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ABSTRACT

This booklet, which highlights and explains the 1975 National Energy Plan, is intended to improve the general public's understanding of U.S. energy policy. Sections in the publication include: (1) The Energy Problem and the Need for Planning; (2) Basic Principles of the Plan and How They Apply; (3) Overcoming the Oil and Gas Shortage; (4) The Importance of Time; (5) Near-term: Now-1985; (6) Midterm: 1985-2000; (7) Long-term: Beyond 2000; (8) The Importance of Environmental Research, Development, and Demonstration; (9) The Role of the Federal Government in Energy Development; and (10) New Directions. (RH)

CREATING ENERGY CHOICES FOR THE FUTURE

A Summary of the National Plan for Energy Research, Development, and Demonstration

ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
USA

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CREATING ENERGY CHOICES FOR THE FUTURE

A Summary of the National Plan for Energy Research, Development, and Demonstration

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U. S. Energy Research and Development Administration
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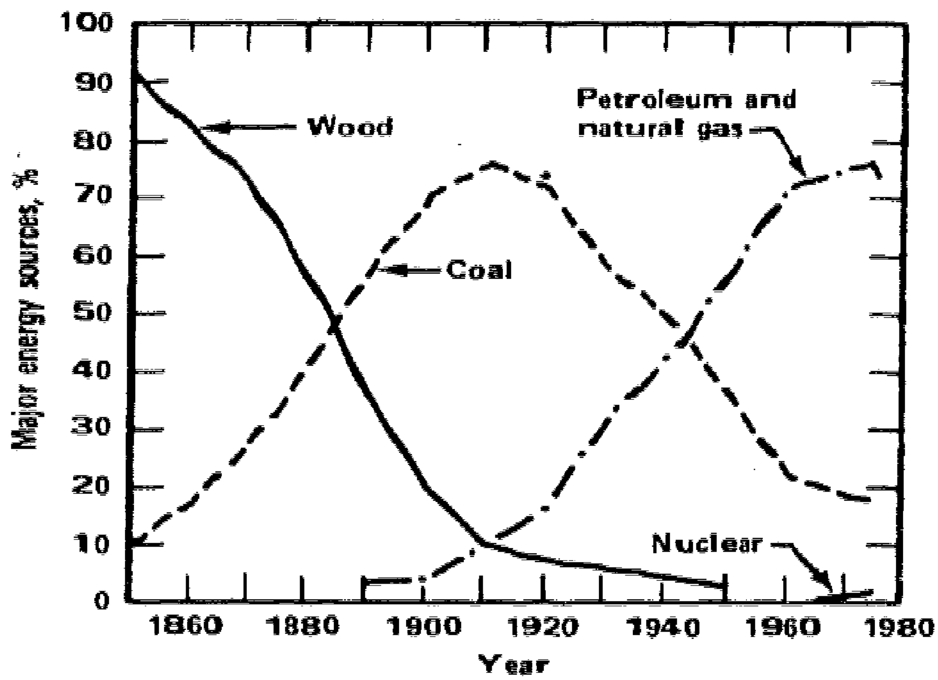
1975

Introduction

The United States must shift to new primary forms of energy. Twice before, it has happened: from wood to coal in the 19th Century and to oil and gas in this Century. Each time it took about 60 years to reach maximum use. We cannot afford to take another 60 years to accomplish the changeover we need now.

These words were a call to action made to the American people by the Administrator of the U.S. Energy Research and Development Administration, Dr. Robert C. Seamans, when he announced the National Energy Research, Development, and Demonstration Plan.

HISTORICAL U.S. ENERGY CONSUMPTION PATTERNS



The Energy Research and Development Administration (ERDA) is required by law to develop a comprehensive plan for energy research, development, and demonstration. As the

Nonnuclear Energy Research and Development Act of 1974 specifies, the Plan is designed to help solve energy and associated environmental problems in the

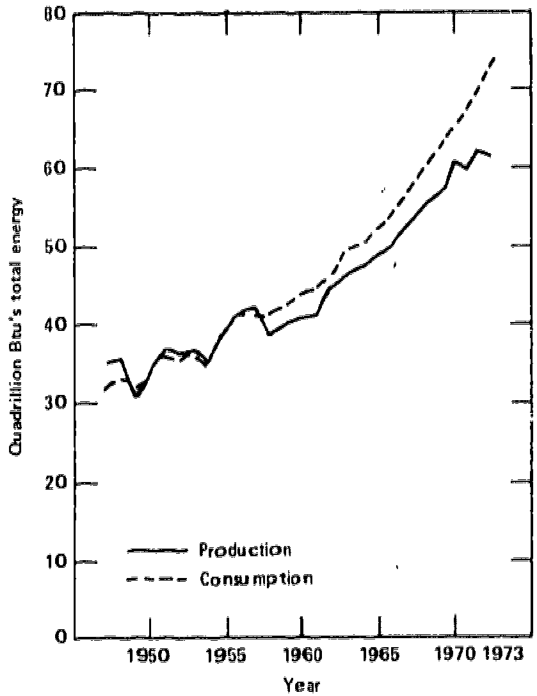
- near-term (to the early 1980s),
- midterm (the early 1980s to 2000), and
- long-term (beyond 2000).

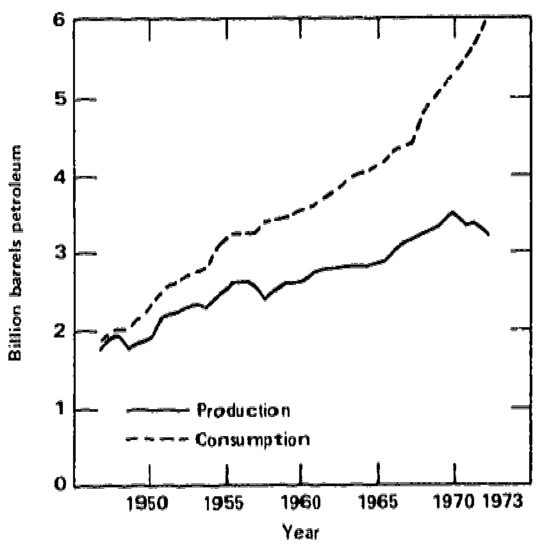
The first plan, which will be revised annually, was submitted to Congress on June 30, 1975. The plan, which was prepared by ERDA with the help of other Government agencies and representatives of the private sector, is part of a broader national response to energy challenges and sets forth the priorities for meeting them.

The energy crisis cannot be solved unless the public understands energy problems, participates in the formation of energy policy, and supports the programs carried on by Government and private enterprise to build more stable and secure sources of energy for the future. This booklet, which highlights and explains the 1975 National Energy Plan, is intended to improve the general public's understanding of U. S. energy policy.

