NRC PDR
50-546

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

MAR 0 3 1980

Mr. and Mrs. Edward Boyles
RFD 1, Box 176B
Versailles, Indiana 47042

Dear Mr. and Mrs. Boyles:

Your letter to the Department of Energy was referred to the Nuclear Regulatory Commission on January 22, 1980.

You propose that a coal-fired plant be built near Patriot, Indiana. The NRC has no responsibility with regard to the building of coal-fired plants, which would be up to the utility concerned and the State authorities. However, you may be interested in the enclosed excerpt from the Second National Energy Plan transmitted to the Congress by the President on May 7, 1979. This excerpt is Chapter V on "Coal and Nuclear: The Transitional Energy Sources."

The policy stated there is as follows: "The Nation's mid-term energy situation depends on successfully maintaining and expanding the use of coal and nuclear power. These two sources are commercially available today and can be enlarged if the markets grow and their critical environmental and social problems are overcome."

Sincerely,

Harold Denton

Harold R. Denton, Director
Office of Nuclear Reactor Regulation

Enclosure:
As stated

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96th Congress, 1st Session - - - - - - - - - House Document No. 96-121

SECOND NATIONAL ENERGY PLAN

MESSAGE

FROM

THE PRESIDENT OF THE UNITED STATES

TRANSMITTING

THE SECOND NATIONAL ENERGY PLAN, PURSUANT TO SECTION 801
OF THE DEPARTMENT OF ENERGY ORGANIZATION ACT

MAY 7, 1979.—Message and accompanying papers referred to the
Committee of the Whole House on the State of the Union
and ordered to be printed

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CHAPTER V

COAL AND NUCLEAR: THE TRANSITIONAL ENERGY SOURCES

Coal and nuclear power now supply 22 percent of the Nation's energy and must provide an increasing share as conventional oil and gas resources are depleted. Over three-fourths of domestic coal consumption and virtually all of the nuclear energy is now used to generate electric power, with oil and gas dominating transportation, space heating, and most industrial uses. Although the Administration is encouraging the direct use of coal in industry, electric generation will continue to be the chief use of both coal (and nuclear energy) for at least the next 40 years. The growth in consumption of coal and nuclear depends in large measure on their environmental and public acceptability, and their competitiveness with one another and with new technologies yet to come.

Both of these energy sources face two basic challenges:

- o the need to resolve institutional and environmental problems that limit the use of existing direct coal-fired and light water reactor plant technology; and
- o the timing and pace of development of more resource-efficient technologies, such as advanced coal-fired power cycles, alternative nuclear fuel cycles, and advanced nuclear reactors.

The first challenge is one of technology survival rather than economics. Unless direct coal burning and light water reactor power plants can achieve environmental and public acceptability, they will not be able to carry their projected share of new electric power generation. If either one falters, then the other will have to grow that much faster, further aggravating its own difficulties. And without competition from the other, the added pressure placed on the remaining source will drive its costs higher.

The second challenge--technology development--depends on the outcome of the first and on the growth in electricity consumption and development of other new energy sources. The role for technologies such as Magnetohydrodynamics (MHD), coal fuel cells, and the liquid metal fast breeder reactor will depend on how expensive they are compared to alternatives.

In the years since the embargo, perceptions of the role for these technologies have changed radically. Electricity consumption, which has doubled every decade (7 percent per year) for more than half a century, is now expected to rise more slowly. The growth rate should approach about half the historic average by the end of the century. This slower growth in demand, though welcome for many reasons, has seriously disrupted utility construction planning, particularly for nuclear plants. On the other hand, the slower demand growth will postpone the potential depletion of uranium resources, avoids greater environmental problems from more coal use, allows more time to develop new technologies, and removes any urgent need to commercialize the breeder reactor.

A. Coal

During the first half of this century, coal was the predominant fuel in the United States. In the late 1940s, however, its dominance began to erode as consumers shifted to cleaner, more convenient, and frequently cheaper energy forms -- primarily oil and gas. Figure V-1 shows how the use of coal changed both as a fraction of total energy use and in physical terms.

For many years, coal was a dominant fuel in all demand sectors, including transportation, in which it supplied the railroads. As coal declined in the 1950s, and even when it revived again in the late 1960s and 1970s, it came to depend on one major market--utilities. In 1978, 78 percent of the coal used in the U.S. was burned by the electric utilities.

