IV. Supply Impacts

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Supply Overview and Findings

The National Energy Plan correctly assesses the gravity of the world energy situation, The Plan accurately conveys the sense of urgency in its statement that:

> . . . the diagnosis of the U.S. energy crisis is quite simple: demand for energy is increasing, while supplies of oil and natural gas are diminishing. Unless the United States makes a timely adjustment before world oil becomes very scarce and very expensive in the 1980's, the Nation's economic security and the American way of life will be gravely endangered. The steps the United States must take now are small compared to the drastic measures that will be needed if the United States does nothing until it is too late.

The National Energy Plan is a comprehensive and generally consistent set of policies that will permit the United States to begin to manage its energy supplies before conflicting claims on diminishing world oil supplies reach crisis proportions, The observations and conclusions that follow are meant to broaden the understanding of the Plan's impact on the Nation's energy supply systems. They are intended to raise the question as to whether the Plan can achieve its goals and not to challenge its value as a sound base for establishing U.S. energy policy over the next several years.

The Plan is a major move in the right direction. It can be improved with adjustments in detail and in scope.—The National Energy Plan acknowledges the hard energy choices the United States must make and the high costs of those choices. The plan correctly emphasizes that cheap and abundant energy is a thing of the past. One of its most important messages is that, even if the United States could afford to import unlimited amounts of oil indefinitely, unlimited supplies of oil simply do not exist anywhere in the world. The Plan accurately perceives this in its basic supply goal, which is to begin to shift the country away from a near-total reliance on oil and natural gas toward the use of energy supplies whose resource bases have a potential for growth. The goals of the Plan that are designed to force that change—reducing the rate of growth in energy demand to 2 percent a year, reducing consumption of oil and natural gas and the level of oil imports, reducing energy waste, and increasing the application of new technologies for providing energy from other sources including coal, nuclear power, and the sun-are properly focused.

The levels of supply projected by the Wan represent the upper limits of capacity and supplies of all fuels are likely to fall below the Plan's goals.—There is little, if any, margin of error in the production schedules of the National Energy Plan. There is no room for delay in opening new coal mines, exploring for new oil and natural gas resources-particularly in the frontier areas such as Alaska and the Outer Continental Shelf—and putting nuclear powerplants into operation. Considering the past 7 years of performance in developing new energy supplies, it is unlikely that all elements of the Plan will fall into place precisely on schedule. The probable causes of delay are different for each source of energy. In oil and gas production, delays are most likely to occur because of laws and regulations that may postpone access to frontier areas for exploration and development, particularly on the Outer Continental Shelf. Ad-

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ditional coal-production facilities will be constructed by the coal industry only if new markets for coal are assured. This may require some short-term tradeoffs between environmental objectives, since the new boilers and pollution-control devices may not be available for the rapid conversion of plants to coal use. Moreover, manpower and capital shortages could delay the opening of new underground coal mines, and transportation bottlenecks could prevent coal from being delivered where it can be used, particularly in the East. If such delays occur, production of oil could fall short of the Plan's goals by as much as 1.0 to 1.5 million barrels per day. Production of natural gas may also fall below the goals by the equivalent of up to 1.0 to 1.5 million barrels of oil per day. Coal production could fall short of the goals by as much as 200 million tons per year (2.4 million barrels per day equivalent). Nuclear powerplants could produce up to 15-percent less energy (0.6 million barrels per day equivalent) than the Plan anticipates.

The Plan contains no contingency plans for stimulating production of energy or further reducing consumption in the event of slippage in one or more sources.—The incentives proposed by the National Energy Plan concentrate more on switching demand than on encouraging higher rates of production. The higher prices proposed for new oil and natural gas are expected to encourage accelerated exploration for those resources, at least in the near future. The Plan's proposals for creating new markets for coal should provide the industry with incentives to increase production. However, as noted above, the Plan's supply objectives can be achieved only if all fuels are produced at the rate assumed in the Plan. The linkage between supply and demand is particularly crucial in coal production. The Plan provides no direct incentives for new coal production but relies entirely on creating higher demand. If, for example, it appeared 5 years from now that oil production would not reach the Plan's goals, the only options would be to increase coal production or buy more oil on the world market, since there is virtually no chance that increased production of natural gas or nuclear power could take up the slack. The Plan should be more explicit about which of these options would best make up for insufficient domestic oil production and what other alternatives might be offered to make up for shortages.

The Plan fails to acknowledge that there will be inevitable conflicts between environmental protection and increased energy production and use. It should face that possibility squarely and propose mechanisms for resolving the conflicts.—If energy production falls short of the Plan's forecasts, it is more likely to be caused by environmental and regulatory conflicts than by lack of available resources, capital, or manpower. For example, more than one-third of the oil and gas which the Plan anticipates will be produced domestically in 1985 still has not been discovered. A large share of new resources probably will come from the frontier areas, Alaska and the Outer Continental Shelf. But environmental objections and proposed new OCS laws could delay new production long enough to cause new supplies to fall short of the Plan's goals.