The difference between the production and consumption of energy in the United States is made up primarily by imported oil. A quarter of a century ago the U. S. was a net exporter of energy; now it imports 15%, including 35% of its oil. The figure above depicts the growing energy gap and the figure below the even wider deficit within the petroleum sector.

U. S. ENERGY PRODUCTION AND CONSUMPTION 1947 - 1973





Source: Exploring Energy Choices, Ford Foundation, Washington, D.C., 1974, p. 2.

The Energy Problem and the Need for Planning

The United States has an energy problem because three-fourths of its energy comes from oil and gas. As domestic supplies of these two fuels continued to dwindle, imports of petroleum products and natural gas during 1974 amounted to 20% of our total energy consumption and cost more than $25 billion.

Our economic stability and way of life may be threatened by other nations that could disrupt the supply and raise the price of our petroleum imports. This bears heavily on our domestic problems and could weaken our influence in the world.

The United States, which uses one-third of the world's total energy consumption, relies most on its least plentiful domestic energy resources and least on its most abundant ones. Coal, our most plentiful fossil fuel, currently supplies less than 20% of our energy needs. Uranium, which has a domestic energy potential even larger than coal, provides only 2% of our energy. The contribution of solar energy is negligible. And, despite a worsening supply situation, our use of energy is often wasteful and inefficient.

National planning for energy research, development, and demonstration is needed to help guide the United States in overcoming the technological obstacles to using our most abundant domestic energy resources. Since it is necessary to develop new energy technologies faster than has ever been done before, planning is especially important to improve the chances of getting the most results from limited research funds and of bringing new technologies into commercial use at propitious times. The U. S. needs a plan to develop a number of technological options, so that the choice among those energy systems that are available for use will be broader and more flexible than it is today and will be based on resources that can provide long-range abundance.

Future problems and needs are difficult to forecast far in advance. It is reasonable to assume, however, that in the years ahead—whatever the problems may be—an abundance of energy and a flexibility of choice as to the sources would help to promote the defense, prosperity, and environmental quality of the Nation and the personal freedom of the American people.

Basic Principles of the Plan and How They Apply

The plan for developing the technology to provide the United States with an adequate supply of energy is based on eight principles.

1. Our domestic supply of exhaustible but economically recoverable energy-producing materials must be expanded. This requires developing improved ways of gétting oil and gas out of existing fields and opening new fields, such as those in relatively inaccessible offshore sites. It also involves relying more on coal, developing shale as a source of liquid fuel, and finding ways to tap more of the heat beneath the surface of the earth—where it is stored in hot water, brines, rock, and gases—and to convert it to electricity.

2. Since the U. S. will eventually run out of these fuels, we need to prepare to increase our use of essentially inexhaustible domestic energy resources by converting them to electricity. To do this, we must develop large-scale solar electric plants, breeder reactors to take advantage of the vast energy in uranium, and fusion reactors to harness the virtually unlimited supply of deuterium in seawater.

3. While developing new energy systems, we must also transform some of our abundant fuels into more desirable energy sources. Coal can be made environmentally acceptable by developing processes that will enable electric generating plants and other industries to burn natural coal in a much cleaner manner than was used in the past. Another way of cleaning up coal is to remove the sulfur by converting natural coal to gas and liquid. Significant amounts of energy could also be produced by transforming waste materials, such as municipal sewage and garbage, into clean burnable gas or liquid fuel. Sometime it might even be feasible to grow biological material and then convert it into useful fuel.

4. In addition to producing more fuel, it is also necessary to make the processes for converting and delivering energy more efficient and reliable. Work must continue to improve

converter-type nuclear power reactors. As the electric-utility system continues to grow, technologies related to more intensive electrification—electric conversion, electric power transmission and distribution, and energy storage—become increasingly important and must be developed to support the electric energy systems of the future that will be based on inexhaustible sources of solar energy, uranium breeding, and fusion.

FUELS AND ENERGY SOURCES

• Coal	• Oil
• Crops grown for energy	• Oil shale and tar sands
• Fertile nuclear	• Sunlight
• Fissile nuclear	• Tides, waves, and ocean currents
• Geothermal	• Waste heat
• Hydroelectric	• Waste materials
• Natural gas	• Water (fusion and hydrogen)
• Ocean heat	• Windpower

5. In order to use energy resources more efficiently, we must change some of the ways we use them. The development and demonstration of solar heating and cooling technology could save substantial amounts of gaseous and liquid fuels for other uses. Waste heat from power plants, which convert only about two-thirds of the heat energy into electricity, is a potentially large source of unused energy, and we must develop technologies to use it. Cars, buses, and trucks powered by electricity generated from coal and uranium would conserve scarce petroleum fuels and also avoid the air pollution caused by today's gasoline engines. Hydrogen powered vehicles could accomplish much the same petroleum-saving and environmental objectives.

6. Energy must also be saved by using less of it to accomplish the same amount of work. Very significant savings can be made by increasing automobile gasoline

mileage and improving industrial equipment. Other examples of energy conservation include reducing heating and cooling requirements for buildings by better insulation and also raising the efficiency with which appliances, such as air conditioners and refrigerators, use energy.

7. Success in developing and implementing energy technology requires supporting efforts in basic research, biomedical and environmental research, systems studies, information dissemination, manpower development, and safety.

8. The general health, safety, and welfare of people, and the quality of the natural environment, related to producing and using energy, need to be protected and improved.

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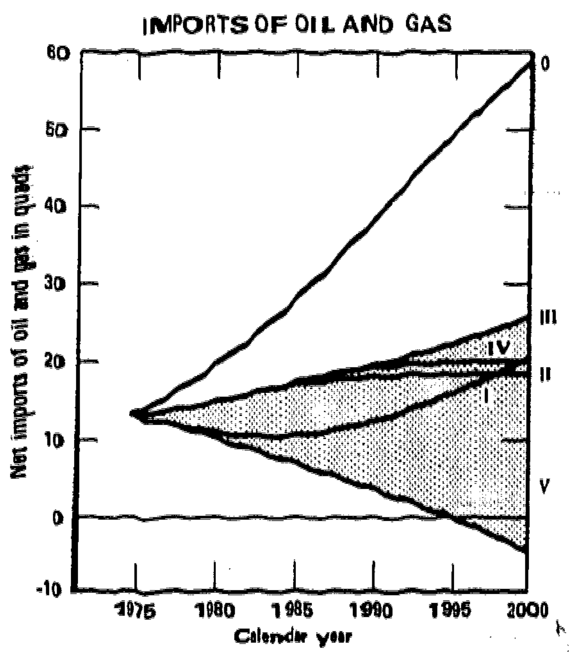
Overcoming the Oil and Gas Shortage

The most pressing U. S. energy problem is the domestic shortage of petroleum and natural gas, together with the potential disruption of supply and the balance of payments burden that results from having to import these fuels. The analysts who formulated the National Energy Plan studied the impact of various technological options on the oil and gas supply situation. The conclusion was that the U. S. can completely eliminate its reliance on imported fuels by 1995 only by pursuing all of the following approaches:

- Reducing waste and inefficiency.
- Producing synthetic gaseous and liquid fuels from coal to substitute directly for natural petroleum and gas.