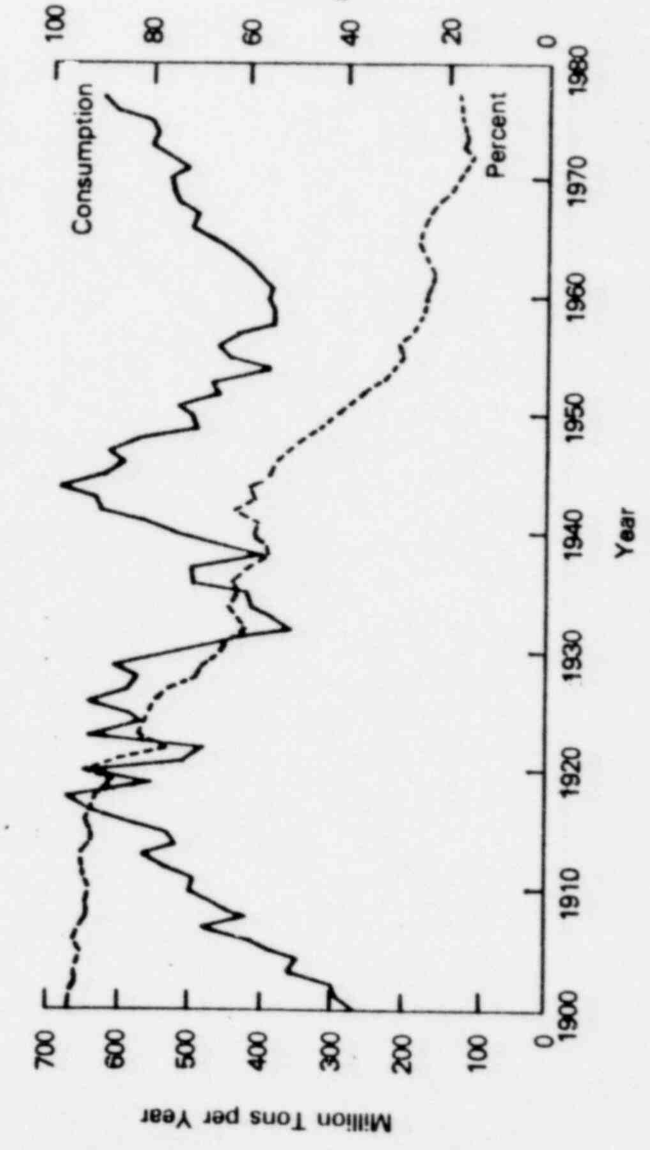
Even today, however, U.S. coal reserves are still hundreds of times greater than annual production levels. While domestic oil and natural gas use is limited by supply, coal consumption is limited primarily by constraints on demand. Even when the fuel cost economics favor coal, firms have been willing to pay sizable premiums for cleaner, more convenient fuels.

Many people remember the time when clouds of smoke hung over U.S. cities. People also remember production disruptions, such as coal strikes, which threatened the entire economy. Coal mining has historically been a dangerous calling, and the health and safety of miners an urgent social concern. Even if past problems do not recur, the attitudes that were created by these problems may persist.

In the past 15 years, coal's environmental problems have been curbed by Federal and State actions dealing with air and water pollution, underground mine health and safety, and, most recently, surface mining and reclamation. However, utilities and industry often found it easier to meet new air emission rules by switching to oil, gas, and lower sulfur coals, than by installing pollution control equipment.

Figure V-1

U.S. Coal Consumption as a Fraction of Total Energy Consumption



Mining safety regulations helped reduce fatalities and disabling injuries in both underground and surface mines, but worker productivity necessarily fell, and labor costs rose (especially in underground mining). Partly because of increased safety costs and other economic reasons, there has been a shift from underground to surface mining. As the new Surface Mining and Reclamation Act is implemented over the next few years, however, the costs of surface mine production may also begin to rise. Meanwhile, concern with another problem of fossil fuel use, especially coal use, has been growing -- the accumulation of carbon dioxide in the atmosphere from coal combustion, which might raise temperatures and affect the earth's climate.

STRATEGY FOR COAL

The U.S. has nearly 4 trillion tons of coal in place, and has economically recoverable reserves that approach 200 to 300 billion tons. But annual production of coal has risen to only 660 million tons per year. The Administration seeks to increase production and encourage greater reliance on coal. To carry out this strategy, the U.S. will:

- o Expand domestic coal markets by vigorously implementing regulations that prohibit the use of oil and gas in utility and large industrial boilers, under the Powerplant and Industrial Fuel Use Act of 1978.
- o Encourage the development of better emission control technologies so that both existing and new utility and industrial facilities can burn coal directly and still comply with current and anticipated environmental standards.
- o Demonstrate the capability to produce synthetic liquids and gas from coal by the mid 1980s so that significant capacity can be built in the 1990s--if increasing world oil prices make them competitive.
- o Develop technologies that will allow a more efficient and environmentally acceptable use of coal in the 1990s and beyond.
- o Improve the competitive economics of coal by correcting oil and gas price distortions; develop cheaper ways to mine coal in an environmentally acceptible manner; and discourage increases in coal prices that do not reflect real increases in the cost of producing and delivering coal.

The program for coal emphasizes direct coal combustion, since about 90 percent of the coal consumed in this country in the next 20 years will be burned directly. Coal gasification, liquefaction, and other advanced technologies will probably not account for a large share of coal use before 2000.

Coal Conversion Regulations

The Energy Supply and Environmental Coordination Act of 1974 (ESECA) provided the authority to require coal use in boilers capable of burning coal. The National Energy Act extended and improved on the ESECA authority through the Powerplant and Industrial Fuel Use Act, which authorizes a variety of regulations for requiring existing and new boilers to use fuels other than oil or gas. In particular, utility and large industrial boiler users may be prohibited from burning oil or gas in new units unless they show that they cannot use coal or another alternative fuel. Regulations under the statute will be promulgated shortly and will indicate how much more costly coal use must be before an exemption to use oil or gas is granted.

The Department of Energy intends to use its statutory authority vigorously, and thereby reduce oil imports by an estimated 300,000 to 450,000 barrels per day by 1985. The Department is also working with other agencies to assure that other Federal regulations, policies, and programs do not needlessly hamper utilities and industry from converting to coal.

One provision of the Fuel Use Act deserves special mention. Before certain exemptions can be granted, it must be shown that use of coal-oil mixtures is not feasible. These slurry-like mixtures contain pulverized coal and oil. They can be burned as liquids in an oil-fired furnace -- either in existing oil burning facilities when it is not feasible to convert exclusively to coal, or in new facilities when exclusive use of coal is foreclosed for environmental reasons.

