can be combined with the magnetic confinement program.

One participant commented that the ERDA development program would never meet the currently proposed time schedule. Even if the nation agreed to fund the program, the United States does not have the necessary facilities, trained manpower, or the knowledge to achieve it.

Another felt that the nation must introduce the problem at the primary school level and change the public's attitude. Our dilemma is not only our physical state but our use of it. A technological awareness ought to be instilled throughout the populace. The resulting increased competency would enable a more practical use of technology. One individual thought that ERDA had been farsighted in granting research to the universities, which must assume a major role in training the requisite future manpower.

Others suggested that ERDA should fund architectural programs at all levels and specially accredited environmental classes. It was also felt that ERDA should fund vocational training courses in solar energy for contractors and heating, ventilating, and air conditioning engineers.

BIOLOGICAL AND ENVIRONMENTAL RISKS OF ENERGY RESOURCE DEVELOPMENT

The public's increasing opposition to the government's lack of concern was evident in this meeting. Several issues, including the use of agriculture as a solar collector and the health hazards of new technologies, were discussed.

ERDA has established an Office of Environment and Safety to ensure the delivery of a safe, clean, and adequate energy supply. This office is concerned with three broad areas:

1. Supporting R&D in the health, environmental, economic, and related fields
2. Ensuring that these concerns are incorporated into the development of energy technologies
3. Ascertaining that ERDA and its activities comply with federal, state, and local regulations.

In this way, energy alternatives and their implications can be defined and compared, and their costs can be quantified. As a result, no undesirable or unforeseen impacts should result when a technology is commercialized.

A number of issues were brought to the forefront during this meeting. The main areas of concern were:

- Environmental Impacts
- Health Issues
- Agriculture
- Funding Priorities.

ENVIRONMENTAL IMPACTS

The administration came under severe attack during this meeting for its disregard for environmental concerns. According to one speaker, the administration has set the stage for a monumental assault on the country's natural and human resources. Beginning with the support of minimal controls on surface mining in 1975, to the promotion of multi-million-dollar private ventures in the nuclear fuel cycle, the administration is steadily undermining a national commitment to environmental protection and deliberately decimating domestic social programs.

One critic charged that the administration and energy industry lobby have been waging an all-out attack against the Clean Air Act so that the electric utilities and oil industry will not only continue past pollution practices, but intensify them. Another critic stated that, even if the environmental consequences outweigh the alleged benefits of energy development, bureaucratic momentum and industry pressure for energy development will prevail.

The current inadequacies of the environmental impact statement processes were also discussed. One speaker thought that, although environmental impact statements allowed the planner to develop projects from many different angles, the planner frequently did

not respond to the findings. Another participant said that preparing an environmental impact statement has a way of becoming a process all its own; furthermore, the statement does not outline the crucial issues involved. It was also felt that the history of the review process provided by the National Environmental Policy Act was both casual and criminal in its disregard of environmental and social issues.

Another speaker stated that delaying controls for surface mining will spell disaster to those regions that will soon undergo development. Streams will be choked with silt, acid runoff will poison the watertable, plains and hillsides will be stripped bare of topsoil, and vegetation will be bulldozed aside, all in the name of energy independence.

According to the speaker, the western expansion of the coal industry would virtually destroy the deep-mine Appalachian coal industry. Because of the difficulty of reclaiming arid and semi-arid areas, this shift could also permanently damage western agriculture. In addition, synfuel plants, which will largely be located in the West, will result in consumption of scarce water supplies, strip mining, air and water pollution, massive influxes of people into sparsely populated areas, wildlife destruction, and the production of carcinogenic substances. In addition, the salinity of the Colorado River will be increased, with disastrous results for agriculture in California and Mexico.

One commentator pointed out that in 25 years we will need five times more energy than is being produced today. This participant believed that the earth cannot withstand such an increase and that the acquisition and expenditure of more energy will endanger natural and human systems. Consequently, ERDA should consider redirecting the use of energy so that it is invested in restoring natural systems and in bringing about a better relationship between man and his environment. ERDA's objective should be to find the most natural means for slowing change and energy consumption and for limiting regulating energy use. Another speaker stated that most natural environments have strong restorative forces; few natural systems are perched perilously on the edge of disaster.

It was also mentioned that the production of energy causes small, localized environmental stresses, which can be reduced almost completely by suitable expenditures. However, the environmental stresses produced during the conversion of energy to heat, light, mechanical motion, or electricity are more severe and not as easily reduced. One attendee mentioned that although appropriate expenditure can reduce environmental stress, it is very difficult to agree on what constitutes an optimum environment. The key question is what kind of environment do we want.

HEALTH ISSUES

Several participants observed that the nation's future planning must address the impacts of our present actions and future policies on health and safety. It was felt that until recently the main emphasis had been on developing efficient means of production; health issues were not being seriously considered. One speaker charged that the purchase price of nuclear power does not begin to reflect the real cost to the people in terms of health, safety, and environment.

Several attendees were concerned that the large-scale development of synthetic fuels would occur before the question of their carcinogenic potential had been resolved. One speaker stated that until last year, cancer death rates rose 1 percent each year. Last year they increased 3-1/2 to 5 percent, depending on the statistics used,

and more than 300,000 people died. This serious increase is almost entirely a result of environmental stress, it was alleged.

Another pointed out that the development of nuclear power would lead to radiation levels, which not only create problems for individuals in immediate contact with the source, but can also result in long-term damages to succeeding generations. On the other hand, another participant stated that more is known about the effects of radiation on living matter than about any other substance in our environment. He felt, therefore, that we did not need as large a safety factor with nuclear power as with the other energy technologies.

Several attendees were concerned that the development of coal gasification would lead to the production of char, which is mainly composed of polycyclic compounds. It was felt that a method must be built into this technology to remove or break down these carcinogenic materials. Otherwise, utilization of low-grade coal through this technology would lead to many serious environmental problems. The ERDA representative remarked that in conjunction with Occupational Safety and Health Administration (OSHA) and EPA, ERDA is currently assessing the health impact of coal gasification projects through occupational health studies.

One commentator mentioned that all the steps involved in the production of energy must be examined in assessing the cost of an energy process. For example, the cost of mining accidents and black lung disease is an integral component of coal mining costs. Black lung disease is currently costing $1 billion annually. It was felt that the nation must commit funds and expertise to define these hidden costs.

Several questions were raised concerning hydroelectric power. One speaker asserted that the damming of water can lead to diseases that are difficult to control. In the Tennessee Valley, for example, the water table has to be artificially raised and lowered to kill the enormous growth of algae. Although the new Egyptian dam stopped the flooding of the Nile, it destroyed the region's sardine industry and permitted the growth of snails leading to increased mortality from schistosomiasis.

One participant declared that the less we know about a toxic material the more we require a large margin of safety. Another stated that appropriate environmental research could anticipate, and thus prevent, many problems. If we first analyzed the adverse effects of energy development at any level, then the people could determine the socially acceptable risk.

FUNDING PRIORITIES

There was a great deal of discussion about the emphasis of ERDA 76-1. One participant stated that the ERDA plan is clearly designed to maintain the status quo and the enormous domestic energy cartels of the oil industry, the nuclear industry, and the electric utilities. The plan continues to overestimate the contribution that nuclear power can safely and economically make, while seriously underestimating the potential of conservation and alternative energy sources. In fact, one attendee stated that the much-publicized emphasis on energy conservation and solar research and development in ERDA 76-1 is nothing more than window-dressing offered as a half-hearted response to the public outcry to the original plan.

Another participant commented that, according to ERDA, conservation in buildings and consumer products would save 7.1 quads of energy per year by the year 2000, one-tenth of the total energy consumption of the United States in 1975. On the

other hand, the American Institute of Architects had found that, if the United States established a serious commitment to efficient energy use in commercial and residential buildings, we could save approximately 12.5 million barrels of oil per day by 1990, or about 26.4 quads per year by 1990. This figure represents 3.5 times more savings, 10 years sooner, than ERDA's maximum projection.

Another attendee pointed out that the total solar flux striking the surface by the United States amounts to approximately 43,000 quads. According to ERDA, despite our technological skills and knowledge, we will be able to convert only 25 thousandths of 1 percent of this incidental sunshine into useful energy by the year 2000. However, in 1974, the Project Independence report stated that if all solar technologies were actively promoted, by the year 2000 we could obtain 39 quads of available energy from the sun.

Another mentioned that, if the $2 or $3 billion subsidy for synfuel development could be channeled into residential housing, it could provide and install solar equipment for over 500 thousand new homes or completely pay for retrofitting 400 thousand existing homes. This move would provide continuous energy savings and avoid the tremendous environmental and socioeconomic destruction from synthetic fuels development.

Several attendees felt that conservation is probably the most promising alternative to massive subsidies of synthetic fuels. One mentioned that several studies have demonstrated that conserving energy is one-quarter as costly as developing similar amounts of a new energy source. Another speaker commented that, despite a year of criticism from citizen and scientific organizations, ERDA is continuing to mislead the public about the potential of alternative energy strategies, another way of insisting that any limits on atomic power will lead to unacceptably high oil imports. Our imports continue to increase because of the lack of any direction from government or industry regarding conservation. It was also pointed out that, despite ERDA's claim to have conservation as one of its major priorities, conservation will only receive $91 million in 1977 while nuclear energy will receive more than $1 billion.

It was pointed out that an active program of energy efficiency and conservation is this country's greatest short-term hope; conservation will aid the nation in achieving energy independence, and at the same time lead to the discharge of fewer pollutants into our atmosphere. However, if the private sector is responsible for energy R&D, it may devalue the importance of environmental control. One speaker stated that the subordination of environmental concerns is evident by the plan's stated priority of achieving market penetration of near-term technologies before all environmental and health issues are addressed. Although the nation's ultimate goal is to restructure our methods of energy production and usage, we cannot permit this objective to undermine our desire to create a healthy environment.

Another felt that ERDA-76 relies too heavily on the development of new conservation techniques by the private sector. Another speaker remarked that the ERDA conservation program is not so much conservation of energy by consumers but conservation of energy in processes.

The government must become actively involved in developing energy-efficient technology and in implementing the requisite lifestyle changes. One participant remarked that the government must develop a conservation ethic for the people through a massive education program.

ENERGY CONSERVATION

The discussion of ERDA's research and development (R&D) efforts in energy conservation focused on the effectiveness of different approaches to conservation in relation to overall energy planning goals.

ERDA stated that the goal of energy independence can only be achieved through a balanced program that combines developing new energy sources with conserving our current resources. Unlike some other new source technologies, energy conservation offers both short- and long-term benefits. In fact, according to one speaker, without conservation, energy requirements could total 2,900 quads between the years 1975-2000. With conservation, this figure could be reduced to 2,400 quads.

ERDA's program in support of energy conservation involves both curtailment of wasteful energy practices and the introduction of new, more energy-efficient technology. ERDA emphasized that its particular role in this program is to encourage the development of new technologies and to improve existing technologies. By developing more efficient technologies, ERDA hopes to ensure increased energy savings without forcing end-use cutbacks.

Because of conservation's near-term potential, ERDA has been concentrating on projects that offer a relatively quick payoff. These projects are in six main areas: buildings, industry, transportation, electric energy systems, and energy conversion and storage systems.

ERDA's efforts to reduce the consumption level in the buildings sector, an area currently responsible for 29 percent of total U.S. energy consumption, include the development of energy-conserving construction materials and designs for new buildings, technologies for retrofitting existing buildings, and minimum energy performance standards for new buildings. Its current R&D efforts also include the demonstration of new heating and cooling technologies.

Industrial operations consume about 40 percent of the nation's energy. In this area, ERDA is concentrating on both unit processes and specific energy-intensive industries. For example, ERDA has a program for developing high-temperature recuperator systems that can recover and recycle waste heat from industrial processes in the glass, finishing, cement, aluminum, and steel industries. This system could potentially save the equivalent of 2.4 million barrels of oil per day if universally applied. In addition, ERDA is studying the feasibility of developing a microwave grain dryer that could save substantial energy currently used by conventional gas or hot air dryers in drying grain crops.