O No new initiatives
I Conservation
II Synthetics from coal and shale
III Intensive electrification
IV Limited nuclear power
V Combination of all technologies

• Indirectly substituting for oil and gas by relying more on electricity, which can be generated from all the abundant domestic energy resources—coal, solar, uranium, and hydrogen fusion.

Any strategy that does not include all three approaches would leave imports at unacceptably high levels. The import levels that were found to result from measures that fell short of the above three principles are compared to the combined approach in the figure on page 9.

The Importance of Time

A National Energy Research, Development, and Demonstration Plan must lead to results when they are needed, and there should be a sense of urgency to the U.S. energy development program. As the future unfolds, the Nation will need a broad range of energy choices, and failure to develop the technologies in advance carries risks of grave economic, social, and environmental costs.

The following discussion of our near-term, midterm, and long-term energy futures shows the need for timely innovations in energy technology by both Government and the private sector and indicates which energy systems are most likely to have a significant impact in specific time periods. An overview of our energy future as envisioned in the Plan is shown in the figure on page 12.

IMPACT OF FUTURE ENERGY OPTIONS

Priority*	
	Near-term: Now–1985
Highest	Enhanced recovery of oil and gas (D)
	Direct use of coal by utilities and other industries (D)
	Waste materials to energy (D)
	Nuclear converter reactors (I)
	Transportation efficiency (D)
	Industrial energy efficiency (D)
	Conservation in buildings (D)
	Midterm: 1985–2000
Highest	Gaseous and liquid fuels from coal (D)
	Oil shale (D)
Other	Geothermal (I)
	Solar heating and cooling (D)
	Waste heat utilization (D)
	Electric conversion efficiency (I)
	Energy storage (I)
	Long-term: 2000+
Highest	Solar electric (I)
	Breeder reactors (I)
	Fusion (I)
Other	Fuels from biomass (D)
	Hydrogen in energy systems (D)
	Electric power transmission and distribution (I)
	Electric transport (D)

D Can directly substitute for or save oil and gas.

I Can indirectly substitute for oil and gas by converting the energy source to electricity or developing technologies to support more intensive electrification.

*Under the Plan technologies with a highest priority would be pursued vigorously with a high level of support. Other technologies would be given support that is more measured but sufficient to permit response to favorable developments.

Near-term: Now–1985

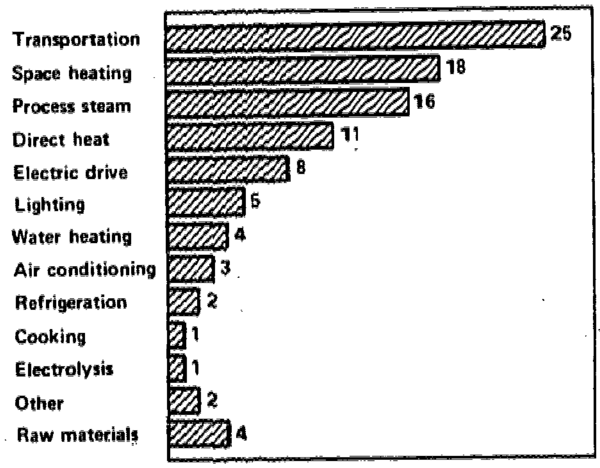
For the next decade the U. S. will have to depend primarily on conservation and expansion of its capacity to use coal and nuclear fuel. All of the technologies and programs discussed in the near-term section would be given the highest priority under the National Energy Research, Development, and Demonstration Plan.

An energy conservation program, involving savings over a wide variety of energy uses, needs to be vigorously pursued. Although the impact of any single activity would be small, the total impact of conservation technologies could make a major contribution to solving our energy problem. Large energy savings can be made and import levels can be restrained by reducing prevailing wasteful habits of energy consumption. This will necessitate such measures as more efficient energy-using consumer products (such as refrigerators and air conditioners), requirements for using less energy to heat and cool buildings, standards for more efficient industrial equipment, automobiles that get more miles per gallon, and conversion of waste materials to energy.

Our coal resources are very large, and technological development can make more coal available for fuel. The near-term challenge is to recover and burn more coal with less environmental impact. Electric utilities, which use about two-thirds of all U. S. coal consumed, and other industries need to use more coal and as little oil and gas as possible. During the next 10 years, clean combustion technology, such as more reliable and durable stack gas cleaning and nitrogen oxide control systems, should enable the U. S. to use more coal in environmentally acceptable ways and in quantities that will enable substantial savings of scarce oil and gas.

Significant quantities of energy, such as methane gas or methanol, could also be produced from waste materials. Waste-to-fuel conversion technologies could save moderate

PERCENTAGE OF UNITED STATES ENERGY USE



Source: U. S. Energy Prospects: An Engineering Viewpoint, National Academy of Engineering, Washington, D. C., 1974, p. 26.

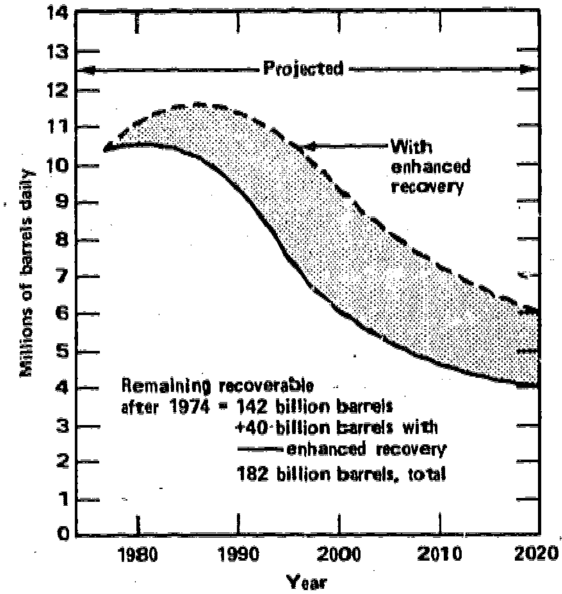
This graph helps to identify the areas of energy use where conservation measures can accomplish the most significant savings: Transportation, heating, and industrial processes.

amounts of conventional fuels in the near-term and even larger quantities in the midterm.