The technical feasibility of such mixtures has been demonstrated only for short periods. More information is needed on long-term performance, the range of applications, and especially on the ability to transport and store the slurries. If the mixtures could be produced at a central plant and shipped to a variety of users, they could be used more widely than if they had to be produced on site. Current testing programs should answer many of these questions.

Environmental Problems of Coal Combustion

Compliance with environmental standards poses the greatest potential constraint on increased direct use of coal. Unless these standards can be met at competitive costs, many firms that might use coal will turn to other fuels instead. The Department of Energy has accelerated its efforts to develop new technologies for improved emissions control. The Department is working with the Environmental Protection Agency (EPA) and other agencies to develop appropriate control strategies for complying with environmental regulations. The future of coal conversion depends in large measure on the success of these efforts.

Although coal utilization is affected by many environmental standards, air pollution is the major problem. Some of the water pollution and solid wastes problems affecting coal use arise from the techniques used to reduce air emissions from coal combustions.

The air pollution control standards that individual utility and industrial coal-burning plants must meet depend largely on the age and location of the facility. Most plants that existed in 1975 must meet the emission standards in the Clean Air Act's State Implementation Plans (SIPs). New facilities must meet New Source Performance Standards (NSPS), which are currently being revised. Those new facilities for which construction was started before September, 1978, must meet the existing NSPS standards. Facilities for which construction began later will have to meet the forthcoming NSPS standards and the still undefined new requiments for visibility maintenance. By 1985, less than 15 percent of coal burned in the U.S. will be affected by the revised NSPS, but by 1990 more than one third will be subject to the new standards. In addition to these minimum standards, special permitting procedures are required by the Clean Air act that will lead to tighter controls in pristine areas and in areas not attaining health standards.

Air Pollutant Risks -- Coal combustion emits a variety of air pollutants that may damage the environment and public health -- including sulfur dioxide, nitrogen oxides, particulates, hydrocarbons, and carbon monoxide. Compliance with existing sulfur dioxide emission standards is the most costly. Closely related and possibly even more difficult to regulate and control are the sulfates formed from sulfur dioxide and particulate matter. Sulfates may have significant effects on human health and ecology. They can be transported several hundred miles in the atmosphere and then "washed out" in the form of "acid rains," which adversely affect both plants, animal life, and humans. Together, sulfur oxides and sulfates are likely to constitute the single most important near-term constraint on direct coal use.

Nitrogen oxide emissions depend on the amount of nitrogen in the coal, and the combustion conditions that can convert nitrogen in the air into nitrogen oxides. Coal contains more nitrogen than other fuels, aggravating the general fossil fuel problem. Special combustion techniques can reduce nitrogen oxide emissions slightly. But major new technologies, such as "post-combustion" controls, will be necessary if reductions in nitrogen oxide emissions from stationary sources are needed.

Particulate emissions can be effectively reduced with current technologies such as electrostatic precipitators. But current technologies are not as effective for the very small, respirable particulates most closely associated with health and visibility effects. These small particulates act as carriers for trace elements and hydrocarbons, many of which may be toxic or carcinogenic. Alternative controls, such as "bag houses," may be needed to reduce respirable particulate emissions. Such controls have not yet been used widely by utilities.

Water pollution and solid waste problems have plagued coal use for many years. More stringent standards set by the Federal Water Pollution Control Act Amendments of 1977 and the Resource Conservation and Recovery Act (RCRA) of 1976 may create new sets of problems for the technologies used to control sulfur dioxide emissions.

This brief review shows that the problems of coal combustion are various and formidable. Several post-combustion cleanup technologies are being introduced to mitigate these problems. If successful they will facilitate the continued direct use of coal as a primary source of electricity until improved and inexhaustible energy sources are available. Also, synthetic fuels and improved efficiency technologies, discussed later in this Chapter, can inherently avoid some of the emissions problems of direct combustion techniques.

Sulfur Oxide Controls -- Sulfur oxide emissions from direct coal combustion can be controlled in three general ways:

- at the front-end (before combustion), through use of low sulfur coal or cleaning of higher sulfur coal;
- at the back-end (after combustion) through the removal of sulfur oxides from the flue gas; and
- during specialized combustion processes (for instance, fluidized bed combustion), through chemical capture of sulfur oxides as as part of the combustion process.

Use of low sulfur coal or cleaning of higher sulfur coal are two common ways to meet current NSPS and SIPs, especially for older plants. They may not satisfy the standards for new plants required by the Clean Air Act Amendments of 1977. Use of lower sulfur coal, obtained with or without physical cleaning, is an attractive method to meet current emission standards because it costs less than back-end (post-combustion) controls. DOE is funding RD&D for pre-combustion coal cleaning at $10 million in FY 1979 and $14 million in FY 1980.

However, revised NSPS will require removal of a substantial part of the coal's original sulfur content. Without use of another control technology (such as flue gas desulfurization), most front-end clean-up will not meet the new standards. One method that will, however, is solid solvent refined coal (SRC-1), an ash-free, hydrogenated solid coal product that may meet the stricter standards for new plants without post-combustion control. On the other hand, some of the intermediate products of such technologies have been found to contain potentially carcinogenic and toxic substances. Although there is no regulation of these by-products presently, it is clear that worker and public health must be protected from such effluents. In recent years, the Government has supported RD&D on two processes for solvent refined coal -- one that produces a solid and the other a liquid. Funding for one commercial demonstration plant has been linked to an upcoming competition between the SRC solid and SRC liquid processes. Funding for a second commercial demonstration plant would now be provided from the Energy Security Fund.