In the transportation sector, which is responsible for 31 percent of total U.S. energy consumption, ERDA has placed top priority on the development of more efficient highway vehicles through designing more efficient components, particularly gas turbine and Sterling engines. ERDA is also exploring the feasibility of electric cars for urban use, and investigating waste heat recovery systems for ships.

To attain increased efficiency and reliability to electric utility systems, ERDA has initiated a number of projects such as the development of direct current transmission systems and superconducting low-resistance transmission lines, which offer little or no resistance to the energy flow. Part of this research involves the analysis of the ecological and biological effects of high voltage fields.

ERDA's energy conversion projects involve increasing the efficiency of heat exchangers, compressors, pumps, motors, generators, and fuel cells. Work in energy storage systems ranges from developing solar energy storage to designing high performance batteries for utility and vehicle use.

ERDA believes that these technologies offer potentially substantial energy savings; however, any savings will not be realized until the technologies have been marketed and implemented. Life-cycle costing principles (i.e., assessing the cost of a product by adding incremental energy costs to the initial purchase price) must be applied by consumers in their purchasing decisions; manufacturers will then respond by producing more energy-efficient products. ERDA maintains that the responsibility for implementing, marketing, and regulating energy practices lies with the private sector and the public.

The majority of comments on ERDA's energy conservation program concentrated in four areas:

- o Allocation of Funds
- o Role of Public vs Industrial Sector
- o Conservation Measures
- o Financial Incentives.

ALLOCATION OF FUNDS

Although this topic elicited a great deal of heated discussion, there was relatively little disagreement among participants about the disbursion of funds within the conservation budget.

The one exception involved the allocation to natural gas conservation. A number of participants expressed concern over the availability of natural gas (which currently supplies one-third of our energy requirements) and the general need for conservation in that industry. It was felt that there was not enough concern for the supply and demand of natural gas, and that gas conservation projects should receive higher priority than those involving electric utilities. One speaker criticized government policy for favoring the development of new electric appliances rather than more cost-efficient gas appliances. Another stated that ERDA's gas conservation programs should be expanded, as conservation in that area offers greater potential energy savings. Furthermore, the conservation program should recognize the use of all forms of energy and their conservation potential.

More criticism centered on ERDA's overall allotment of funds to energy conservation. Specifically, there was a general consensus that ERDA oversubsidized nuclear-related projects (48 percent of total budget) at the expense of energy conservation, which was only allocated 4 percent of total budget. While acknowledging the 60-percent increase in funds from the previous year, several participants contrasted these figures with ERDA's averred high priority on conservation. In fact, one attendee questioned the seriousness of ERDA's commitment to conservation. Another asked whether other federal agencies focus sufficiently on energy conservation to compensate for ERDA's failure to allocate sufficient funds. One participant charged that research on energy conservation fell into a gap between the Department of Commerce, ERDA, and FEA.

Energy conservation was considered a safe, proven, cost-effective means of maintaining energy supplies. In contrast, nuclear power research was held to be hazardous, unproven, and expensive. Some felt that ERDA's pro-nuclear bias reflected the concerns of companies who had invested heavily in nuclear research and are forced to continue research to receive a return on their investment. ERDA was also criticized for concentrating on high-technology, capital-intensive projects, such as nuclear research, instead of less complex, labor-intensive projects. According to one speaker, energy was less expensive than capital equipment or labor until recently. It was recommended that ERDA allocate funds according to the cost-savings potential of the different technologies. Specifically, one participant advised ERDA to make money available to small industries for regionalized energy application and equipment studies, which would provide information on different climates, energy sources, and environmental conditions. Funds also should be allotted for the development of educational programs.

A number of participants addressed ERDA's role in new source research, particularly in the field of solar technology. One stated that the short- and long-term potential of solar energy had not been adequately assessed or emphasized in ERDA 76-1. For example, the plan did not mention the new National Solar Energy Institute. It was also contended that ERDA could significantly accelerate the commercialization of solar heating and cooling technology in the food industry.

While some felt that the plan overemphasized new energy sources, others thought ERDA's program priorities were consistent with current technical knowledge and energy requirements. One attendee concluded that ERDA should seek a balance in spending that recognizes the urgency of short-term conservation actions, strengthens support for solar research, and realistically assesses the adverse effect of interstate price controls, particularly for interstate natural gas.

Although several attendees asserted that ERDA 76-1 should reflect the current American lifestyle and attempt to maintain it as efficiently as possible, many challenged the assumptions underlying the plan. One felt that ERDA 76-1 ignored the environmental effects of energy development. Others voiced the same general criticism: the ERDA plan perpetrated current patterns of energy use, assumed unlimited expansion, and reflected business interests. They believed that ERDA should explore alternatives in community and urban design, agricultural systems, and land use patterns.

One speaker pointed out that all of ERDA's transportation projects concentrate on technical changes in the design of the transport vehicle, a focus that assumes continuation of America's highway-defined social and geographical organization. Highway systems foster decentralized land use patterns and single-family homes. It was argued that, unless the transportation system itself changes, significant overall energy savings cannot be achieved.

ERDA's own figures project only a 2-percent energy savings in the transportation sector by 1985. According to this speaker, transportation energy must be reduced by 20 to 30 percent within a decade to maintain a reasonable degree of energy independence. Retaining our current transportation system means continuing the nation's economic dependence on foreign oil for at least 20 years or until alternative energy sources are developed.

This speaker concluded that if ERDA is serious about energy conservation it should incorporate social R&D into its technological research. Four areas were suggested which, if combined, could potentially offer energy savings of 1-3 million barrels per day of oil.

1. Potential conservation of transportation energy through changes in land use relations (i.e., effectively concentrating residential, employment, and consumption centers)

2. Substitution of communication for transportation

3. Improvements in the organizational efficiency of mass transportation modes

4. Improvements in operating efficiency of both public and private highway-based systems.

A speaker from ERDA countered this broad critique by explaining that ERDA 76-1 does not reflect all traffic projects undertaken by government. For example, other agencies are conducting studies on traffic flow, the impacts of changes in urban growth patterns, and telecommunications. Furthermore, other branches of ERDA have studied urban change and land use relationships, and community systems.

ROLE OF PUBLIC VS INDUSTRIAL SECTOR

Many participants expressed concern about the role of the federal government vs the industrial sector in regard to research, marketing, education, and an overall energy conservation plan.

Industrial representatives discussed the potential for and limitations of conservation research in the industrial sector. As one speaker noted, the relative cost-effectiveness and quick payback of energy conservation often prompt industry to engage in many of their own plant-specific projects. One attendee argued that ERDA's allocation to conservation does not reflect the nation's overall emphasis on conservation as private industry can provide proportionally more support to energy conservation than to high-risk technology. On the other hand, another speaker pointed out that pure research, which involves large investments and greater risks, generally requires some form of government aid to industry. Since small industries face proportionately higher risk, they require government funding for energy application and equipment.

Several participants named various constraints on private sector RD&D, e.g., future profitability, environmental standards/regulatory policy; size of investment of effort required; and magnitude of technological risk. Others were concerned with price controls, declaring that they prohibit further industrial involvement in more intensive energy R&D.

One representative identified several broad areas in which industry and government could work together: implementing conservation, developing domestic and new energy resources, and maintaining environmental and economic balance. Another suggested several other areas for combined government/industry research efforts, e.g., combination heat pump/fossil fuel systems, heat recovery systems, solar heating/cooling projects, solar space and water heating systems, and low pressure extraction steam from electric generators.

In relation to marketing, one person questioned ERDA's heavy reliance on private enterprise and market forces to implement energy technology. Another contended that ERDA 76-1 overestimates the importance of marketing and education to promote wide-scale use of technologies. Although public energy consciousness is vital, it is hindered by widespread distrust of government energy information systems.

Many asserted the importance of effective consumer education, communication, and marketing strategies for moving technology into the marketplace. One speaker stressed the education and training of engineers to operate and maintain equipment in the buildings industry. Energy conservation requires engineers not only to design mechanical and electrical facilities, but to assist operating personnel as well.

For example, the engineers could supply the operating personnel with information regarding the cost-benefits of specific energy-savings measures, which they, in turn, could pass on to individual building owners. This educational function could facilitate more effective implementation of conservation measures in buildings.

One attendee recommended that the government aid conservation education programs; another outlined a detailed company marketing action plan similar to ERDA's. As part of this plan, the company has met with a variety of groups to discuss energy conservation, and developed displays on energy conservation and application for energy information centers. These displays include insulation, solar energy, high-efficiency air conditioning, pilotless gas appliances, and heat pumps. However, it was concluded that the dissemination of conservation information on a large scale requires more detailed knowledge of regional differences than most individual utilities possess.

One participant mentioned that conservation practices are often a function of regional characteristics, as energy resources and requirements vary from region to region. For example, Michigan is rich in renewable resources, e.g. solar, wind, urban wastes, peat, and biomass, and requires a significant amount of natural gas for its food industry. Conservation offers the greatest near-term potential for this region. Specific programs, such as heat recovery from industrial processes, combined heat/electricity generation, and increased efficiency of energy-consuming devices, could reduce energy requirements.

Some speakers voiced the need for division of federal and state roles and urged greater federal and state cooperation. Others praised ERDA's recognition of regional differences and willingness to assist regions in developing their own programs. As one speaker remarked, implementation of effective state plans could further nationwide energy savings. Another commentator remarked that many states have difficulty coping with the myriad federal programs required to establish meaningful state plans.

CONSERVATION MEASURES

A number of speakers reported on specific energy-savings measures. Several were concerned about the benefits over time of conservation measures and the plan's emphasis on projects with rapid payoff. One participant, who stressed the urgency of short-term conservation measures in the gas industry, praised ERDA's awareness of this need. Another criticized ERDA's emphasis on short-term projects in the transportation sector, charging that 5 years was long enough only to implement existing technology, not to develop new technogy.

One speaker noted that there were significant possibilities for fuel and electrical reduction in commercial, institutional, and multiple residential buildings. However, because of the difficulty of retrofitting old buildings, available equipment has frequently not been installed. It was recommended that outside experts be hired to identify energy-saving measures applicable to specific buildings. These recommendations could include both new technologies and regulated use of existing equipment. For example, one consultant estimated that a small college could achieve substantial savings by installing flow control valves on shower heads in gyms and dormitories, which would reduce natural gas consumption by nearly 10 percent.

Another participant mentioned that proper maintenance of both new and existing boilers, furnaces, and other heating devices could greatly increase energy efficiency. Further research was recommended to improve instruments for measuring temperature, humidity, air flow, and remote control.

A number of alternative heating and cooling systems are discussed, including the use of internal lighting as a heating source. Suggestions for regulatory actions ranged from installing separate meters (vs a master meter) in apartment buildings to replacing 5-gallon toilets with 2-1/2-gallon units. On a larger scale, legal restrictions on the design of new buildings were recommended.

One representative recommended a number of promising conservation projects for further research and development in the gas industry. For example, high-efficiency gas heat pumps could heat and cool a home using less energy than gas furnaces use just in home heating. Furthermore, the combination of a gas heat pump with coal gasification technologies could provide a more efficient, and less costly, source of heating energy than electric heat pump. The speaker recommended that ERDA expand its current research on gas heat pump and coal gasification to include heat pump systems.

Representatives listed several current projects in the electrical industry that could reduce peak loads through conservation heat recovery and storage. Several examples were given, including a stored ice-bank cooling project heat for residences, and the utilization of solar energy with a heat pump assist. In addition, electric boilers could be installed for off-peak use with an alternative energy supply. These programs could achieve cost savings as well as conserve energy.

Several speakers discussed the potential use of electric cars, especially for intracity transportation. ERDA stated that the safety of these vehicles has not been proven, and that energy storage technology must first be developed.

One attendee discussed the food industry, which, according to the FEA, consumes about 17 percent of the nation's energy and is extremely sensitive to nearly all the variables affecting fuel supply and demand. The food industry relies heavily on natural gas, which produces 36 percent of the energy used in the industry; 60 percent of the energy for food and kindred products processing; and 90 percent of the energy required in the essential support industries (e.g., fertilizer, feed, farm machinery, pesticides, and petroleum products). Given the energy price and supply constraints projected for the next 5 years, as well as price controls, conservation is the only action that the food industry can take to lessen the impact of price increases and minimize its reliance on energy. This speaker thought FEA should concentrate on accelerating the application of new technology, such as the development of solar-heated and -cooled restaurants.