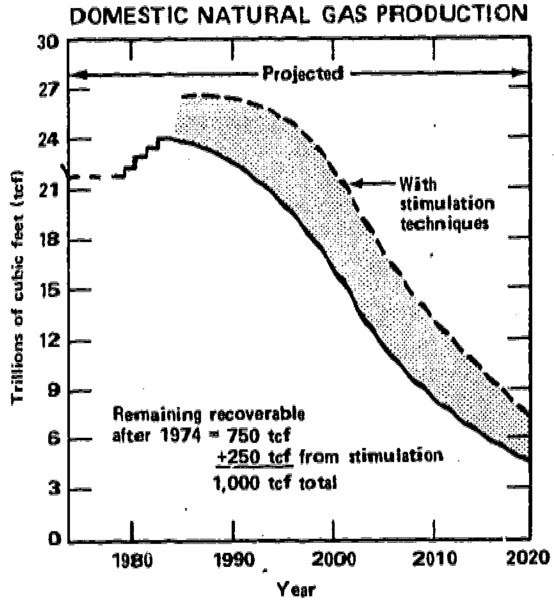
Nuclear energy can be used instead of gas and oil to generate electricity. In the near-term the technology of light-water converter reactors must be more fully developed, along with the associated requirements for uranium enrichment capacity, fuel reprocessing, waste management, and safeguards for fissionable material.

Despite conservation measures, increases in the use of coal and nuclear fuels, and waste conversion, the U. S. dependence on oil and gas will have to continue until 1985 and beyond, even though domestic production of petroleum has been declining since about 1966 and the effect on our price structure and balance of payments might become even

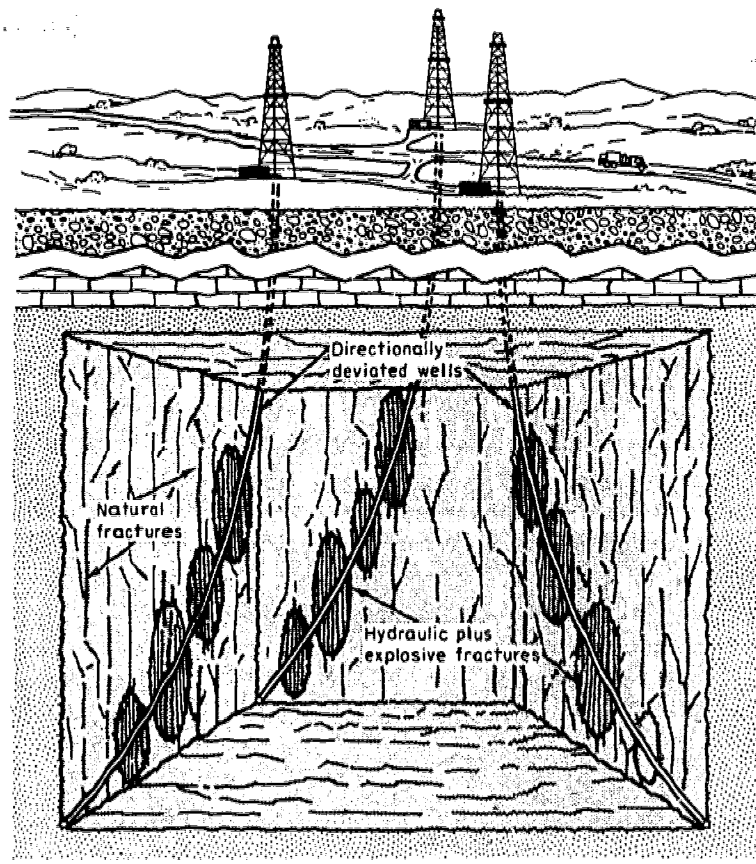
PROJECTED DOMESTIC OIL PRODUCTION



PROJECTED DOMESTIC NATURAL GAS PRODUCTION

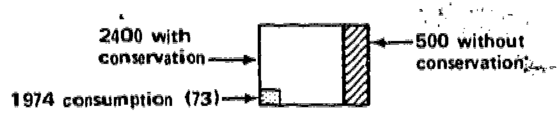


more adverse. By the mid-1980s it is unlikely that major new energy sources will be ready, and domestic oil production will probably begin to decline rapidly by that time unless steps are taken to develop more effective methods for recovering our more i: :cessible sources of oil and gas.



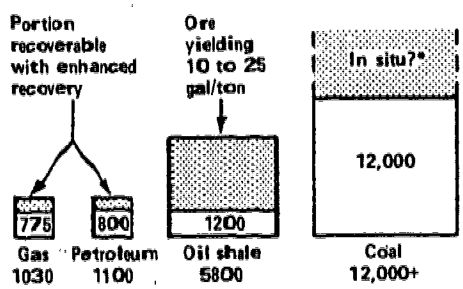
This illustration of enhanced recovery techniques shows directionally drilled wells through natural fractures followed by hydraulic and explosive fracturing.

QUADS OF ENERGY REQUIRED 1975–2000
(1 quad = 10^{15} Btu's)



Total 25-year requirement: 2400+

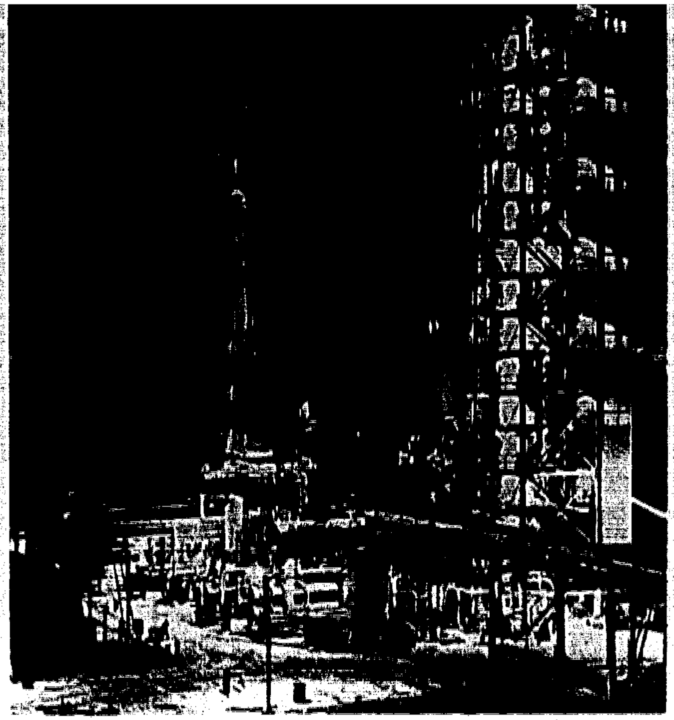
AVAILABLE QUADS OF ENERGY IN FOSSIL FUELS
(1 quad = 10^{15} Btu's)



Total available: 19,930+

*Coal that may be recoverable by converting it underground to combustible gas, which would flow to the surface, instead of by using conventional underground mining techniques.

Current techniques recover only one-half or less of the oil in a field. Enhanced recovery, which requires technological development, would allow us an additional 10 years, from 1985 to 1995, to develop new energy sources if we use the time until 1985 to develop, demonstrate, and commercially apply the technology of enhanced recovery. Methods of enhanced recovery include injection of fluids, massive hydraulic fracturing, and thermal and chemical techniques to stimulate additional production in existing oil and gas fields.