Back-end control systems, particularly flue gas desulfurization (FGD), are now being used to meet sulfur oxide emission standards. However, their economics and reliability have not been demonstrated fully. New FGD systems to meet even more stringent standards are being developed. These improved FGD technologies, particularly regenerable systems, limit the volume of wastes collected and thus reduce many of the water pollution and waste disposal problems which face the "throw-away" processes.

The new "regenerable" systems are expected to be available in the 1980s. The sulfur emission control costs for existing and improved systems will range from about $.40 to $.70 per million Btus (compared with coal costs of $1.00 to $1.50 per million Btus). FGD is a critical control technology that requires high priority if coal is to realize its full market potential. The Energy Department's budget to improve FGD technology has been increased from $3 million in FY 1979 to $25 million in FY 1980.

Fluidized bed combustion (FBC) is another way to meet air pollution standards with high sulfur coals. The coal burns in a fluidized bed of coal and limestone. Sulfur dioxide is captured chemically by the limestone and discarded with the ash. Small industrial-scale FBC units are available now and the Department of Energy is encouraging demonstrations. Larger-scale utility systems require more technical development and initial commercial demonstrations. In the near term, industrial FBC systems should provide energy at about the same cost as conventional coal combustion with FGD. Aside from their environmental advantages, FBC systems could also become more economical and efficient once they have been fully demonstrated and are being built in commercial quantities. Development of fluidized bed combustion systems is funded at $41 million in FY 1979 and $48 million in FY 1980.

Because of the critical importance of environmental controls for direct coal use and the uncertain relative costs of all these approaches in the face of current and projected standards, the Government's strategy is to develop several major technology options on an accelerated basis. Total funding for these efforts jumped from $17 million in FY 1979 to $57 million in FY 1980.

Synthetic Liquids and Gases

The Government intends to demonstrate the capability to produce synthetic liquids and gas from coal by the mid 1980s so that significant capacity can be built when oil prices rise enough to make synthetics competitive. Technologies for making premium synthetic liquids and pipeline quality gas from coal can be modified to make lower cost industrial fuels. Industrial use of synthetic fuels will depend on the economic conditions in the industry and whether health and environmental problems associated with production and use of synthetics can be resolved. In fact, satisfactory development of all of these technologies depends on solving environmental and worker safety issues in parallel with economic and technical issues.

The Energy Department's synthetic fuel program includes a number of different research, pilot, and demonstration projects as well as participation in international R&D programs. The following activities are underway:

- Demonstrations of the manufacture of boiler fuels from coal to displace residual fuel oils and other products. Demonstration of a Solvent Refined Coal (SRC) process on a commercial-scale has high priority, and related processes are being pursued in the pilot plant phase.

- Limited investments in alternative ways to produce coal substitutes for lighter oil products--such as gasoline, distillate fuels, and methanol.
- Commercial-scale use of a conventional gasification process to convert noncaking Western coal to pipeline gas.
- Support of an advanced gasification process to demonstrate the ability to use a broader range of coals and to lower costs.
- Expanded RD&D to stimulate industrial uses of medium Btu gas, low Btu gas and synthesis gas from coal.
- Development of methods to reduce synthetic fuel costs by work on highly advanced ("third generation") processes.
- Research and development to define the environmental and safety effects associated with the production and use of coal-derived liquids and gases. These efforts will also develop appropriate control technologies and the operational environmental data on which to base future standards and regulations.

These activities span a wide range of processes and fuel products. But certain elements are common to many of the processes and specific applications. Virtually all of them involve gasification, either to convert raw coal into gas for further processing or to convert a residual char into hydrogen for subsequent use. For this reason, it should not be necessary to build separate pilot or demonstration plants for every possible combination of processes to make liquids or gases. Judicious selection of R&D projects, pilot plants, and commercial demonstrations can develop useful information on a wide spectrum of coal synthetic options.

As Table V-1 shows, the Administration continues to support a robust mix of programs for synthetic fuels. Due to stringent budget requirements the Administration had to be more selective when funding demonstration projects in FY 1980. However, creation of the Energy Security Fund will help support more projects to develop major technology options. For example, the Fund will make it unnecessary to choose between the SRC-I (solids) and the SRC-II (liquids); the Federal share for a second SRC plant would come out of the Fund.

TABLE V-1

FUNDING FOR COAL SYNTHETICS
(Million Dollars)

	FY 1979	FY 1980
Liquefaction	206.4	122.3
Pipeline (Hi-Btu) Gasification	67.0	85.0
Low- and Medium-Btu Gas	54.0	40.7
Advanced Research and Support	42.6	39.9
Total	366.0	291.7

The Fund could also make available loan guarantees for selected coal-synthetic projects which need Federal assistance to overcome market barriers. Although current Federal statutes give generic loan guarantee authority to the Department of Energy, they include a number of requirements that inhibit the issuance of the guarantees. The Administration will propose modifications of existing statutes to streamline procedures for making loan guarantees.

Improved Coal Use Efficiency

Many advanced coal technologies for the generation of electricity hold the promise for much higher efficiencies in the conversion from coal to electricity. These technologies also reduce pollution as an integral part of the process rather than in back-end clean up systems. There are several major technology options:

- Magnetohydrodynamics (MHD) uses advanced generation techniques and very high temperature coal combustion process to generate electricity at high efficiency for base load applications.
- Advanced fuel cells convert synthetic gas from coal to electricity in electrolytic cells--another option for base or intermediate load generation.[1]

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[1] Fuel cells that use natural gas or petroleum-based naphtha as a fuel are becoming commercial now; but fuel cells that use coal-based fuels still require extensive development.