FINANCIAL INCENTIVES

As one participant pointed out, economic incentives are inherent in energy conservation: saving energy means saving money. Industry participates in conservation projects because there is a real financial incentive to do so. For example, an energy-intensive industry, such as the food industry, can realize cost savings by implementing energy conservation procedures. On the other hand, the ERDA 76-1 plan assumes the industrial sector will initiate new energy research. However, industry will not use investment funds for such high-risk research without economic incentives. Several speakers argued that price controls act as a negative economic incentive and discourage industry from undertaking research.

A number of participants suggested specific options for providing economic incentives, to both industry and the consumer, for conserving energy. New pricing mechanisms were recommended, including peak-load pricing with detailed, itemized billing as an incentive for the homeowner to conserve energy. According to the Midwest Research Institute study for FEA, 35-37 percent more electricity is saved when residents pay their own bills. However, one speaker warned that the costs of individual meters and billing procedures might outweigh these benefits. In another conservation project, a Michigan utility is assessing the use of pricing mechanisms to encourage customers to shift their energy loads from peak to off-peak periods.

One attendee recommended an energy tax to increase the rate of return for conservation and esoteric technologies (e.g., solar). Such a tax would help consumers evaluate the future cost of energy. The feasibility of offering loan guarantees was also discussed. One utility provides loans to residential customers for the installation of insulation.

One attendee proposed a national energy policy containing the following recommendations for government action:

- Deregulate oil and natural gas prices
- Decrease substantially the time required to place additional nuclear power plants on stream
- Develop realistic regulations to optimize development of cost use
- Streamline environmental impact statements and decrease review time
- Define the role of the federal government in the development of alternate energy sources.

GOVERNMENT, INDUSTRY, AND THE PUBLIC INTEREST

The workshop on government, industry, and the public interest indicated that, to a certain extent, state, local and regional groups are aware of the national energy problems, as well as their responsibility in finding solutions to these problems. However, both ERDA representatives and other participants believed that the roles of the various sectors (e.g., industry, universities, and state governments) need to be better defined and overall communication improved in order to effectively carry out the goals of the plan. In particular, the participants seemed to favor ERDA's emphasis on energy conservation but were concerned about the successful implementation of energy-saving measures in the various sectors.

ERDA's major concern is the integration of its RD&D programs with those of industry. ERDA's interventions are intended to supplement private sector efforts and to achieve timely introduction of new energy technologies.

ERDA's role in creating energy choices for the future consists of two phases: R&D and demonstration. During the R&D phase, ERDA examines the industry organization and the near- or long-term application of the technology to determine the need for its participation. For example, if the technology has a certain and immediate payback and the industry is capable of conducting R&D without government assistance, ERDA will not become involved. On the other hand, if the technology has an uncertain and distant payback, private industry will not take the lead. In such cases (e.g., the development of fusion technologies), ERDA must ensure that the necessary R&D is performed. Joint industry and government funding is required in less certain technologies (e.g., coal conversion). Eventually, as the technology matures and the profits become more certain, industry will begin to fund an increasing share of the R&D expenses; ultimately, it will assume the total responsibility.

In the development of energy-conserving technologies, ERDA's R&D involvement is more extensive (regardless of industry organization) for two reasons:

1. Energy conservation is applicable to all sectors, and within the private sector, it pertains to both large and small businesses.

2. The private sector is only interested in implementing those energy-savings measures that reduce production costs.

The intent of the demonstration phase is to allow time for the assessment of the environmental and regulatory implications. Although most valid technologies would probably be introduced at some future point without any government involvement, private industry action may be impeded by environmental and regulatory uncertainty. In addition, the time and capital involved in implementing the technology can act as a barrier. To resolve these constraints, ERDA shares the cost of demonstration projects with industry. Once their feasibility has been demonstrated, industry will assume responsibility for the marketing and implementation.

ERDA personnel noted, however, that, historically, joint government/industry demonstration projects have not been successful. For such programs to be successful, the government must convince the private sector of the technical reliability, economic viability, and environmental acceptability of these technologies. Ultimately, it is private industry, not ERDA, who must produce and use these technologies in an economically successful manner.

The workshop comments on the plan and suggestions for the future centered around the various interest groups:

- o Industry
- o Public Sector
- o State Agencies
- o Universities.

INDUSTRY

The discussion of industry and government interaction in RD&D efforts centered around big and small businesses and their different needs and capabilities. ERDA sympathized with the difficulties encountered by all businesses in light of the energy shortage, energy conservation, and the development, production, and marketing of new technologies, and offered to help industry with these problems.

One representative suggested that ERDA recommend to the administration and Congress that industry be permitted greater freedom to cooperate on matters relating to energy R&D. For example, to promote energy R&D, certain activities should be exempt from antitrust laws that interfere with industry's free exchange and pooling of information, talent, and resources. It was pointed out that the rapid development of such essential materials as aviation gasoline, synthetic rubber, and styrene was made possible by the granting of antitrust immunity to industries.

One participant suggested that government and business join together to explore all possible avenues for energy R&D; however, the government should provide incentives to encourage industry participation. One participant commented that, because small businesses have limited product lines and resources, they usually do not view energy conservation as a business opportunity. Only when the paybacks are fast, cost is low, and risks are minimal, will such businesses develop new technologies as products. The level of risk involved in modifying existing products or introducing new products is easier for large companies to accept. For small businesses, this risk must be balanced with appropriate incentives. Small businesses need financial assistance because of the high capital costs of energy-conserving equipment.

In response to an allegation that industry views government money for demonstration as an interest- and risk-free loan, ERDA explained its funding priorities. The government funds the design stage of the demonstration program. Once actual construction begins, the costs are shared equally, a fact that may discourage some industries from participating. For small businesses to participate, the rate of return must be equal to or greater than that of other production processes; in medium-sized businesses, the rate must be greater than 20 percent. The risk is lessened with large industries, which historically have attempted to utilize energy efficiently for economic reasons.

Small businesses will begin to conserve more energy as equipment and processes are replaced; however, according to one participant, extensive conservation will probably not occur before the 1980s and 1990s. While ERDA was commended for its energy conservation program, one attendee remarked that conservation will not be a total solution to the projected 4-percent annual growth in energy demand.

One participant commented that the Office of Minority Business Enterprise is a source of funding for small businesses. The Small Business Administration (SBA) also guarantees loans to small businesses that have already been turned down by banks. Moreover, in some cases, the SBA will provide for direct loans.

Another commentator felt that small businesses need assistance in developing marketing tools to demonstrate the energy-savings characteristics of their products to the consumer. For example, a local manufacturer's representative who sells truck door curtains that are efficient from a life-cycle costing viewpoint could use ERDA's assistance in identifying product areas and delineating techniques for further market penetration.

ERDA was criticized for its past history of ineffective communiction with small business. According to the Department of Commerce, 98 percent of U.S. firms employ less than 50 people. According to one speaker, effective communication between government and small business is inhibited by limited capital resources and management time. At a recent meeting of the Chicago Association of Commerce and Industry, for example, only 6 of the 36 participants had even heard of ERDA. In addition, the speaker maintained that there was no explicit consideration in ERDA 76-1 of the affect of "across-the-board" regulations on small businesses.

An ERDA speaker noted that, in developing its small business program, the agency has recognized the gains to be had from an association with the small business community. In many cases, small businesses have a more rapid accomplishment pattern than a major company. ERDA's ongoing procurement office deals with small businesses and establishes special rules for them; in addition, it is initiating a new small business policy and plans to establish a close relationship with the SBA.

It was felt tht ERDA's concept of a small business task force was good, although more specifics were needed before such a program could be effectively evaluated. It was also believed that the joint program proposed between ERDA and the National Bureau of Standards (NBS) would be effective if communications could be established.

The need for ERDA to develop commercial partners in the private sector was addressed. It was felt that ERDA must either establish new markets for its products or it must penetrate existing markets and displace existing products. This penetration must occur to the extent that there is a satisfactory return on investment. According to the University of Michigan Social Research Institute, consumer confidence is higher today than it has been in recent years. To benefit from this confidence, ERDA must recognize a commercial partner who has capital, knowledge, production facilities, and a distribution and service system. In addition, ERDA must be able to convince the partner of the viability of the technology (i.e., it is desirable, durable, safe, serviceable, socially acceptable, and warranted). Only when industry is convinced of a suitable return on its investment will it enter into such a partnership with the government. A precedent for this type of cooperation is the National Aeronautics and Space Administration's involvement with private industry.

On the other hand, another speaker felt that the joint industry/government work was not beneficial to the public. A dollar investment in energy industries created less than one-half of the jobs created by a dollar investment in other industries. For

example, one Illinois utility has reduced its employment by 17 percent, while collecting almost $20 million in employment tax credits. The public is neither enjoying cheaper and more efficient energy nor more jobs through tax subsidies of energy industries. The participant asserted that the existing relationships between government agencies and corporate powers made for cheating and abuse.

Another commentator felt that, left alone, the private sector market forces would not arrive at an optimum mix of alternative energy technologies. It is a mistake to believe that private interests have as much control or objectivity as implied. Their interests are basically economic in nature. To ensure consideration of such noneconomic factors as health, safety, and environmental quality, the government should take an active role.

The question arose as to how ERDA would become involved in training skilled workers and technicians for the energy industries. Currently, ERDA has a joint program with Memphis State University to train skilled engineers for placement in the utilities. Once initial training is completed, the utilities are expected to assume this responsibility.

PUBLIC SECTOR

The workshop attendees, including ERDA representatives, recognized the importance of public opinion in the successful implementation of any national plan. If the public will not accept new energy sources and technologies and is not convinced of the need for such developments, ERDA's energy planning will not be effective. One participant remarked that the scientific and technological problems may be simpler to solve than the problems of dealing with public awareness and acceptance of possible changes in lifestyle.

Several participants were concerned about convincing the public of the seriousness of the energy problem, considering the failures of past approaches. ERDA responded that, although education is everyone's responsibility, the administration should take a strong role in this area and should have assumed that responsibility several years ago. Although FEA could have served this role, the administration and Congress gave the agency limited visibility. In addition, if the public were provided a means by which to assess program successes and failures, it would gain a better understanding of the reasoning behind the allocation of public monies. The public could then make educated suggestions for increased allocation in one area or another.

One panelist suggested the use of national laboratories as a means of effectively disseminating information and educating the public and described the key components to a successful program of information exchange:

1. Development of a rapid information exchange system, whch establishes a series of lead centers where some of the research will be done, and where the most knowledgeable scientists will be located.

2. Use of a trained research librarian who will transmit data using computer techniques. Computers will link the lead centers together, which will permit maximum flexibility during a crisis or a problem.

3. Development of national policy advisory boards, which would also have computer facilities.

According to the speaker, this type of decentralized program would allow for adequate government interaction with the public and industry, and, thereby, circumvent the government responsibility to justify its actions to the public.

An ERDA representative mentioned the energy extension service as a means of decentralized information dissemination. Currently, ERDA proposes to implement a pilot extension program in locations throughout the country. Through this approach, different management and program techniques could be investigated, and the service could be evaluated for its nationwide applicability. If congressional approach is received, implementation will begin in 1977.

One representative criticized ERDA 76-1 for not reviewing previous energy developments. If the plan is a "blueprint for the future," past successes and failures must be considered. In addition, the expenditures of public monies during the previous year should be reviewed as there is a tendency to equate "dollars spent" with technical achievements. For example, although more dollars are being spent to develop nuclear power than solar energy, the returns to the public may be far greater from solar energy development.

In response, the ERDA representative stated that, although some technologies (e.g., synthetic fuels) may not be economic at the present time, they must be supported because of the long lead time involved in their implementation. To avoid a more expensive crash-learning program in the future, the nation must be willing to undergo the expense of these massive programs.