ERDA's experimental HYGAS pilot plant at Chicago is designed to convert 75 tons of coal per day to 1.5 million cubic feet of high-Btu gas. Gas made from coal consists of a mixture of hydrogen, carbon monoxide, and methane.

Midterm: 1985–2000

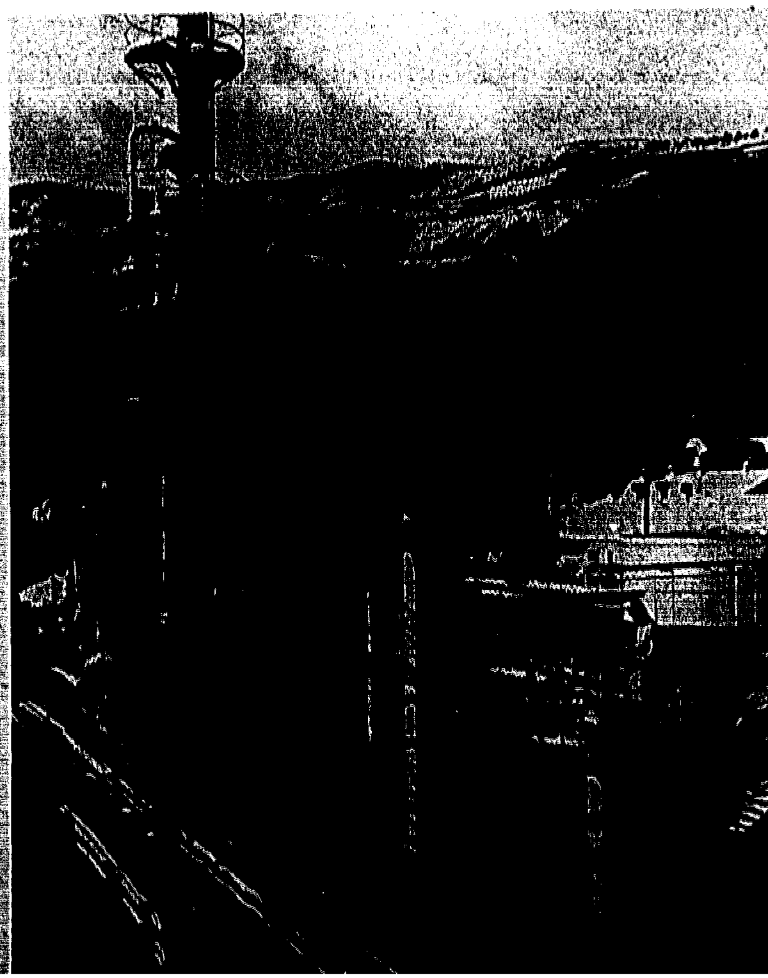
During the 15 years preceding the turn of the century and possibly beyond, the most critical problem is expected to be the liquid fuels gap. Midterm energy projections require both the establishment of a synthetic fuels industry and preparations for continued growth in that portion of our energy consumption that is supplied by electricity.

Development has already started on the two high priority technology programs that are expected to make a vital and major impact during the 1985–2000 period: (1) gaseous and liquid fuels made from coal and (2) liquid fuel made from oil

shale. Synthetic fuels made from coal will do some of the work previously done by oil and natural gas. Other systems being developed to contribute significantly during the mid-term are geothermal, solar heating and cooling, waste heat utilization, electric conversion efficiency, and energy storage.

In developing more advanced coal gasification and liquefaction technology, priority should be given to high-Btu

This experimental shale oil refinery is located at an ERDA engineering facility near Rifle, Colorado. An oil shale formation can be seen in the background.



gasification processes that will produce natural gas (methane) substitutes and to liquefaction processes that make both boiler fuels and crude oil substitutes for refinement. It is also necessary to develop improved low-Btu gasification processes to supply fuel for electricity generation and industrial

Electric generating plants at The Geysers, a natural steam field in California, now have a capacity of 400 megawatts. The total potential geothermal capacity at this location is estimated to be in the range of 1000 to 4000 megawatts, enough to serve one-half the present needs of the greater San Francisco metropolitan area. The technology is limited in its application, however, because additional dry-steam fields are not now known and are not believed likely to exist in the U. S.

processes. To develop an adequate coal-based synthetic fuels industry, demonstration plants for low-sulfur gaseous and liquid boiler fuels and synthetic pipeline gas should be in operation by the early 1980s.

Oil shale deposits in Colorado, Wyoming, and Utah are estimated to contain 100 billion barrels of accessible oil—approximately 27 times current U. S. domestic crude oil production or 80% as much as all the domestic crude produced in U. S. history. Only about one-fifth of this resource, however, is relatively available. Economical recovery of the more dilute shales (which contain between 10 and 25 gallons of oil per ton) will require considerable development. Without new technology, the resource base is comparable to domestic oil or gas and one-tenth as large as coal. The principal emphasis on oil shale is to develop methods of recovering the oil while leaving the shale in place rather than mining it.

Of other midterm impact technologies, geothermal and solar heating and cooling are sources that promise to supplement our energy supply. Although not critical, these under-used technologies can provide a margin of error, or cushion, against failures and delays in developing other energy sources.

The only available estimate of U. S. geothermal resources suggests that the total energy in localized hot water fields is equivalent to about 5 or 10 times the current U. S. total energy consumption or possibly 20% to 40% of our remaining recoverable reserves of oil and natural gas. Geothermal energy could supplement our electricity supply and could also have heating and cooling applications.

The second unused or under-used midterm technology in the low priority category is solar heating and cooling, which seems especially suited for residential and commercial buildings. Some space heating and hot water systems are already available in the United States, and some industrial and agricultural applications are also possible. By the year 2000

solar heating and cooling could make substantial savings in our use of oil, gas, and electricity and might contribute approximately 5% of total U. S. energy consumption.

Significant amounts of additional energy might also be derived from heat that is now lost through energy conversion, such as in electric generating plants, which reject from one-half to two-thirds of the heat produced from fuel. Within the next three decades it should be possible on a significant scale to increase the efficiency with which this heat is converted into energy production and develop ways of using rejected heat to meet other heat requirements.