- o Pressurized fluidized bed (PFB) combustion links fluidized bed combustion with advanced turbines and other heat recovery systems to achieve high efficiencies in the generation of electricity. This technology may be more effective in reducing emissions than atmopheric fluidized bed combustion.

- o Improved turbines can attain higher operating temperatures and higher efficiencies, as well as handle heavier and dirtier fuels within environmental limitations.

Most of the advanced electric generating systems that emphasize fuel efficiency will play a longer term role in the Nation's energy strategy. One exception is a technology that combines coal gasification with a gas turbine and a steam cycle. With advanced high-temperature turbines, this "combined cycle" system can raise efficiency, lower generating costs, and reduce emissions in the long term. With conventional turbines, the system still has significant environmental advantages; and it may permit coal-fueled electric generation, though at higher cost, even in areas with severe environmental constraints. Accordingly, one California utility system and a consortium of Midwest utilities intend to demonstrate such a coal-fired combined cycle system.

The Administration will fund programs for the advanced conversion technologies at $184 million in FY 1979 and $142 million in FY 1980.[1]

Coal Supply and Production

Coal use will not increase if supplies are too costly. Movement toward replacement-cost pricing for oil and gas will make coal use much more attractive. But coal prices are not regulated, and some oil-import savings may not occur if those prices needlessly increase.

The Administration intends to discourage higher coal prices that do not reflect real increases in the cost of producing and delivering coal supplies. It will also support development of more cost-effective methods to mine and transport coal in an environmentally acceptable manner. Specific actions include the following:

1/ This accounting does not include funding for fluidized bed combustion.

- o Timely leasing at fair market value of Federally-owned coal reserves in the West will help increase competition within the industry. This leasing program is intended not only to permit greater coal production on Federal lands, but also to assure that such production is consistent with comprehensive land use management principles.

- o Federal R&D will seek to develop lower-cost, more efficient mining technology. The R&D program for underground and surface coal mining is funded at $66 million in FY 1979 and $46 million in FY 1980. The Energy Security Fund will support the accelerated development of mining systems that will increase both worker safety and labor productivity, as well as meet water and land reclamation regulations.

- o The Department of Energy will intervene as necessary before the Interstate Commerce Commission to assure that railroad rates properly reflect the marginal cost of transporting coal.

- o Coal slurry pipelines will improve the Nation's ability to use coal, and to deliver it economically from areas where it is mined to plants where it can be used. The Administration supports legislation to ensure that coal slurry pipelines can secure necessary rights of way. Under appropriate conditions, coal slurry pipelines can improve competition and offer a cheaper way to move coal. Each system approval requires a careful assessment of impacts on water availability, local ecology, and competing modes of transportation. The Administration will work with the Congress to develop an efficient review procedure to minimize the time required for these assessments and to assure prompt decisions.

The President has also directed the heads of the three Federal agencies having the major responsibilities for coal regulation--the Department of the Interior, the Department of Energy, and the Environmental Protection Agency--to report to him within 60 days concerning ways to increase coal production, development and use.

B. Nuclear Power

Although nuclear power has its origins in nuclear weapon research conducted during World War II, nuclear-generated electricity was not important in the civilian economy until the early 1960s. At that time, after government and industry had jointly funded and operated several demonstration plants, electric utilities began to place orders for large numbers of commercial nuclear reactors. The first of these began operation in the early 1970s. Orders for new nuclear plants exceeded orders for coal-fired plants through the late 1960s and early 1970s. From 1971 through 1978, utilities placed orders for 105 nuclear plants. By 1978, 38 of these orders had been cancelled. In all of 1978, only two new plants were ordered.

In part, this sharp decline reflects the downward revisions of electricity growth forecasts. Equally important, however, public concerns have increased over a series of unresolved questions about nuclear power--specifically, the management of nuclear wastes, the safety of reactor operations, health and environmental risks, and proliferation of nuclear weapons. Permitting delays arising from the public controversies over these critical issues coincided with a substantial decline in labor productivity. Some nuclear projects experienced large cost overruns and often required what some utility executives viewed as excessive management attention.

The recent accident at the Three Mile Island plant in Pennsylvania has reinforced safety and other public concerns. But as the U.S. regards its energy options after Three Mile Island, the role of nuclear power must receive a considered and objective assessment. The future of nuclear power will change--for the better, if safety and other issues are successfully resolved.

The U.S. now obtains 13 percent of its electricity from nuclear power. Any precipitate action to close a large number of reactors in operation now could seriously aggravate U.S. oil import dependence. In the long term, nuclear energy can help ensure a balanced energy supply system. In the absence of a nuclear power, alternative domestic energy supply sources (especially coal) would be harder pressed, and their costs pushed higher.

In the past, coal, oil, gas, uranium, and hydropower have competed with each other for shares of the electricity market. Regional factors determined the mix, and the price of electricity has been stable. In the future, however, coal is expected to replace large quantities of oil and gas in electricity and many industrial uses. Coal use is expected to double or triple by the end of the century and continue to grow at 3 percent a year thereafter. If nuclear power were not available, coal would have to supply most of the mid and long term electrical demand until new sources such as solar were developed. This would cause serious environmental, occupational safety, and social problems as well as the possiblity of a significant rise in coal prices.

STRATEGY FOR NUCLEAR POWER

First, the Administration seeks to re-establish the light water reactor (LWR) with the once-through fuel cycle as a viable supply option and thereby ensure that nuclear power will be a significant source of energy for the rest of this century. Second, it will continue the development of nuclear power as a potential backup technology for the next century. To implement this strategy, the Administration is pursuing two courses:

- o To establish the safety of nuclear power and resolve other technical and institutional issues now impeding nuclear growth; and
- o To develop new technologies that permit expanded use of nuclear resources.