Nonetheless, several participants insisted that ERDA's approach to energy planning is misguided. For example, energy conservation should not be used as a short-term effort to provide planning time for the nation. The government should concentrate on developing a long-term policy to improve energy efficiencies and to control demand. Another participant indicated that it is in our best interest to switch from nonrenewable sources. For example, since the end of World War II, the government has promoted energy-intensive air and auto travel at a great cost to the taxpayer, instead of promoting mass transit, electric railroads, and gasoline rationing.

It was also suggested that we start using our natural resources responsibly and develop the use of solar energy in order to reduce end-user energy costs. An ERDA representative responded that solar heating, which is still costly to implement, will eventually be an important part of the nation's energy supply. As production volumes increase and design problems are resolved, we should see progress in solar heating in the 1980s and 1990s.

Other commentators stressed that existing and future jobs are dependent on reasonably priced energy supply. However, it was stressed that environmental quality should not be abandoned as a criterion in the selection of energy supply sources regardless of pressing economic and social concerns. Any choice should involve a tradeoff analysis.

An industry representative described the criteria used by the consumer when purchasing or accepting a new product or technology. Performance, convenience, comfort, appearance, and economy of operation are all purchase decision factors.

However, economy of operation is not always a significant criterion. For example, a 50-percent increase in the cost of gasoline has had little effect on automobile owners who seemed to be more concerned about the availability of the fuel than the price. However, if the consumer believes that the technology has little value, he/she will be more concerned about the cost, particularly the first cost.

One participant believed that the apparent close relationship among utilities, suppliers, and the federal government could be detrimental to the public interest. If public funds are going to support energy technology development in the private sector, the public must also realize some of the benefits. Currently, the public, rather than the stockholders and the utilities, is bearing the risks and costs of new energy technologies. For example, one utility is requesting that their synthetic fuel plan be depreciated in 10 years, since the company is uncertain that it will be able to operate the plant after that time.

It was pointed out that these economic uncertainties should be the responsibility of the stockholders, not of the rate payers. Operating efficiencies should be established, and if utility operations do not meet these standards, bills and escalation bases for rate hikes should be reduced accordingly. If the government commits public funds in this area, it must protect the public from inefficient plants. The public return on investment of public monies is negligible. In fact, energy prices are higher, private profits are higher, and labor is taken for granted.

STATE AGENCIES

Several participants noted that the ERDA plan recognized the need for and importance of state involvement. However, several participants questioned how ERDA would actually integrate its activities at the state level, and how regional and state differences (e.g., geography, climate, and available natural resources) would be taken into account in a national plan.

One attendee suggested that ERDA develop a one-to-one relationship with the states as a means of gaining sensitivity to individual state needs and resources. It was felt that regional conferences (e.g., the Midwest Governors' Conference and the National Governors' Conference) were an inadequate means of developing a larger plan for solving regional needs. The participant viewed the results of such conferences as compromises that do not reflect the actual thinking of the individual states. Although such conferences could be important in relation to ERDA's overall planning process, only information received directly from the states would solve the problem of regional differences.

It was suggested that the states assume a stronger role in national energy plans by selecting from the myriad of programs advanced by the federal government and shaping these programs around regional characteristics. The states should then allocate their resources to the development of those programs that are in the best interests of their residents. In other words, federal and state interaction should occur during the planning process, as well as after the plan has been established.

Another participant suggested that state governments not only prepare an RD&D plan on the state level but also explore avenues for commercialization. The state government should work with industry within its state or with the industrial capability of other states. However, the participant cautioned that this would be no easy task, because of the diversity of organizational structures and geographic, climatic, and demographic differences within the state.

The importance of establishing contact with the federal government to coordinate information flow was also stressed. With a centralized federal agency carrying out a national plan, substantial organization would be required if the plan were to be accomplished. State agencies have neither the money nor the staff to process great amounts of information. It was suggested that ERDA appoint an individual to work specifically with the states. This person should be informed of all ERDA's activities and meet frequently and regularly with state agencies.

Currently, ERDA is working on a plan to establish closer cooperation with the states, which, in many cases, do not have major R&D programs. ERDA recognizes the advantages of state clearinghouses as a means for solving the problems that are peculiar to a given state. For example, in the southwest, assistance is needed to develop solar energy; in the midwest, assistance is needed to develop clean fuels from coal.

One speaker denounced the plan's emphasis on commercializing energy conservation techniques. Instead, the Federal government should emphasize land use and zoning controls, conservation in building designs, and mass transit. It was felt that ERDA should work at the state level to develop model zoning ordinances to transform consumption and development plans. Another speaker pointed out that the nation is developing low-density, inefficient communities.

The ERDA representative responded that ERDA is working with the states on a building code, but that a model code would not be useful because of the radical differences in codes. In addition, the Department of Transportation, who has R&D monies, is responsible for mass transit.

UNIVERSITIES

Representatives of the academic community spoke about incorporating university programs into the energy R&D program. The available manpower located in universities was also stressed as an important resource.

One speaker felt that academic interests and resources have received too little attention in the plan. If ERDA wishes to achieve its goal of creating energy choices for the future, members of the scientific and technological community must be involved in new ways. The Argonne National Lab was presented as an example of joint academic and government research efforts.

The speaker also listed the qualities that universities can provide to the energy planning effort:

1. The universities are an unbiased channel through which energy issues can be brought to the public.

2. The universities contain a vast reservoir of scientific and engineering talent that can be drawn upon to provide timely answers to energy problems.

3. Universities will probably be the only source of professionally-trained manpower for the future needs of the energy industries; however, students must become more involved in the issues and the solutions before they enter the job market.

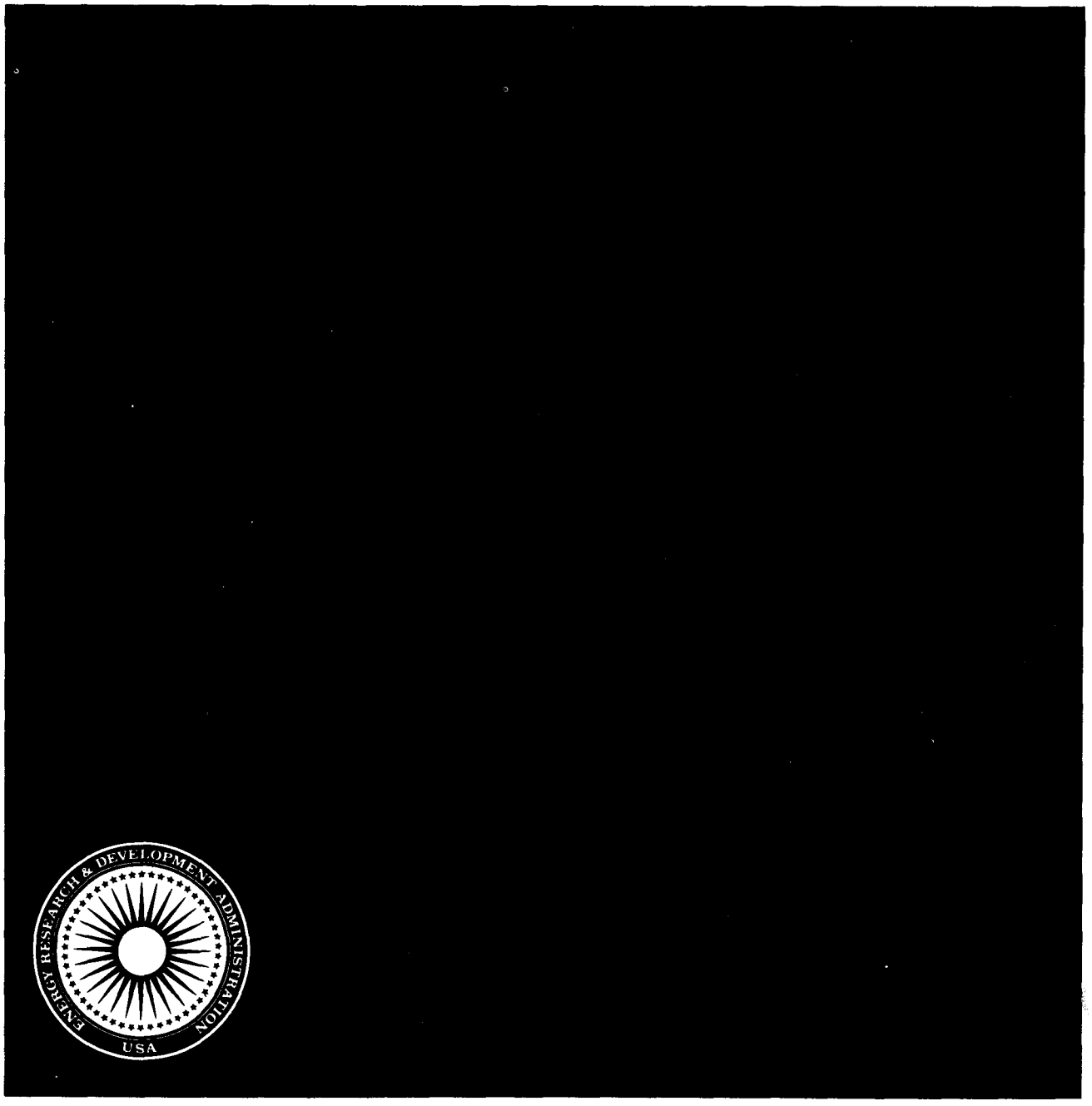
In addition, if universities and national laboratories conducted joint R&D research, the quality of the manpower graduating from the universities would be benefited, as students would receive both university instruction and laboratory experience.

One speaker mentioned that a possible barrier to joint R&D efforts was the universities' belief that such cooperation implies the loss of funds. ERDA must provide encouragement and financial support for such joint activities. Major research projects such as large-scale regional and environmental studies offer opportunities to combine the efforts of national laboratories, industrial scientists, and energy researchers, such as social scientists, economists, and legal specialists.

ERDA 76-1

A NATIONAL PLAN FOR ENERGY RESEARCH, DEVELOPMENT & DEMONSTRATION: CREATING ENERGY CHOICES FOR THE FUTURE 1976

VOLUME 1: THE PLAN



Executive Summary

Key Points of The Summary

Representing an evolution in approach over the initial planning of June, 1975, this National Plan expands the scope and depth of coverage of the earlier Plan. The basic goals and strategy are refined, but remain essentially intact.

Significant points of emphasis in this report are as follows:

- The paramount role of the private sector in the development and commercialization of new energy technologies is addressed.
- Conservation (energy efficiency) technologies are singled out for increased attention and are now ranked with several supply technologies as being of the highest priority for national action. The primary responsibility for developing and bringing into use improved technologies for energy efficiency rests with the private sector but the Federal Government is increasing its funding for this area to provide encouragement and stimulus to the total national effort.
- Federal programs to assist industry in accelerating the market penetration of energy technologies with near-term potential are a key element in the Plan.
- The close coordination of technology development with socioeconomic and environmental factors, at regional as well as national levels, is provided.
- The President's 1977 Budget recognized the high priority of energy RD&D by proposing a greatly expanded program at a level appropriate to the responsibilities of the Federal Government. Specifically, it:
  - —Accelerated energy RD&D programs directed at achieving greater long-term energy independence.
    - ——Expanded efforts to assure the safety, reliability, and availability of commercial nuclear power plants.
    - ——Placed greatest funding on technologies with the highest potential payoff in terms of recoverable resources (i.e., nuclear and fossil).
    - ——Greatly increased the Federal investment in conservation technologies.
    - ——Continued to expand the investigation of other technologies where they can make significant contributions to meeting the long-term energy requirements of the U.S. (i.e., solar, and fusion).
  - —Encouraged cost-sharing with private industry (e.g., coal liquefaction demonstrations) and avoided undertaking RD&D more appropriately the responsibility of the private sector (e.g., in areas of conservation technology).
  - —Supported the commercial demonstration of synthetic fuel production from coal, oil shale, and other domestic resources by providing loan guarantees beginning in FY 1976.
- A new short-term, five-year-forward planning category is added to the Plan to focus attention on opportunities for technology development that may have effect within five years.