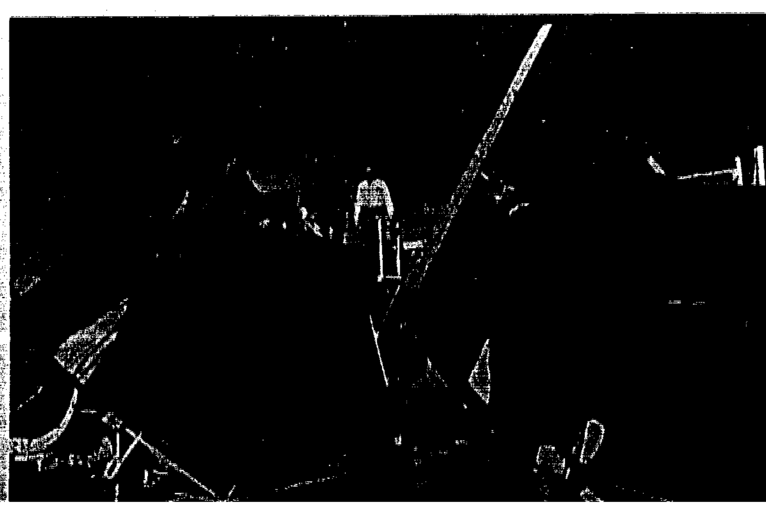
Advances in storing both thermal and electric energy will be needed to make more efficient use of generating capacity and to take advantage of both electric and thermal solar energy systems.

Long-term: Beyond 2000

After the turn of the century, the U. S. should rely primarily on energy sources that are essentially inexhaustible. But the technological development of these sources must be actively pursued now so that they will be available when urgently required.

Most of the energy resources and conservation measures that are the mainstay of energy planning throughout the near-term and midterm slacken in their capacity to support further energy growth in the long-term. Current estimates of oil and gas reserves provide for no more than 50 years production at projected rates of consumption. Similarly, if coal production quadruples by 2000—as it probably must to support synthetic fuels development—our domestic reserves may be reduced to a level where coal could not play a dominant role in meeting the major growing energy needs of the 21st century. Uranium resources if used in converter reactors would also be significantly committed by 2000.

These solar reflectors have been installed for solar energy research at ERDA's Sandia Laboratories in Albuquerque, New Mexico. The reflectors are 9-x-12-foot mirrors, which are made of fiberglass and polyester and lined with aluminum reflector sheets. Heat will be moved by fluids through tubes to a storage tank, which has instruments, pumps, and control valves.



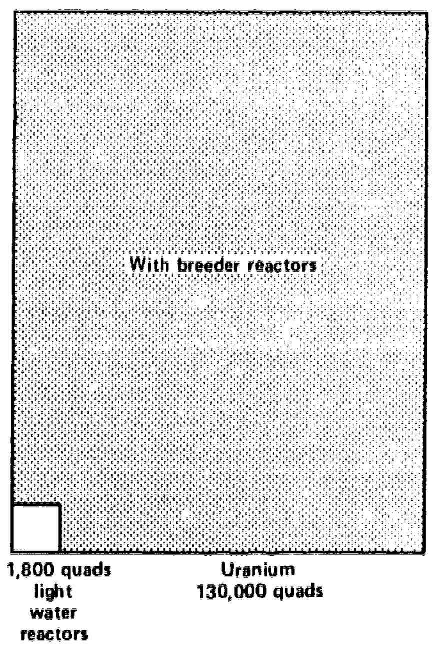
Part of ERDA's fusion research facility at the Los Alamos Scientific Laboratory in New Mexico.

In addition, as conservation technologies approach theoretical limits of efficiency, further savings become more difficult to achieve. Thus, some time after the year 2000, the Nation will have to depend on essentially inexhaustible sources of energy from solar electricity, breeder reactors, or fusion.

Each of these, however, is unproven and requires long technological lead times to develop. Certainly, most of the technical problems associated with these systems are anticipated to be at least as difficult as those encountered in the development of nuclear converter reactors. For example,

even with substantial Government funding and widespread industrial support, a quarter of a century was required for converter reactors to supply about 2% of total national energy demand, although nuclear development did occur during an era of inexpensive and plentiful fossil energy sources.

The most formidable challenges of all are unlocking the energy potential of (1) uranium-238 with the breeder reactor (2) the deuterium in the oceans with fusion and (3) the sun with solar electricity. Any of these three technologies could



This shows the total energy (in quadrillions of Btu's) from recoverable domestic uranium resources. Breeder reactors, which produce more energy than they consume, would increase the energy value of our domestic uranium resources approximately 70 times. The fission process in light-water converter reactors uses only from 1% to 2% of the energy in uranium. Breeder reactors, however, could enable us to use 60% of the energy in uranium.

conceivably meet a major portion of long-term energy needs. One or more will be critical to the 21st century. All have some serious technical, environmental, or cost problems. Because of a vital need for success in long-term energy technology, all three must be developed on a high priority basis.

Developing solar electricity involves wind power, photovoltaic and thermal-electric conversion, and ocean temperature differences. Breeder development involves primary emphasis on liquid metal fast breeder reactors, with other breeder concepts being developed as alternative systems. Fusion is a high-risk, high-payoff concept that has to be pursued despite very formidable engineering challenges, with the goal of reaching the demonstration stage before 2000.

Electricity generated from inexhaustible solar, breeder reactor, and fusion sources should eventually, some time beyond 2000, make us much less dependent on imported and dwindling supplies of domestic petroleum and on liquid fuels synthesized from coal. Urban transportation could be based primarily on electric-powered cars and mass transit vehicles.

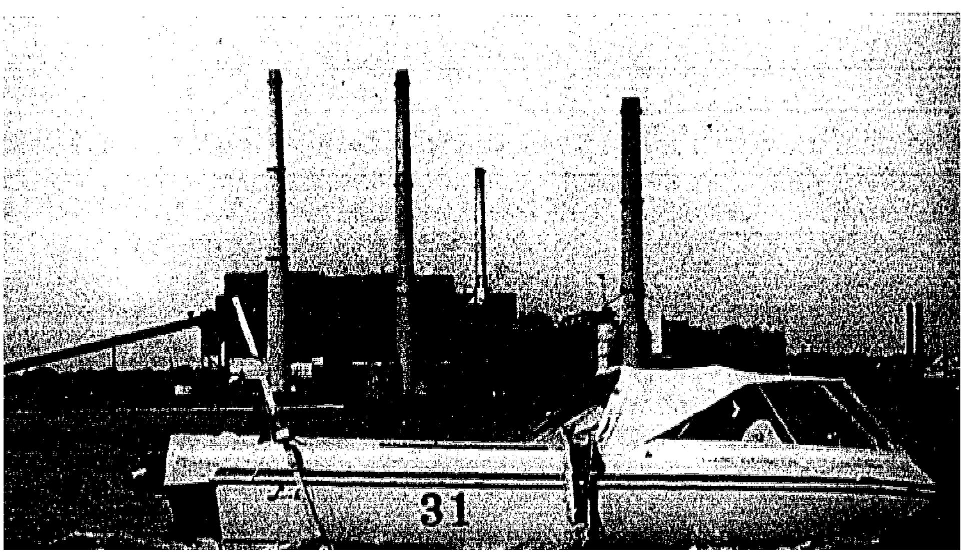
The long-term aspect of the plan also includes some other technologies that could be used to supplement high priority energy systems. Because all these inexhaustible resources will produce electricity, electrification technologies must be developed to complete the system. To electrify transportation and other energy-dependent functions, we must also develop the technology to store, transmit, and distribute electric power on a far more massive scale and with more efficiency, reliability, and flexibility than we do today.