Light Water Reactors--The Technical And Institutional Issues

To reestablish the light water reactor as a viable supply option, three issues must be resolved--reactor safety, nuclear waste management, and nuclear siting and licensing. Until reactor safety and waste management issues are resolved, utilities will hesitate to commit to new nuclear plants. Improved siting and licensing procedures are needed to ease the transition through this period of uncertainty by changing the requirements for planning additional plants. Other Federal programs are designed to improve uranium utilization so that existing uranium resources can fuel a larger number of light water reactors, using a once-through fuel cycle. This will extend the time available before breeder reactors need to be commercialized.

Reactor Safety--In response to the Three Mile Island accident, the President has established a fully independent Presidential Commission, including nuclear experts. The Commission will investigate:

- o the circumstances that led to the accident and the events that followed;
- o the technical questions that the accident raises about the operation of safety and back-up systems for this plant and plant design; and

- the nature and adequacy of the response to the accident by all levels of government.

The President has asked the Nuclear Regulatory Commission (NRC), an independent regulatory body, to accelerate its schedule for putting permanent resident NRC inspectors at every reactor site. Under a program started in 1978, the NRC now has permanent inspectors at 20 reactor sites covering 26 individual reactor units. The President has also instructed the Department of Energy to work closely with the NRC to determine what additional safety precautions may be necessary.

Nuclear Waste Management--Radioactive wastes are generated in a wide variety of activities--research, medicine, defense-related nuclear operations, and in the operation of commercial nuclear power reactors. Over the last decade, the public has become increasingly concerned over whether these wastes can be safely managed. This concern has been tied to the question of whether nuclear power generation should be allowed to expand.

Recognizing the urgent need to find an effective solution to the problem, the April 1977 National Energy Plan pledged to develop a national nuclear waste management policy and program. To acquire the views of pertinent Federal agencies and State and local interests, the President established an Interagency Review Group (IRG) and asked it to design a strategy for dealing with the waste management problem.

The primary objective of waste management planning and implementation is to assure that "existing and future nuclear waste from military and civilian activities (including spent fuel) should be isolated from the biosphere and pose no significant threat to public health and safety." The IRG developed the concept of an "interim strategic planning basis" to use during the interim, since the required environmental and safety studies had not yet been completed and final decisions could not be reached.

The IRG found the most urgent need was for a safe, permanent repository for high-level military and civilian wastes (including spent fuel). Such an effort will require detailed studies of repository sites in a wide variety of geologic environments and diverse media, using a systems approach. Pending completion of the decision process under the National Environmental Policy Act, the IRG has recommended the following actions from the interim planning:

- A number of potential sites in a variety of geologic environments should be identified and early action should be taken to resolve whether to use them at an appropriate time. A single national repository for wastes should be avoided. Near-term strategy should seek to have at least two (and possibly three) repositories in operation within this century; insofar as technical and other considerations permit, these repositories should be in different regions of the country. Under such a regional approach, the geologic, hydrologic, and other technical characteristics of the sites and safety considerations will constitute the primary basis for selection.

- Construction and operation of each repository should proceed in steps. Initial emplacement of waste, at least in the first repository, should be planned on a technically conservative basis. The wastes should be retrievable for some initial period of time. The manner and circumstances in which waste would be retrieved and the technical aspects of waste packaging, containment and handling must be further defined.

A second major waste management concern is the disposition of existing and future uranium mill trailings. In the case of existing sites that pose excessive health risks, the Department of Energy is developing programs to stabilize tailings at the site or remove them to other locations. In addition, new technologies to stabilize tailings are currently being developed to meet the most stringent criteria.

Away-from-reactor (AFR) storage of spent commercial reactor fuel is needed as a temporary bridge between storage of spent fuel at the reactor site and permanent repositories. Possible approaches include modification of an existing storage facility (either in Barnwell, South Carolina; Morris, Illinois; or West Valley, New York);1/ construction of a new facility within the U.S.; or construction of a new facility in a remote off-shore area.

The Administration takes the position that some AFR storage capacity is needed by 1983 for domestic spent fuel. Because of this deadline, use of some existing storage facility is preferred. Furthermore, the U.S. wishes to assure foreign users that the it will be able to receive limited amounts of foreign spent fuel to the extent this serves nonproliferation objectives. Environmental impact statements on AFR

1/ These existing storage facilities were built by industry as a part of commercial reprocessing plants. Since reprocessing is not permitted, these facilities are not being fully utilized by their industrial owners.

domestic fuel storage, foreign fuel storage and fee charges for such storage should be completed this year. In addition, an environmental impact statement on three potential ARF sites is now being prepared. The Administration has submitted legislation to Congress to implement this AFR program.

The Energy Department has funded waste management programs in the amounts shown on Table V-2.

TABLE V-2

FUNDING FOR NUCLEAR WASTE MANAGEMENT
(Million of Dollars)

	FY 1979	FY 1980
Commercial	191	199
Defense	257	372
Spent Fuel Disposal	11	21
Away from Reactor Storage	0	300[1]
Total	459	892

Nuclear Siting and Licensing Legislation--Last year the Administration proposed legislation to reduce the uncertainties in the nuclear power plant siting and licensing process and to shorten the 10 to 12 year period it now takes to plan, design and build a plant. The Administration will continue to work with Congress to reduce unnecessary and duplicative steps in the siting and licensing process without compromising safety.