National priorities for energy RD&D are not the same as priorities for the allocation of *Federal* funds for energy RD&D. In many cases, Federal spending for the development of a particular energy technology may not be justified because:

- —the RD&D function can better be performed by the private sector,
- —the objective can better be achieved by some means other than RD&D, or
- —the funding required is not sufficiently high in priority compared to other demands for Federal funds.

Furthermore, the level of Federal resource commitment for any particular area of energy technology is also influenced by the stage of technology development as a technology moves from the less expensive research phase to the more expensive pilot and demonstration plant phases.

While ERDA's proposed plan is national in scope, the Federal Government can neither uni-

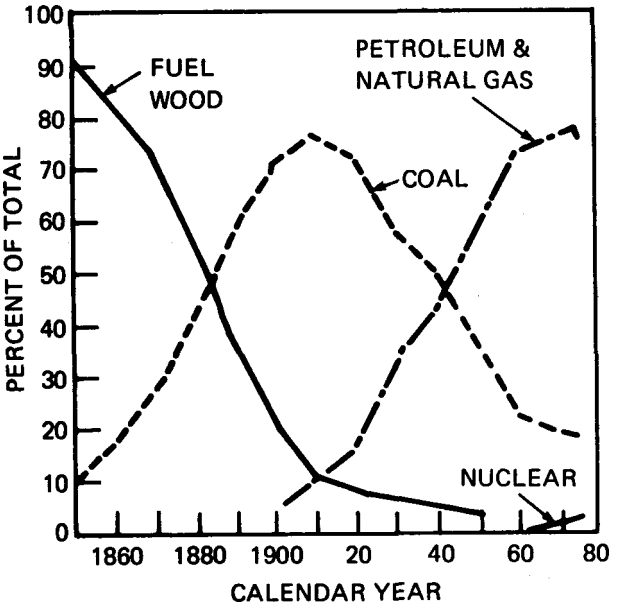
laterally plan the course of national action nor accomplish all the necessary actions defined by such a plan. This planning process is a useful mechanism because the Federal Government can use such an approach as one context for its own actions and as a way to promote consensus on the Nation's approach to energy RD&D.

Background of the Plan

The Nation faces a serious and continuing energy problem characterized by limited energy choices and increasing dependence on diminishing oil and gas resources. This problem is currently exemplified by an undue reliance upon imported fuels.

This serious energy problem has come about because most of the fuel currently used by the Nation is in the form of petroleum and natural gas, and these fuel resources are becoming rapidly depleted. Actions must be initiated to prepare for a transition from dependence on oil and gas to reliance on alternative energy sources, particularly coal and nuclear in the near and mid term. Historically, however, such transitions, as illustrated in Figure I, have required more than half a century.

To provide alternatives to undesirable dependence on oil and gas, the Nation must undertake a program of technology development which will be technologically difficult and costly, and will require time.



SOURCE: HISTORICAL STATISTICS OF THE UNITED STATES BUREAU OF THE CENSUS; U.S. BUREAU OF MINES, 1974

Figure I U.S. Energy Consumption Patterns

The problems of transition to new energy sources are difficult. New domestic energy sources are potentially available—indeed, solar energy and nuclear fission (breeder) and fusion represent essentially inexhaustible energy sources—but there are significant economic, environmental, social and technological problems to be solved before these new energy sources can become adequate supplements for oil and gas. Meanwhile, existing domestic alternatives in such forms as abundant coal resources, and the full benefit of nuclear light water reactors cannot be completely realized without further technological improvements.

Figure II presents current potentially recoverable resource estimates for key domestic fuels. Shaded areas indicate the additional resources that may become recoverable if the necessary technology and utilization techniques can be developed. In addition, Figure II illustrates the relative paucity of domestic oil and gas resources compared to the estimated cumulative energy demand from now until the end of the century. Coal and nuclear represent the major exploitable resources to supplement oil and gas over the next several decades. Geothermal, oil shale, and solar energy in the form of solar heating and cooling represent supporting resources to ease overall supply problems in that same time period. Nuclear breeders, solar electric, and fusion represent technologies that can exploit major resources for the next century. These latter three technologies differ significantly as to the status of their development and demonstration, the severity of the economic, environmental, social and technological challenges to be overcome and their potential for meeting energy needs within given time frames. With respect to the latter point, the first two of these have the potential to contribute to meeting energy needs during the later part of this century.

In summary, even though the Nation is blessed with abundant energy resources, it is currently dependent upon a narrow base of diminishing resources.

This Plan is designed to describe likely options for the introduction of new technology that will assist the changeover from dependence on this narrow base of diminishing domestic resources to reliance on a broader range of less limited alternatives.

The transition to less limited resources poses substantial technological and environmental problems. Of equal importance are the difficult economic, social, and institutional problems that will be associated with this transition. These problems must be addressed more intensively than ever before and a RD&D program, however successful technically, can fail because of failure to solve any one of these problems.

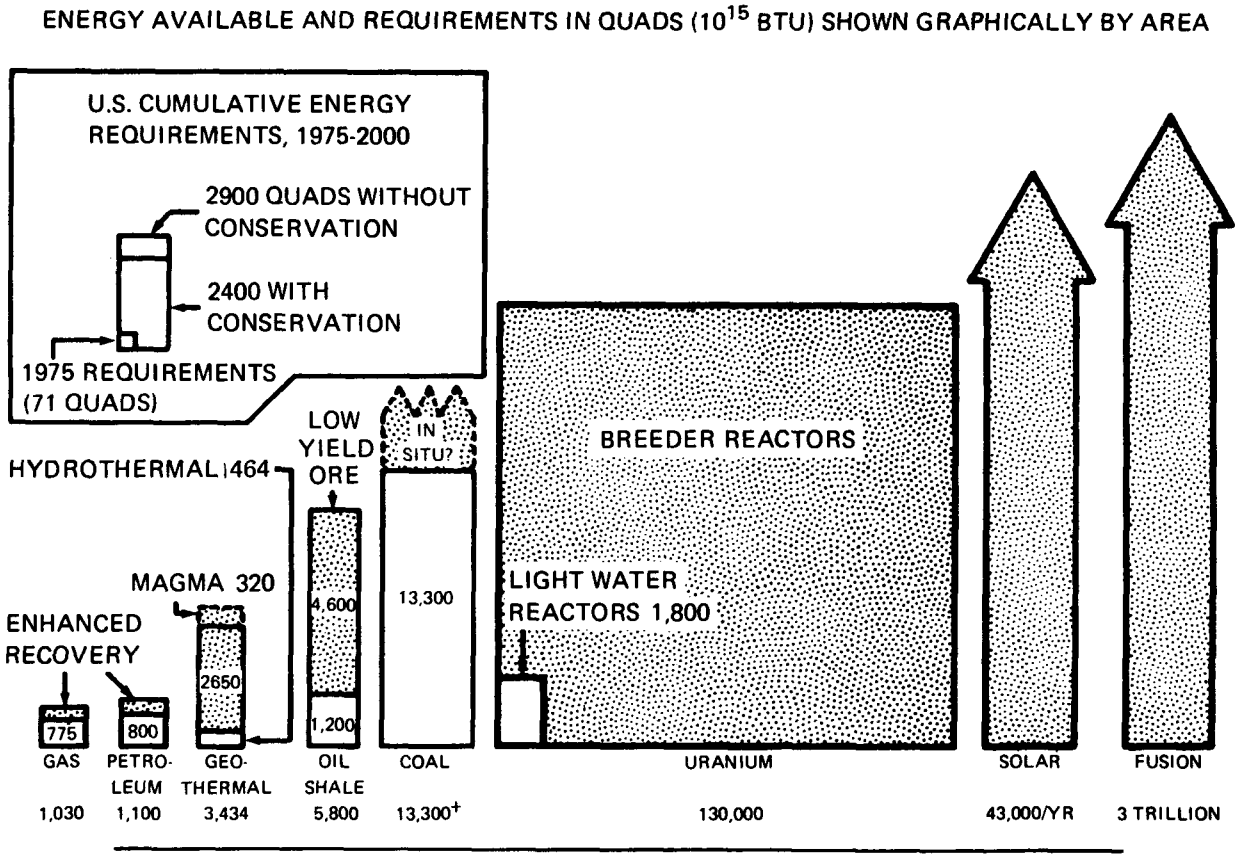


Figure II Potentially Recoverable Domestic Energy Resources

Technology development is made more difficult by uncertainty as to how the future will evolve with respect to energy demand, energy costs and many other factors. There is, today, uncertainty as to the future of energy demand; the relative economics of energy technologies; the interplay with the environment; the choice of preferred energy systems; the date of introduction or the rate of implementation of a particular energy technology; the international aspects of the world-wide energy problem; and other factors affecting solution to the domestic energy problem.

While technological development is a necessity for almost every aspect of the energy problem, the design of a program for technology development must remain responsive to such factors as:

- How much domestic oil and gas is actually found and produced
- The availability of imports from secure sources, plus the backup protection against supply disruption that can be gained from stockpiling policy
- The rate of implementation and level of development of both existing and emerging new technologies
- The degree of protection afforded human health and the physical environment
- The degree of modification of life styles which the Nation finally adopts
- The end-use energy efficiencies that may be finally attained
- The level of effort that can be placed in the development of new technology
- The economic and technical success finally achieved by new technologies
- The impact of economic and sociopolitical considerations.

Even though this list is not exhaustive, it is illustrative of the difficulties in dealing with the energy problem. Decisions on this development must be made today in the face of uncertainty, without foreclosing future options. Indeed, the basis for undertaking a program of energy RD&D is to broaden the Nation's range of available energy options—**to create energy choices for the future.**

While RD&D is clearly needed, an insufficient amount is being conducted in the private sector because of uncertainties with respect to future profitability; environmental standards and other regulatory policies; the magnitude of technological risks being faced; the lack of present institutional organizations to undertake the effort; or simply because of the sheer size of the effort or investment. Energy RD&D

is one element of the total National policy which must seek to reduce these risks and uncertainties and improve the economic and regulatory climate for private action.

The starting point for this Plan for technology development is the broader concept of national energy goals and principles.

Ultimately, decisions as to which technologies are found to be acceptable have wide-ranging implications for the country's security, and involve the future environmental and economic well-being of all citizens. The process of developing alternatives to the present energy system needs to be carried out in a context which continually considers the broader issues of public concern.

The programs to achieve Energy Independence were guided by the following principles: These principles are still sound today:

- "Provide energy to the American consumer at the lowest possible cost consistent with the need for secure energy supplies.
- "Make energy decisions consistent with our overall economic goals.
- "Balance environmental goals with energy requirements.
- "Rely upon private sector and market forces as the most efficient means of achieving the Nation's goals, but act through the government where the private sector is unable to achieve our goals.
- "Seek equity among all our citizens in sharing costs and benefits of our energy program.
- "Coordinate our energy policy with those other consuming nations to promote interdependence, as well as independence."

In keeping with the above principles, the President set forth the following goals for a comprehensive national energy effort in the 1976 Energy Message:

—First, to halt our growing dependence on imported oil during the next few critical years.

—Second, to attain energy independence by 1985 by achieving invulnerability to disruptions caused by oil import embargoes. Specifically, we must reduce oil imports to between 3 and 5 million barrels a day, with an accompanying ability to offset any future embargo with stored petroleum reserves and emergency standby measures.

—Third, to mobilize our technology and resources to supply a significant share of the free world's energy needs beyond 1985.

It is the purpose of the National Plan for Energy RD&D to translate these principles and goals into specific Federal programs for technology development, recognizing that industry initiatives in implementing this development will be of paramount importance and that the public's support as citizens and consumers is essential.

A basic premise in national energy policy and planning for RD&D is that the private sector has the primary role in creating new energy alternatives; the Federal Government's role is to assist the private sector in the development and market penetration of new energy technologies.

With few exceptions, the private sector is the main producer and consumer of energy. The role of the private sector is therefore paramount in the accelerated introduction of energy technology, and in the solution of the Nation's energy problem.

In part, this is so because the private sector is motivated and prepared to take the risks involved in developing and introducing new energy technologies. In addition, the private sector has the inherent flexibility to act; the preponderant share of new investment funds; and the managerial capabilities for carrying out most of the RD&D and virtually all of technology introduction. Moreover, market forces as they are perceived by decision-makers in the private sector will determine the economically optimal mix of alternative energy technologies to displace the undue reliance on petroleum and natural gas.