Another supplementary technology is the potential of raising biological material, such as fast-growing plants, and converting them to fuels, such as alcohol or methane gas. Finally, hydrogen energy systems will be explored as a possible source of liquid and gaseous energy for transportation and other functions.

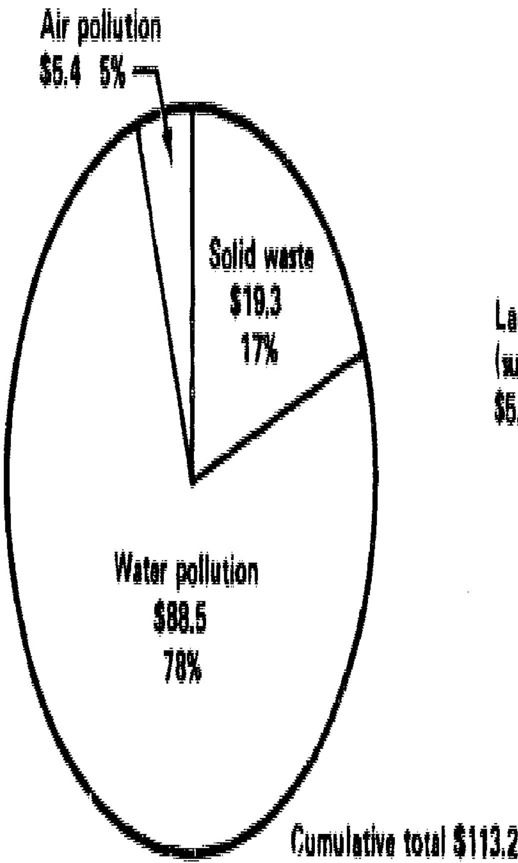
The Importance of Environmental Research, Development, and Demonstration

In addition to demonstrating the technical feasibility of new energy systems, it will also be necessary to ensure that the environmental, health, and safety aspects are acceptable. The National Energy Plan recognizes that an assessment of the environmental effects must be started early in the research, development, and demonstration process and that environmental safety and controls must be developed as an integral part of energy systems design. The two most difficult challenges to environmental research and development related to energy may be (1) to avoid unanticipated and adverse environmental effects and (2) to provide a scientific basis for overcoming unwarranted public fears of risks that may delay or deny energy benefits.

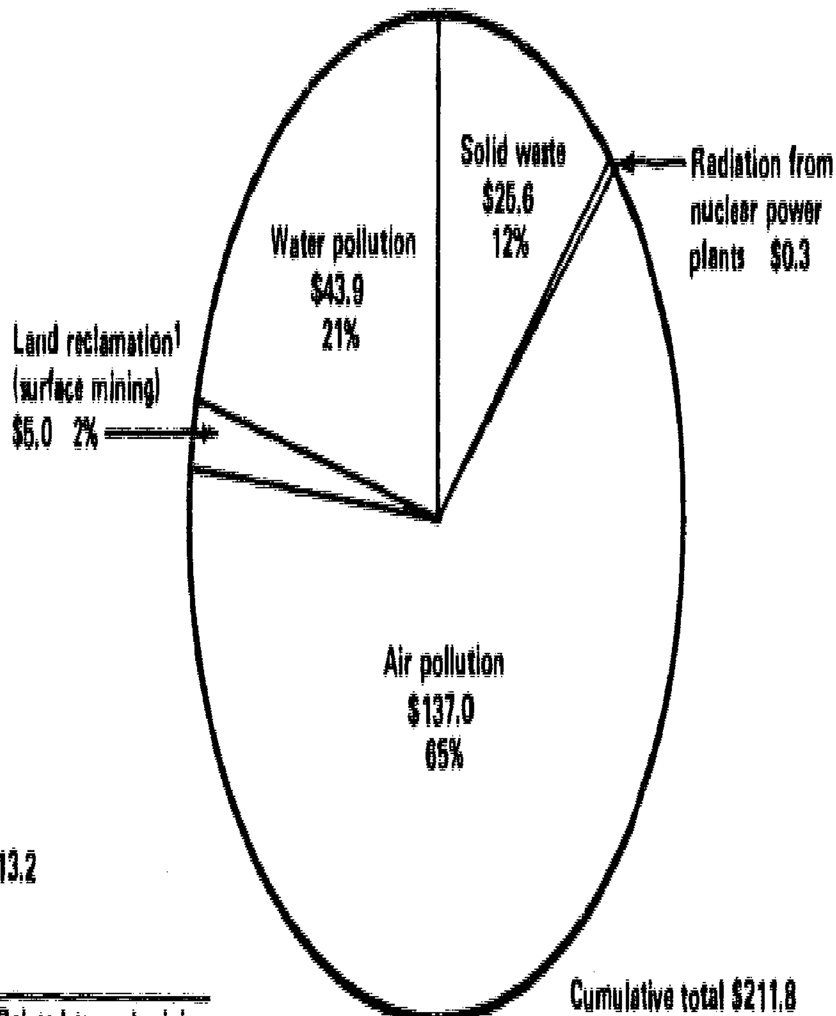
Energy development and expansion require strong support in biomedical and environmental research and safety, including an integration of safety and environmental analysis at an early stage in the design of the new technologies. The boat in the picture is measuring the effects of heated water discharged into Lake Michigan by the 1186-megawatt-electric, coal-burning power plant in Waukegan, Illinois.



PROJECTED POLLUTION CONTROL EXPENDITURES: 1973 - 1982 (BILLIONS OF 1973 DOLLARS)



PUBLIC EXPENDITURES



[1]Related to coal mining.

PRIVATE EXPENDITURES

The Role of the Federal Government in Energy Development

In carrying out the National Energy Research, Development, and Demonstration Plan, the guiding principle is that the Federal Government will provide overall leadership, but will undertake only those efforts that industry cannot initiate. As new technologies approach commercialization, the role of the private sector will be paramount. Strong Federal support, including a significant portion of the burden of financial risk, will be essential for the following reasons:

- Private industry is not always able to finance the total cost of developments that, although technically feasible, are not expected to yield a financial return for a number of years.
- Because it is not certain which concepts will turn out to be technically feasible and economically acceptable, private financing will not be able to bear all the commercial uncertainties associated with some new technologies.
- Energy research, development, and demonstration needs to proceed according to an overall plan and at a pace that is accelerated to meet national needs, instead of responding to private perceptions and serving narrower interests.
- Federal leadership is essential if energy development is to be reconciled with health, environmental, and safety considerations.