The key provisions of the bill included early site selection, environmental and safety review, and "banking" of a site before construction permits are filed for. It also provided for early approval of standardized plant designs independent of the site selection process and combining the application for a construction permit and an operating license. The bill transferred much of the responsibility to the States and called for more public involvement in the decisionmaking process.

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[1] Special authorization request accompanying proposed legislation for away from reactor storage facilities.

It is essential that questions about safety and environmental protection and the timeliness with which the process is carried out be reviewed thoroughly and necessary changes made. The Administration expects to work with the Congress to find the appropriate next steps to improve the siting and licensing process to assure both greater safety and efficiency. The Secretary of Energy will submit nuclear siting and licensing legislation to Congress.

Uranium Resources and Their Use

Concern over whether the U.S. uranium resource base is adequate has led to pressures to accelerate the breeder program and to commit to reprocessing. Because of the large uncertainties in present knowledge, a systematic appraisal of domestic uranium resources is being conducted through the National Uranium Resource Evaluation Program (NURE). It is designed to lay an adequate foundation for future fuel cycle decisions and domestic and foreign utility planning.

To recover the maximum energy from the domestic resource base, the Department of Energy has developed programs to:

- o Stimulate private industry R&D to improve light water reactor operating efficiency.
- o Construct an energy efficient gas centrifuge enrichment plant designed to produce 8.8 million "separative work units" (SWU). The first 2.2 million SWU are now planned to be in operation around 1988. Additional 1.1 million SWU modules can be added up to design capacity as demand grows. The added capacity permits operation of the enrichment enterprise in a way that conserves uranium resources by recovering a greater portion of the fissile uranium isotope.
- o Develop advanced isotope separation technology (AIST). This technology, if successfully developed, would permit economic production of nuclear fuel from depleted uranium "tails," thereby increasing by about 20 percent the enriched uranium recoverable from known reserves.
- o Examine advanced converter reactor concepts in cooperation with foreign developers as an alternative way to increase uranium conversion efficiency.

The Department's funding for these activities is summarized in Table V-3.

TABLE V-3

FUNDING FOR IMPROVED URANIUM UTILIZATON
(Million Dollars)

	FY 1979	FY 1980
National Uranium Resource Evaluation (NURE)	69	84
Light Water Reactor Efficiency	24	25
Gas Centrifuge Operations & Support (including construction)	241	409
Advanced Isotope Separation	54	55
Advanced Converter Program (Gas Cooled Thermal Reactors)	42	12
Total	430	585
Revenues from Enrichment Operations Excluding Centrifuge Plant but Including Sales of Enrichment Services.	-262	-493

New Technologies

In the long term, the U.S. will rely increasingly on renewable or essentially inexhaustible sources of energy. The breeder reactor is one long-term energy option because it has the capability to produce more fissile ("burnable") fuel than it consumes. The breeder reactor would not only sustain itself, but would also generate fuel for light water reactors.

Interest in the breeder reactor grew out of a desire for an option that would not disappear with the inevitable exhaustion of natural fissile uranium. The interest intensified when early estimates promised even lower cost electricity from the breeder than from the light water reactors, and resulted in programs for early commercialization.

This Administration, however, believes that rapid steps toward breeder commercialization are not needed now. The timing of the breeder program depends on the economic need for the technology and on nonproliferation issues. It is also linked to resolution of the reactor safety and waste management problems affecting the whole nuclear option. The leading breeder candidate (liquid metal fast breeder), if commercialized, would necessarily lead to reprocessing and to widespread use of plutonium. The President, in the context of his nonproliferation policy, directed deferral of such activities and cancellation of the Clinch River Breeder Reactor project while alternative fuel cycles are examined.

While preliminary results of the International Nuclear Fuel Cycle Evaluation (INFCE) do not suggest the likelihood of risk-proof breeder alternatives, improvements over current and proposed practices are being developed. The INFCE is considering various technical approaches to improving the proliferation resistance of breeder and converter reactor fuel cycles. It is also studying the appropriate timing for their development and commercial use.

Over the past decade, economic arguments have been used to justify the pace of the breeder program. Such justifications hinge on a few key factors--the overall demand for electricity, the uranium resource base, reactor efficiency, and the relative capital costs of light water reactors and breeders. If the demand for electricity grows rapidly, if domestic uranium resources are limited, and if breeders cost little more than light water reactors, then rapid commercialization would be economically attractive. Such perceptions prevailed in the late 1960s and early 1970s when electricity generation, particularly nuclear electricity, was growing rapidly.

Since the 1973-74 oil embargo, several circumstances have changed. Projections of electricity growth rates have dropped from 7 percent a year to around 3 to 4 percent for the long term. Light water reactor growth has slowed because of the problems noted earlier, indicating that uranium resources will last longer. Finally, early optimistic estimates of breeder reactor capital costs ranging from 0.9 to 1.3 times those of light water reactors have been replaced by estimates of 1.25 to 1.75.