Therefore the establishment of the Federal program and activity levels, the objectives are:

- To assist and reinforce private sector actions rather than to compete with them
- To ensure relevance of governmental activity by achieving extensive private sector involvement at the earliest possible moment in the development cycle.

An important theme of this report is that the private sector and market forces are the most efficient means of achieving the Nation's energy goals.

The role of the public sector, especially that of the Federal Government, is therefore supplementary—to do what cannot otherwise be done privately. The Federal role, in turn, divides into three parts: Government can establish an appropriate policy climate for private sector action, share risks, and conduct a complementary RD&D program.

In general, a preferred role of government is to establish an appropriate climate for private introduction of energy technology, such as:

- **Leadership and assistance:** establishing a consistent and stable policy and regulatory network.
- **Management of energy resources located in Federal lands:** making available these resources for use over time with due regard to environmental, aesthetic, conservation, land-use, or other factors of national interest.
- **Economic and anti-trust regulation:** making energy decisions consistent with national economic goals; providing energy consistent with the need for secure energy supplies; and assisting in the devel-

opment of standards, criteria, and certification procedures.

- **Human health, safety, and environmental Protection:** ensuring the protection of the Nation's environment and the public's health and safety.
- **International policy:** coordinating our energy policies with those of other consuming and producing nations to promote interdependence as well as independence.

Within the Federal Government, ERDA has specific leadership responsibility in energy RD&D.

Energy RD&D is an important component of the total Federal role, and ERDA plays a leadership role here in three ways.

First, ERDA develops and updates the National Plan for Energy RD&D. This Plan cannot, and is not intended to, represent technology as a total solution to the energy problem, nor can it predict certain success for any particular program, ensure immediate results, or preselect a single energy future. Rather, the Plan performs three principal functions:

1. Establishes a likely order of technology introduction from the near to the long term, and identifies current major guideposts for measuring and assessing the rate of technology introduction. These guideposts are useful in determining whether enough new technologies are being introduced to solve the Nation's energy problem, and in identifying possible compensatory government action.
2. Proposes national energy RD&D priorities linked directly to the order of technology introduction. These priorities are intended to be generally helpful in evaluating the national energy RD&D effort. In particular, the priorities bear on the allocation of government RD&D resources.
3. Stimulates debate on the technology options open to the Nation in the context of the total energy problem. ERDA believes this context, which forces the weighing of all alternatives together, facilitates the objective evaluation of individual technologies. It is a debate that should be encouraged.

Second, ERDA has the responsibility to monitor and report on the entire Federal energy RD&D effort. In this way, a coordinated program aimed at common objectives is more likely to emerge. Volume II of this Plan summarizes the activities of 23 Federal agencies as they relate to the total RD&D program.

Finally, ERDA is itself the principal sponsor of Federal energy RD&D, including programs involving risk-sharing with the private sector.

Fundamentals of the Plan

To propose effective solutions to the Nation's current energy problem, the National Plan for Energy RD&D addresses technology development from the standpoint of both private sector and Federal Government activities, and also proposes approaches to incorporate pertinent nontechnological considerations which can affect the results of RD&D.

The National Plan for Energy Research, Development and Demonstration is an integral part of an overall approach for addressing the Nation's energy needs. It is responsive to the national energy policy goals and principles enunciated in the President's 1975 State of the Union Message, and reiterated in the 1976 Energy Message. While its emphasis is on technological development, it is consistent with and reflects broader policy concerning import levels, foreign relations, the needs of industry and consumers, fiscal policy, environmental protection, and human health and safety concerns.

In its initial response to the Nation's energy needs, the Energy Research and Development Administration (ERDA) formulated the first National Plan for Energy RD&D, which proposed national priorities for the development of new energy technologies. That approach, published in June 1975, remains the basis for this first annual update.

The dual emphasis of this updated Plan is:

- The further refinement of priorities and strategic approaches identified in the initial National Plan for Energy RD&D
- The integration of the critical nontechnological aspects of energy development into RD&D consideration.

Technological Emphasis

The overall emphasis of this Plan is to support the private sector in the development and implementation of energy technologies that can begin to reduce the demand for oil and gas significantly in the balance of this century, and, where possible, in the near term.

To accomplish this, the Plan:

- Singles out conservation (energy efficiency) technologies for increased attention and ranks them with several supply technologies as being of the highest priority for national action
- Identifies six key supply technologies which can enter the market penetration phase in the near term
- Outlines initial program steps to overcome technological barriers to the rapid implementation of key technologies with near-term potential
- Adds a short-range planning category to focus attention on opportunities for technology development that may have effect within five years.

To balance these initiatives, the Plan also develops in further detail the longer-range programs given priority in ERDA's initial Plan.

Nontechnological Emphasis

The nontechnological emphasis of this Plan is to ensure that RD&D has taken account of all those factors which can facilitate the rapid integration of new energy technologies into the framework of the society.

To accomplish this, the Plan outlines approaches to:

- Government support to the private sector to accelerate market acceptance of key technologies after technological barriers to market penetration have been removed
- Integration of environmental planning at each stage in the process of technology development
- Interaction of public and private sectors at national, state, regional and local levels to ensure appropriateness of energy RD&D
- Development of a management process within ERDA to provide overall guidance and coordination of both technological and nontechnological aspects of energy development.

These approaches will be summarized and the basis for their emphasis will be explained in greater detail below.

The foundation of the National Plan is a set of recommended national energy technology goals, a strategy for achieving these goals, and a proposed set of national priorities for energy technology development.

To provide a basis for setting priorities in technology development and developing strategies for implementation, the Plan identifies eight national energy technology goals:

I. Expand the domestic supply and economically recoverable energy producing raw materials
II. Increase the use of essentially inexhaustible domestic energy resources
III. Efficiently transform fuel resources into more desirable forms
IV. Increase the efficiency and reliability of the processes used in energy conversion and delivery systems
V. Transform consumption patterns to improve energy use
VI. Increase end-use efficiency
VII. Protect and enhance the general health, safety, welfare and environment related to energy
VIII. Perform basic and supporting research and technical services related to energy

The Plan then develops a strategy for attaining these national goals:

NEAR TERM (Now to 1985 and beyond)	• Increase the efficiency of energy used in all sectors of the economy and extract more usable energy from waste materials • Preserve and expand major domestic energy systems: coal, light water reactors, and gas and oil from new sources and by enhanced recovery techniques.
MID TERM (1985 to 2000 and beyond)	• Accelerate the development of new process for producing synthetic fuels from coal and extracting oil from shale • Increase the use of fuel forms such as geothermal energy, solar energy for heating and cooling, and extraction of more usable energy from waste heat.
LONG TERM (Beyond 2000)	• Permit the use of the essentially inexhaustible resources: nuclear breeders; fusion; and solar electric energy from a variety of options including wind power, thermal and photovoltaic approaches, and ocean thermal gradients • Provide the technologies to use the new sources of energy, which may be distributed as electricity, hydrogen, or other forms throughout all sectors of the economy.

Initial ERDA analyses have led to the preliminary conclusions that only the successful development and implementation of a number of these technologies in a combination of approaches can provide adequate solutions to the present energy problem. All the national energy technology goals must therefore be pursued together. However this does not mean that every conceivable technology approach can or should be pursued with equal vigor or at all.

Although the proposed strategic approach is broad in scope, it recognizes the existence of limited resources, and consequently, the importance of setting priorities.

All appropriate technologies will be drawn upon to some extent in achieving the national technology goals. However, the development of some technologies is absolutely essential, while the development of others is more supportive and complementary. This distinction is based on six criteria:

- How substantial an energy contribution would successful development of the technology make possible?

Table I Technologies Now Available for Pursuing Major Energy Technology Goals

The last column of this table presents data from ERDA-48. It represents the maximum impact of the technology in any scenario measured in terms of additional oil which would have to be marketed if the technology were not implemented. Basis for the calculation is explained in Appendix B of ERDA—48. These data are being reexamined, and changes will be made when analysis is completed. In a number of cases, revised projections of impacts will be lower.

Technology	Term of Impact*	Direct Substitution For Oil & Gas**	RD&D Status	Impact in Year 2000 in Quads
GOAL I: Expand the Domestic Supply of Economically Recoverable Energy Producing Raw Materials				
Oil and Gas—Enhanced Recovery	Near	Yes	Pilot	13.6
Oil Shale	Mid	Yes	Study/Pilot	7.3
Geothermal	Mid	No	Lab/Pilot	3.1-5.6
GOAL II: Increase the Use of Essentially Inexhaustible Domestic Energy Resources				
Solar Electric	Long	No	Lab	2.1-4.2
Breeder Reactors	Long	No	Pilot/Demo	3.1
Fusion	Long	No	Lab	—
GOAL III: Efficiently Transform Fuel Resources Into More Desirable Forms				
Coal—Direct Utilization Utility/Industry	Near	Yes	Pilot/Demo	24.5
Waste Materials to Energy	Near	Yes	Comm	4.9
Gaseous & Liquid Fuels from Coal	Mid	Yes	Pilot/Demo	14.0
Fuels from Biomass	Long	Yes	Lab	1.4
GOAL IV: Increase the Efficiency and Reliability of the Processes Used in the Energy Conversion and Delivery Systems				
Nuclear Converter Reactors	Near	No	Demo/Comm	28.0
Electric Conversion Efficiency	Mid	No	Lab	2.6
Energy Storage	Mid	No	Lab	—
Electric Power Transmission and Distribution	Long	No	Lab	1.4
GOAL V: Transform Consumption Patterns to Improve Energy Utilization				
Solar Heat & Cooling	Mid	Yes	Pilot/Demo	5.9
Waste Heat Utilization	Mid	Yes	Study/Demo	4.9
Electric Transport	Long	Yes	Study/Lab	1.3
Hydrogen in Energy Systems	Long	Yes	Study	—
GOAL VI: Increase End-Use Efficiency				
Transportation Efficiency	Near	Yes	Study/Lab	9.0
Industrial Energy Efficiency	Near	Yes	Study/Comm	8.0
Conservation in Buildings and Consumer Products	Near	Yes	Study/Comm	7.1

* Near—now through 1985
Mid—1985 through 2000
Long—Post-2000
** Assumes no change in end-use device.

- In which time frame does the technology produce its initial energy impact?
- Does the energy output of the technology substitute directly for oil and gas supplies?
- What is the economic status and potential of the technology?
- What are the environmental and human health implications of the application of the technologies?
- What is the stage of development of the technology in the spectrum from the laboratory to the marketplace?

Table I summarizes the key characteristics of each technology with respect to some of these factors. These considerations and the strategic considerations discussed provide a basis for the priority ranking of the technology categories, listed in Table II.

Priority Ranking of Conservation Now Significantly Increased

Conservation (energy efficiency) technologies are singled out for increased attention and are now ranked with several supply technologies as being of the highest priority for national action. This ranking represents a major change from the initial Plan and reflects observations of only moderate progress to date on supply technologies, evaluation of public

Table II Proposed National Ranking of RD&D Technology Categories*

HIGHEST PRIORITY DEMAND	
NEAR-TERM CONSERVATION (EFFICIENCY) TECHNOLOGIES	• CONSERVATION IN BUILDINGS & CONSUMER PRODUCTS • INDUSTRIAL ENERGY EFFICIENCY • TRANSPORTATION EFFICIENCY • WASTE MATERIALS TO ENERGY
HIGHEST PRIORITY SUPPLY	
NEAR-TERM MAJOR ENERGY SYSTEMS	• COAL-DIRECT UTILIZATION IN UTILITY/INDUSTRY • NUCLEAR-CONVERTER REACTORS • OIL AND GAS ENHANCED RECOVERY
NEW SOURCES OF LIQUIDS AND GASES FOR THE MID TERM	• GASEOUS AND LIQUID FUELS FROM COAL • OIL SHALE
"INEXHAUSTIBLE" SOURCES FOR THE LONG TERM	• BREEDER REACTORS • FUSION • SOLAR ELECTRIC
OTHER IMPORTANT TECHNOLOGIES	
UNDER-USED (LIMITED APPLICATION) MID-TERM TECHNOLOGIES	• GEOTHERMAL • SOLAR HEATING AND COOLING • WASTE UTILIZATION
TECHNOLOGIES SUPPORTING INTENSIVE ELECTRIFICATION	• ELECTRIC CONVERSION EFFICIENCY • ELECTRIC POWER TRANSMISSION AND DISTRIBUTION • ELECTRIC TRANSPORT • ENERGY STORAGE
TECHNOLOGIES BEING EXPLORED FOR THE LONG TERM	• FUELS FROM BIOMASS • HYDROGEN IN ENERGY SYSTEMS

* Individual technologies are not ranked within the technology categories.

comment on the initial Plan, and further analysis of conservation opportunities. Specific reasons for assigning this higher priority to energy efficiency technologies are identified below.