Federal policy should encourage maximum private participation and financial support in energy research and development. Industry should pursue what it can do profitably on its own, and Government-supported programs should be turned over to private industry as soon as possible.

Specifically, ERDA will look to the private sector to help in developing and reviewing the economic, technical, safety, and environmental aspects of ERDA's research, development, and demonstration programs; to give advice and financial

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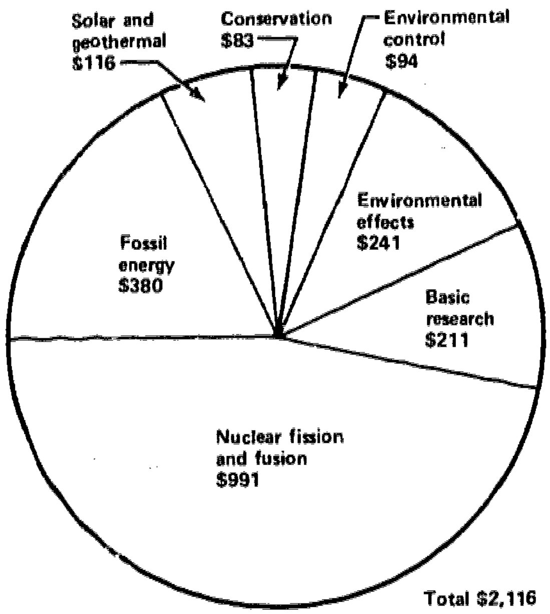
FEDERAL SPENDING FOR ENERGY R & D
1976 ESTIMATES
($ MILLIONS)



Source: Special Analyses, Budget of the U. S. Government: Fiscal Year 1976, p. 253.

support; to plan the major financial and technical role in large demonstration projects; and to bring the technology into commercial use.

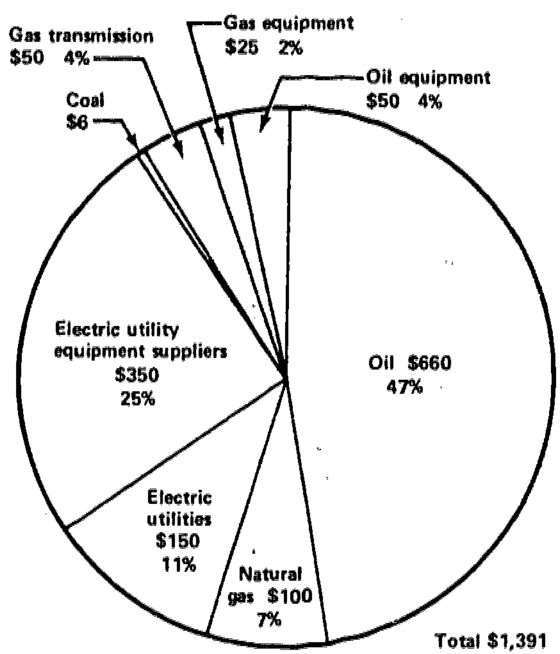
In the near-term, federal policies must help industry and consumers develop and fit new technologies into existing facilities and activities. Some examples of this are techniques to enhance recovery of oil and gas, incentives for utilities to burn coal instead of gas and oil, gasoline consumption standards for automobiles, and improved building insulation.

For technologies that will have a primarily midterm impact, the federal role will be to stimulate the development of coal gasification and the production of liquid fuels from coal and oil shale.

For post-2000 technologies the responsibility is now primarily federal. At their present stage of development, systems for long-term impact carry risks that are so high and prospective payoffs that are so distant that private investors cannot rely on a calculable return from such a research and development investment.

In addition to the federal contribution, state and local governments and regional groups must play a vital role in

PRIVATE SECTOR ENERGY R & D FUNDING – 1973
($ MILLIONS)



In calendar year 1973, private industry spent almost $1.4 billion on energy research and development, which is almost twice the federal funding level in fiscal 1973. Much of the private funding was for solving technical problems in operating existing systems.

providing regional and local perspectives. They will become involved in such questions as environmental control, resource extraction, plant siting, industrial regulation, and revision of building codes to accommodate innovation.

New Directions

Some of the impetus and programs for putting the Plan into effect are already in motion. However, some new focus and emphasis—different from past research, development, and demonstration policy—is needed to move U. S. energy development toward the objectives in the National Plan.

For the short-term, more emphasis should be given to technical problems that are inhibiting the expansion of abundant sources, especially the use of coal-fired plants and light water nuclear reactors.

There should also be an immediate focus on conservation. Existing technology should be implemented and improved. Its viability should be demonstrated, and the results should be widely disseminated. The primary emphasis should be on automotive transportation, buildings, and industrial processes.

For technologies with a midterm impact, development of a commercial capability to extract gaseous and liquid fuels from coal should be accelerated. Existing technologies must be implemented as soon as possible to gain needed experience with large-scale synthetic fuel production. A Synthetic Fuels Commercialization Program is now being developed to implement the President's synthetic fuels goals. Parallel efforts must be aggressively pursued to develop a more efficient generation of synthetic fuel plants with lower product costs and less environmental impact.

Also for the midterm, increased attention should be given to new but neglected technologies that can be rapidly developed. Geothermal power and solar heating and cooling are close to implementation and promise a significant impact for the midterm and beyond.

For the long-term, solar-electric power should be given the same high priority as the two other essentially inexhaustible resources, fusion and the breeder reactor.

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A word about ERDA . . . .

The mission of the U. S. Energy Research & Development Administration (ERDA) is to develop all energy sources, to make the Nation basically self-sufficient in energy, and to protect public health and welfare and the environment. ERDA programs are divided into six major categories:

- CONSERVATION OF ENERGY—More efficient use of both existing and new sources of energy in industry, transportation, heating and cooling of buildings, and the generation of electricity, together with more efficient transmission of energy.
- FOSSIL ENERGY—Expansion of coal production and the development of technologies for converting coal to synthetic gas and liquid fuels, improvement of oil drilling methods and of techniques for converting shale deposits to usable oil.
- SOLAR, GEOTHERMAL, AND ADVANCED ENERGY SYSTEMS—Research on solar energy to heat and cool buildings, and eventually provide electrical power, on conversion of underground heat sources for electricity and industrial heat, and on fusion reactors for the generation of electricity.
- ENVIRONMENT AND SAFETY—Investigation of health, safety, and environmental effects of the development of energy technologies, and research on management of wastes from energy production.
- NUCLEAR ENERGY—Expansion of medical, industrial and research applications and upgrading reactor technologies for the generation of electricity, particularly using the breeder concept. Production of nuclear materials for civilian needs.
- NATIONAL SECURITY—Carrying out the research and development, production, and testing of nuclear weapons as well as focusing on a wide range of related issues such as safeguards and security and international political/military security matters.

ERDA programs are carried out by contract and cooperation with industry, university communities, and other government agencies. For more information, write to USERDA–Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.

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