These changed factors have been reflected in a recent analysis of the pace of breeder development. Typical of this analysis is the case summarized in Figure V-2. Nuclear electricity demand is described by the amount of installed nuclear capacity in 2000 and in 2020; uranium resources are described in terms of price; and breeder capital costs are described in relation to LWR capital costs. Figure V-2 shows that with reasonably attainable improvements in current LWR fuel efficiency, breeders would not be needed until after 2020 in most cases. The exceptions are when uranium costs are high, nuclear demand is high, and

Figure V-2
Timing of the Need for a Fast Breeder Reactor in the Long Term[1]

Fast Breeder Reactor Capital Cost[2]	U_3O_8 Price	Installed Nuclear Capacity (Gigawatts Electric)									
		200			300			400			← Year 2000
		400	500	600	500	600	700	600	700	800	← Year 2020
175	Intermediate	□	□	□	□	□	□	□	□	□	
	High	□	□	□	□	□	□	□	□	□	
150	Intermediate	□	□	□	□	□	□	□	□	□	
	High	□	□	□	□	□	▨	▨	▨	▨	
125	Intermediate	□	□	□	□	□	□	□	▨	▨	
	High	▨	▨	▨	▨	▥	▥	▥	▥	▥	

▥ 2000-2010
▨ 2010-2020
□ After 2020

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[1] Assumes 15 percent improvement in U_3O_8 utilization over current practice in a once-through cycle.
[2] Relative to the capital cost of a light water converter reactor.

breeder capital costs are low. Only under the most extreme cases would the breeder be economically justified in the 2000-2010 period. Successful development of advanced isotope separation technologies would ease the pressure for an early breeder even further. In such a case, the need for an early breeder occurs only for 400 GWe on line in 2000, for breeder capital costs of 1.25 times those light water reactor, and for high uranium prices.

In light of this economic analysis, the four possible RD&D program strategies will be considered below:

- o Late Breeder. This strategy assumes that the resource base is adequate for a long period of once-through light water reactor operations, that the nuclear growth rate will be low, or that breeder economics will be unfavorable. Consequently, breeder development would be pursued at a low level and commercialization of the breeder would be deferred as long as possible. A decision on a demonstration plant would be deferred until the 1990s, as would be reprocessing development. Light water reactor improvements, advanced converter reactor development, advanced isotope separation, uranium resource evaluation, and centrifuge facility deployment and development would be emphasized.

- o Hedged Breeder. This strategy assumes that the resource base, nuclear growth, and breeder economics do not require rapid commercialization of the breeder. However, because of uncertainty, the strategy would maintain sufficient flexibility and options so that program shifts could be made easily and effectively whenever information or events dictate. The programs for light water reactors, advanced converter reactors, advanced isotope separation, uranium resource evaluation, and centrifuge facilities would be emphasized, but less strongly than in the late breeder.

  Breeder development would continue at a moderate level with emphasis on engineering and component development. A decision on a demonstration plant could be taken in 1981, but also could be deferred until 1986-1990. Plans for both a 20-year and a 30-year commercialization program could be developed. Reprocessing technology would be developed, but commercialization deferred. This program attempts to minimize risk at a moderate cost.

- o Early Breeder. This strategy assumes that the uranium ore base is limited, that the nuclear growth rate will be high, and/or that breeder economics will be very favorable. It implies an early commitment to the breeder, with completion of a conceptual design study by 1981, commitment to a demonstration facility by 1982, and initial commercial deployment 20 years thereafter. Reprocessing development would be given high priority through commercialization. Programs for light water reactor improvement, advanced converter reactor development, advanced isotope separation, and uranium resource evaluation would be de-emphasized. This strategy would require a relatively high cost, high risk program.

o <u>Expanded Nuclear</u>. This strategy assumes that nuclear power will play a predominant role in our energy future, with installed capacities at least equal to the highest values assumed in the analysis. Aggressive programs would be indicated for light water reactors, advanced converters, and breeders--with commitments to commercialize them at the earliest possible dates. For the breeder, this would call for a demonstration plant decision in 1981 and planning for both a 20-year and a 30-year deployment schedule. Reprocessing, through the commercialization stage, would be accelerated. The program would be very costly but would provide the greatest assurance of maintaining and deploying the nuclear option.

The Administration favors the <u>hedged strategy</u>. The breeder program itself includes the liquid metal fast breeder (LMFBR) as the primary option, but would also support two others--the light water breeder reactor (LWBR) and the gas cooled fast reactor (GCFR). Each has particular strengths and weaknesses and provides a hedge against failure of one particular approach.

The Administration's decision not to build the Clinch River Breeder Reactor, a large LMFBR demonstration plant, needs to be viewed in light of the analysis that has taken place over the past decade. Furthermore, for a variety of technical and economic reasons, the Clinch River Plant is no longer considered to be adequate in size or design for a commercial demonstration. Those elements of the Clinch River project which can be used intelligently will be completed. The systems design will be completed together with certain components which have value for test purposes.

In place of the Clinch River plant, the Administration proposes substitution of a conceptual design study as the central focus of the LMFBR program. The results of this study together with recommendations regarding the future course of this program will be presented to the Congress in March 1981.

C. <u>Policy for Coal and Nuclear Power</u>

The Nation's mid-term energy situation depends on successfully maintaining and expanding the use of coal and nuclear power. These two sources are commercially available today and can be enlarged if the markets grow and their critical environmental and social problems are overcome.

The markets for coal and nuclear power are closely tied to the growth in demand for electricity, although coal can also be used in large industrial facilities. The Fuel Use Act gives the Department of Energy the regulatory tools to stimulate the use of coal and nuclear energy resources.

The primary constraints on this movement away from oil and gas arise from the regulatory and technical problems surrounding coal and nuclear power. Development of methods to use coal more efficiently, convert coal into clean fuels, and improve breeder reactors will be important for the long term as coal and conventional uranium fuels are exhausted. It will be different to make this long-term transition, however, without increased use of direct coal burning and light water reactors. Efforts to develop long-term options must be balanced with programs to assure that direct use of coal and nuclear power will be available in the mid term, consistent with public safety and maximum environmental protection.