Many of the technologies to improve energy efficiency currently appear to share one or more of the following characteristics:

- A barrel of oil saved can result in reduced imports.
- It typically costs less to save a barrel of oil than to produce one through the development of new technology.
- Energy conservation generally has a beneficial effect on the environment in comparison to energy produced and used.
- Capital requirements to increase energy use efficiency are generally lower than capital needs to produce an equivalent amount of energy from new sources since most new supply technologies are highly capital intensive.
- Conservation technologies can generally be implemented at a faster rate and with less government involvement in the near term than can new supply technologies.
- Energy efficiency actions can reduce the pressure for accelerated introduction of new supply technologies. Since the actions persist over time, the benefits are continuing.

These reasons deal generally with conservation technologies. The rate of application and introduction of conservation technologies in specific instances will be determined by the comparative economics and social acceptability of the available alternatives.

Because conservation technologies are characterized by their large number, their diversity, and the relatively small energy contribution of any one—in contrast to major supply technologies—a broad, general strategic approach is required to stimulate the market introduction and implementation of these more diverse technologies. Supportive of this approach, the new short-range planning category initiated in this Plan is particularly appropriate.

In addition to the near- (1985), mid- (1985-2000), and long-term (post-2000) planning horizons established by ERDA's enabling legislation, a new planning horizon—0 to 5 years—will be included in the National Plan for Energy RD&D. The 5-year forward focus is intended to roll forward each year,

and will be institutionalized and monitored for successes and failures.

While opportunities to be considered within this focus are sought throughout the entire ERDA program, and nuclear, fossil, and solar and other technical areas are being included, it is likely that the predominant opportunities will be identified within the conservation program. Opportunities for fuel substitution are also being sought because of their beneficial impact on oil imports and relief of gas shortages.

While technologies such as geothermal and solar heating and cooling are assigned only a moderate priority in the ranking, because of projected limitations in their application, both technologies can have an impact on the Nation's energy demand in the mid term if the institutional infrastructures to support their market penetration can be established. These technologies are important because they are sufficiently well developed to be employed on a regional basis when the resources can be exploited economically. The geothermal resources and technologies included in this category are limited to hydrothermal and geopressurized applications, and the solar heating and cooling technologies may be limited to areas that enjoy high levels of insolation and experience relatively high costs for alternative fuels.

The Plan and The Federal Energy RD&D Program

Federal budget allocations are designed to encourage and support private sector initiatives in energy RD&D; national energy technology priorities do not, therefore, translate directly to the ERDA energy budget for any one year for several reasons:

- Differences exist in the scope of effort and the extent of funding required at different phases in the maturing of energy technologies. In general, earlier research efforts require a lower level of funding than, say, demonstration phases.
- Many of the technologies will be developed in the private sector and the distribution of necessary effort between the private sector and the Federal Government will vary tremendously.
- The nature of government involvement may differ for different technologies. RD&D is only one mechanism for government involvement.
- Other government agencies also have responsibilities in energy RD&D. These are reflected in the total Federal budget and in ERDA's planning process, but do not appear in the ERDA budget.

The 1977 Federal budget and the Administration's legislative program provide strong support for energy RD&D. The total allocation for energy RD&D has been increased by more than 30 percent. The Federal budget for 1977 demonstrates the Administration's commitment to the importance of energy research, development, and demonstration as stressed in the Plan which was a key input to the President's budget process. In this year's budget, the amount earmarked for energy research, development, and demonstration represents a 30 percent increase in budget outlays over the previous year. Significant budget increases this year occur in many energy RD&D areas.

Among the specific budget decisions, the President has placed emphasis on closing the fuel cycle in the nuclear light, water reactor program by providing a substantial increase for management of nuclear waste and chemical reprocessing. The increased funding in nuclear waste management represents a recognition on the part of the Administration that safe and environmentally sound nuclear waste disposal, which is a responsibility of the Federal Government, should be demonstrated on an expedited basis. To encourage and enable private sector to build, own, and operate additional U.S. enrichment capacity, the Nuclear Fuel Assurance Act was proposed to Congress in June 1975. The Act will provide ERDA necessary authority to negotiate cooperative agreements with private firms which, after Congressional approval, would provide temporary financial assurances to these firms.

Conservation, recommended in the Plan for accelerated development, has also received an increase in FY 1977 over FY 1976 of 64 percent, or essentially a rate of increase two times the overall program average.

The budget also provides funds to initiate a synthetic fuel program in 1976 as an essential part of a national RD&D effort. Its purpose would be to provide assistance to the private sector to encourage the development of both conventional energy technology (e.g., fossil fuel and nuclear power plants) and emerging technologies (e.g., synthetic fuel from coal, oil shale, and other domestic resources).

Even with the energy conservation measures outlined in this Plan, the demand for oil and gas is expected to outstrip the combined domestic supply and the current level of imports. Moreover, the gap between demand and domestic production is widening.* Over the next 25 years, synthetic fuels offer a domestic energy alternative to imported oil and natural gas.

A program of legislative, budgetary, and administrative actions to undertake a Federally supported synthetic fuels initiative was considered by Congress in the fall of 1975 and, although the program was not authorized during that session, the 1977 Budget provides funds to implement during 1976, a $2 billion loan guarantee program in ERDA. With the

* This relationship is graphically portrayed in Figure III–3.

enactment of EIA, this program would be transferred to EIA and expanded from $2 to $6 billion in loan guarantees, to meet the current 1985 objectives of 350,000 barrels of oil per day of synthetic fuel production capacity.

In Tables III, IV and V, growth of Federal energy RD&D programs is depicted. Table III lists budget outlays of all Federal agencies performing RD&D and Tables IV and V show ERDA budget amounts. Figure III illustrates percentage increases in ERDA's major program areas.

Volume II of this Plan (published separately) describes in detail the Federal programs for development of the technologies.

Table III Federal Energy R&D (in millions)

	FY 75		FY 76*		FY 77	
	BA	BO	BA	BO	BA	BO
Direct Energy R&D						
ERDA	$1,317.0	$1,011.0	$1,657.0	$1,427.0	$2,435.0	$2,009.0
DOI	89.9	54.2	104.0	93.3	98.3	96.3
EPA	80.8	18.2	56.8	76.6	55.4	76.6
NRC	58.9	51.7	87.5	76.9	104.0	98.2
NASA	0.8	0.8	1.7	1.0	–0–	0.8
Subtotal	1,547.4	1,135.9	1,907.0	1,674.8	2,692.7	2,280.9
Supporting R&D						
ERDA	362.0	313.0	403.0	373.0	430.0	404.0
DOI	33.2	30.9	59.0	56.7	66.8	65.2
EPA	53.2	5.0	43.2	43.4	41.6	43.4
NRC	2.3	2.1	9.6	9.1	5.3	5.0
NSF	103.2	65.9	114.6	74.2	123.4	106.9
Subtotal	553.9	416.9	629.4	556.4	667.1	624.5
Total Federal Energy R&D	$2,101.3	$1,551.9	$2,536.4	$2,231.2	$3,359.8	$2,905.4

* Funds for FY 76 Transition Quarter are not included.

Table IV ERDA Energy R&D Budget (Outlays in millions)

	FY 75	FY 76†	FY 77	FY 76 to FY 77 percent change*
Direct Energy R&D				
Nuclear Fuel Cycle and Safeguards	$ 120	$ 163	$ 282	73
Conservation	21	55	91	64
Geothermal	21	32	50	57
Fusion	151	224	304	36
Fission	538	522	709	36
Solar	15	86	116	35
Fossil	138	333	442	33
Environmental Control Tech.	7	12	15	24
Subtotal	1,011	1,427	2,009	
Supporting Research				
Basic Energy Sciences	165	188	205	9
Environmental Research	148	185	199	7
Subtotal	313	373	404	
Total ERDA Energy RD&D	$1,324	$1,800	$2,413	

† Funds for FY 76 Transition Quarter are not included.
* Percentage change calculated prior to rounding outlays.

Table V ERDA Energy R&D Budget (Authority in millions)

	FY 75	FY 76†	FY 77	FY 76 to FY 77 percent change*
Energy RD&D Programs				
Nuclear Fuel Cycle and Safeguards	$ 118	$ 173	$ 347	101
Conservation	36	75	120	60
Geothermal	28	31	100**	223
Fusion	183	250	392	57
Fission	567	602	823	37
Solar	42	115	160	39
Fossil	335	398	477	20
Environmental Control Tech.	8	13	16	23
Subtotal	1,317	1,657	2,435	
Supporting Research				
Basic Energy Sciences	191	210	227	8
Environmental Research	171	193	203	5
Subtotal	362	403	430	
Total ERDA Energy RD&D	$1,679	$2,060	$2,865	

† Funds for FY 76 Transitional Quarter are not included.
* Percentage change calculated prior to rounding authority.
** Includes $50 Million for Geothermal Loan Guarantee Program.

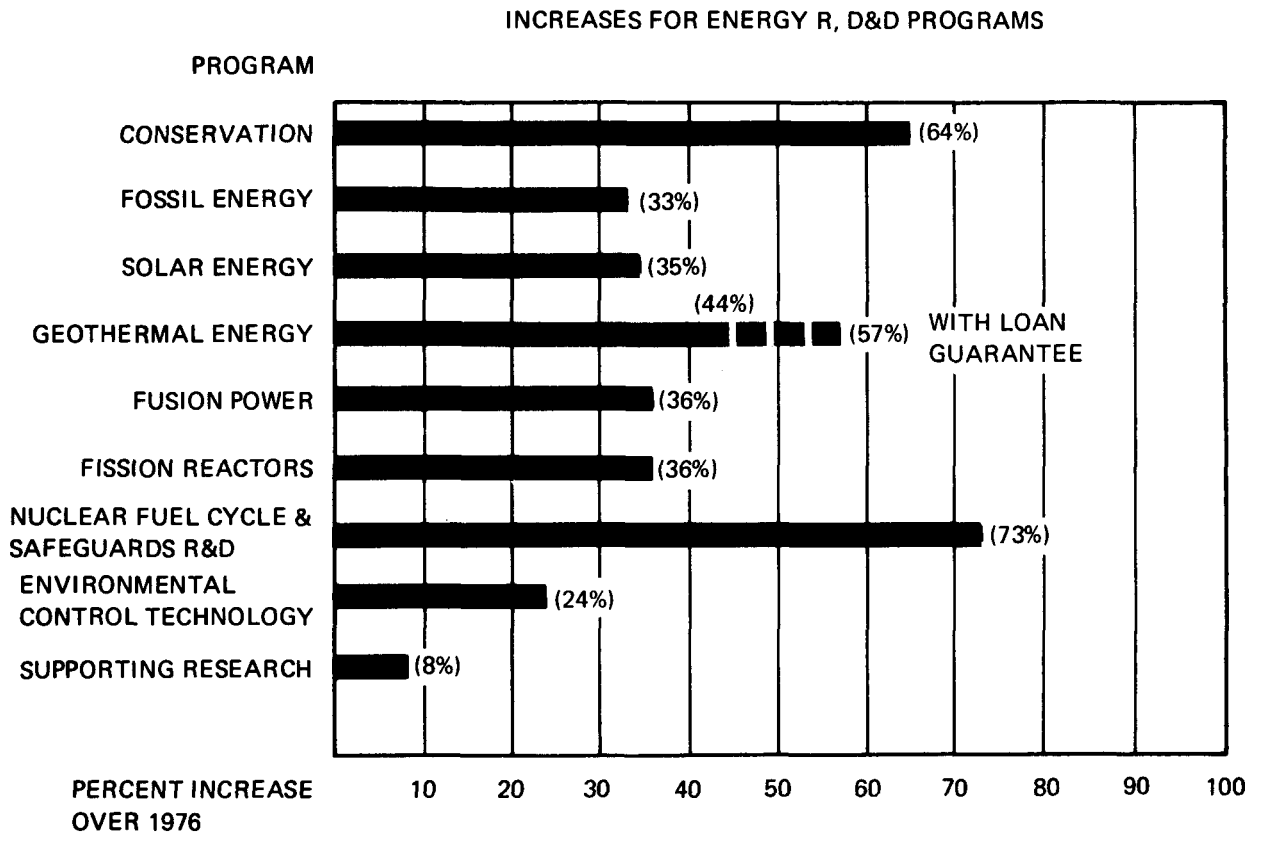


Figure III Energy Research and Development Administration FY 1977 Budget

This Plan focuses on a set of technologies (involving both supply and demand) and a related set of operational approaches. If successfully pursued, these approaches could result in significant market penetration of technologies that could ease the overall energy problem within the next critical decade.

The Plan therefore identifies seven high-priority technologies that have the potential for making significant energy contributions in the near term and mid term. They are:

- Conservation (energy efficiency)
- Light water reactors
- Enhanced oil and gas recovery
- Direct utilization of coal
- Synthetic fuels
- Geothermal energy
- Solar heating and cooling

The Plan develops a preliminary strategic approach for each, analyzing its marketability and a strategic approach to support its commercialization by the private sector.

The Plan also identifies strategies for the development of three high-priority programs with longer-term potential:

- Breeder reactors
- Solar electric
- Fusion

To be effective in supporting the private sector in the development and commercialization of energy technologies, the Federal Government must take the lead in helping to create mechanisms for interaction between ERDA and other public and private sector groups. Introduction of new energy technologies will directly or indirectly touch all Americans and all private institutions, and will require the concrete action of all—Congress, Federal Government agencies, state and local governments and regional groups, and the private sector.

An important operational element of the Plan, therefore, is to ensure the participation of each of these groups and to promote interaction among them, so that RD&D program planning can be responsive to the international, national, regional, and local objectives. To this end, the Plan outlines initiatives designed to:

- Promote and support cooperative international efforts to develop solutions to common energy problems

- Improve interaction among Federal agencies involved in energy RD&D
- Strengthen interfaces between ERDA and industry, state and local governments, universities, and the public
- Capitalize on ERDA's existing regional structure to coordinate research, development and demonstration of energy technology with local economic, environmental, and social concerns.

ERDA is developing an internal management system for analysis, resource allocation, implementation, and evaluation of its programs to ensure the most effort to complement the private sector in meeting national energy goals. The implementation of this system will take time, will be difficult, and will require the assistance of the private sector. It is vital that ERDA develop a well-coordinated and integrated system for program planning, budgeting, and review (PPBR system). Such a system is needed to provide a framework for:

- Analyzing the Nation's energy needs
- Formulating Federal plans for addressing those needs.
- Designing programs to carry out specific objectives.
- Allocating resources consistent with the Plan and programs
- Ensuring that the programs are effectively designed and managed.

For example, it is necessary in developing an energy plan to be able to determine which technologies are likely to be developed by the private sector with minimal government involvement and which will require more specific government assistance. To make these projections, planners must be familiar with industry criteria for market penetration and must be able to anticipate probable private sector behavior in terms of investor and consumer acceptance of new technology. If a technology is judged to be a poor commercial risk in the private sector, a judgment must be made as to whether the potential public benefits are sufficient to justify a government role. Inputs to determine this must come from interaction with industry and with the public (e.g., consumers, local and regional entities, environmental groups). This logic is presented in Figure IV.

Through the use of PPBR, the current process of establishing priorities among technologies in the Plan can be vastly improved. The PPBR system is being designed to develop an energy system option which can evaluate public and private rates of return and develop measures of relative value among technology programs.

It is anticipated that for each technology program, the system will develop five basic documents:

1. **Program Strategy:** This document will explore the need, if any, for a Federal role and the effectiveness of RD&D and other potential programmatic solutions as illustrated by Figure II. It will present a program strategy and establish the major goals and milestones for the program.
2. **Program Plan:** The program plan will chart the detailed course of the program, typically over a several-year period leading to a major programmatic decision (e.g., should a demonstration phase be undertaken?). The basis for the program plan is the program strategy, but the plan would be more specific in assigning program responsibility and developing management structure and will seek to define the most cost-effective Federal program to achieve the agreed objectives.
3. **Environmental Development Plan:** The plan for environmental development will be a companion document to the program plan, detailing the program of environmental research that must parallel technology development. Environmental issues involved in developing the technology are identified and a program outlined for resolving these issues in a time period consistent with the rate of technology RD&D.
4. **Program Approval Document:** This is an internal ERDA document that will present in some detail the activities to be conducted and milestones to be achieved within approved budgets for a given fiscal year. Its purpose is to provide a baseline for monitoring program operations.
5. **Environmental Impact Statement (EIS):** Within the structure of the National Environmental Policy Act, ERDA intends to use the EIS as a major input to decision processes. Where required, an EIS will be prepared to illuminate a major "go/no go" program decision. It summarizes the information developed by the Environmental Development Plan and uses it to address the issues raised. In this way, ERDA hopes that these issues can be identified at the start of an appropriate program phase, so that they can be systematically addressed.

Developing the Plan

Because the nature of the energy problem is dynamic, the annual revisions of this Plan can be expected to evolve in response to changes and to new information.

The National Plan for Energy RD&D is required to be updated annually to remain responsive to continuous changes in the external environment, both with regard to energy and non-energy events and policies. Technical and nontechnical

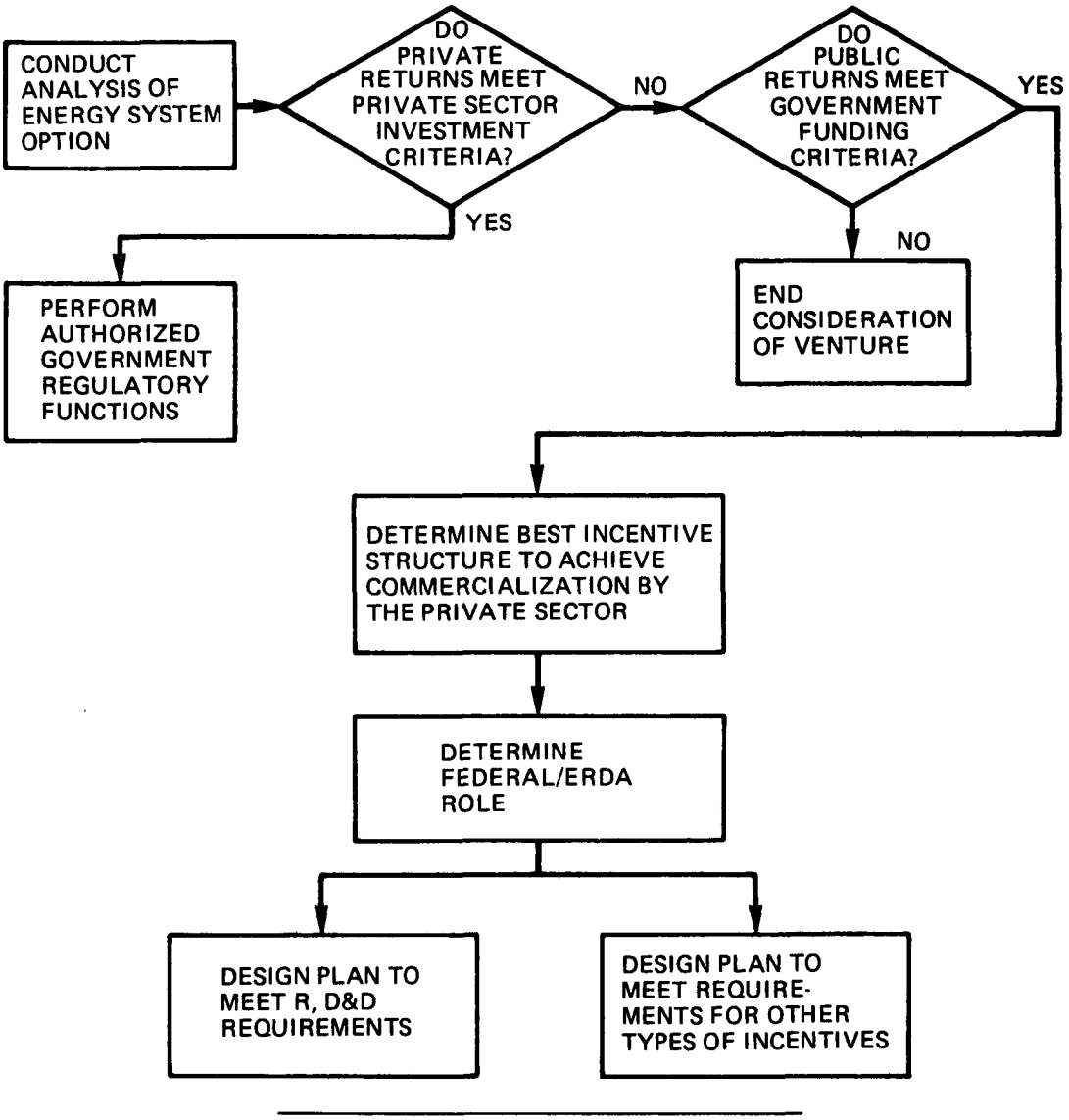


Figure IV Strategic Planning Logic

factors which constitute these changes and influence the evolution of this Plan can be characterized as:

- Assessments of international and domestic events and their effect on the Plan
- Assessments of the National Plan for Energy RD&D based on the viewpoints and insights of others
- Assessments of the results of energy systems analysis studies and their effect on the Plan
- Assessment of RD&D activities in the private sector.

An integral part of this Plan is a detailed program for improving the informational base for these assessments, facilitating ERDA's access to this information, and developing the tools to better analyze the implications of new energy technologies in terms of economic growth, environmental impact, and public policy.

Decisions on the adequacy of energy RD&D programs are being continually refined on the basis of improved analyses and evaluation mechanisms being developed within ERDA.

Successful implementation of new energy technologies will produce changes in the underlying economic and institutional systems of this country. To provide information to the public as a basis for wise

energy choices, analyses of energy systems attempt to identify these changes and assess their potential impacts.

This update draws from preliminary conclusions from three selected areas of analysis aimed at:

- Understanding the relationships among energy, economic growth, and environmental impact as a result of the introduction of new energy technologies and other energy policy initiatives
- Calculating the net energy aspects of energy technologies
- Supporting market penetration initiatives through specific market studies (e.g., the Electric Utility Study mentioned in Chapter VI).

Most of these studies are not yet complete. It appears, however, that they will be useful in selecting promising energy technologies and in clarifying the degree of Federal participation—if any—required to develop and introduce new technologies. Analyses to date do not yet suggest the need for a sharp revision in the basic goals and strategies in this Plan.

Although it is too early to state with certainty what will be included in future reports, the results of three efforts essential to ERDA's own planning will probably be included and help to shape the next annual Plan.

These activities are:

- Developing benefits and costs of energy RD&D
- Establishing priorities for component programs
- Analyzing energy RD&D activities in the private sector.

During 1976, it is ERDA's goal to apply the tools of energy systems analysis to the quantification of costs and benefits of selected energy technologies and to report on this work in the next Plan.

Using its developing PPBR system, ERDA expects in the coming year to be able to extend the process of priority-setting to a much greater level of detail than is presently possible. The PPBR can make program priorities and the bases for resource allocations more explicit which, in turn, will help to delineate the implications of various alternatives.

Finally, as an essential means to reinforce and support private sector activities, it is ERDA's goal to initiate an analysis of ongoing and anticipated RD&D efforts in the private sector and to provide an interim report in the 1977 Plan.

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