The Plan also may assume too much in its implied schedule for additional nuclear generating capacity. Accelerating the licensing process for new powerplants, as the Plan proposes, deals with only one factor in a process which now makes the lead time for nuclear powerplants as long as 12 years. Other factors include environmental issues, and the questions of public acceptance of accelerated nuclear plant construction and of State authority to grant or deny permits for building and operating nuclear plants,

Finally, the Plan leaves open the question of potential conflicts between air quality and a virtual doubling of the use of coal as an energy source. The Plan is designed to encourage greater use of high-sulfur Eastern coal by requiring "best available" control technology for al l new coal-fired powerplants, whether they burn Eastern coal or lower-sulfur Western coal. What the Plan does not say is that control equipment also would be required on many, if not most, new coal-burning industrial boilers, most of which are likely to be built near urban areas where air pollution already exceeds Federal standards. Delays in converting powerplants and industrial boilers from oil or gas to coal that result from the requirement for pollution control could, in turn, reduce demand and retard the increased production of coal which the Plan ant ic i pates. Delays in coal production would prolong the period during which the United States depends for more than 60 percent of its energy on oil and natural gas.

The pricing policies in the Plan may require revision in a few years to avoid distortions in both supply and demand.—The Plan projects growth in all domestic energy production. Without discoveries of new oil fields, production could decline from today's levels by as much as 25 percent; the production of gas could decline by 45 percent. To achieve the Plan's production goals, oil and gas discovery rates must at least double the industry's finding experience over the past 15 years. This optimistic goal can be justified largely by the fact that there are still areas of Alaska and the Outer Continental Shelf which have the necessary reserve potential. The higher prices proposed for new oil and gas should encourage continued exploration, but the Plan does not clearly establish that the proposed oil and gas pricing policy will provide the necessary funds to achieve its projected oil and gas production rates. Rather, the question is approached as a judgment which, in the beginning, may be acceptable. It may be necessary to reopen the question and make adjustments if discoveries and, in turn, production fall below the Plan's goals.

The Plan does move toward correcting energy price imbalances which it says have contributed to the current energy crisis by encouraging the overuse of scarce fuels, in particular natural gas. The proposal to raise the delivered cost of petroleum to U.S. consumers to world price levels in 3 years is a positive step in that direction. However, the Plan could prolong the distortion of consumer choices among available fuels by holding natural gas prices below those of alternative energy sources. The "new gas" price ceiling would be made equivalent, on a Btu basis, to the average price of all domestic crude oil which is lower than the ceiling price for "new oil". Furthermore, the transportation and refining costs of crude oil are ignored, as is the intrinsic value of natural gas as a premium fuel. Thus, even at the new price, gas is substantially cheaper than competitive fuels. Natural gas will *re*main a first choice among available fuels as

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long as it is even slightly below the price of other fuels. The long-range impact of this continued disparity in the pricing of natural gas should be addressed by the Plan.

The Plan's goal of accelerating development of solar energy is commendable, but its specific proposals are silent on serious impediments to expanded use of solar equipment.— In order to achieve the Plan's goal of installing solar energy equipment in 2.5 million homes by *1985,* sales must increase at a rate of about 75 percent each year. Considering the number of institutional barriers to wider use of solar energy units, that growth rate may be too optimistic. The Plan does not address these barriers, which include a lack of national performance standards for solar equipment that could protect consumers against flawed systems. The Plan contains no guidelines for local governments which must approve solar equipment under their building codes. It contains no direct incentives for manufacturers to expand facilities and promote sales of solar devices.

The Plan is silent on post-1985 energy development: specifically, it does not relate short-term plans to long-term energy demands and supply patterns.— The appropriate focus of the National Energy Plan is on the period between now and 1985 because actions are urgently needed during that time to adjust the patterns of U.S. energy demand and supply to try to avoid intense world competition over scarce oil supplies. If the Plan is implemented, the U.S. energy base will be different in 1985 **than it** is now. But the Plan is silent on the question of whether the new U.S. energy base will provide a strong foundation for developing new energy technologies and resources after 1985.

For example, if the Plan's petroleum goals are met, the United States will still depend on oil and natural gas for about 60 percent of its energy supplies in 1985. Domestic oil and gas production, which will represent about 42 percent of total supply in 1985, **almost certainly will continue to decline after 1985. Despite these trends, the Plan does not address the question of U.S. policies between now and 1985 that are needed to prepare the country to deal with a continuing decline in domestic oil and gas production. The Plan should address the possibility of directing capital to programs to accelerate development of synthetic liquids and gases that can replace oil products and natural gas after 1985.**

By 1985, direct burning of coal will provide 29 percent of U.S. energy if the Plan's goals are met, compared with 19 percent in 1976. Is this growth trend expected to continue after 1985? If so, the Plan should address that. Achievement of the Plan's goals by 1985 will require huge investments of capital, large manpower training programs, and extensive research and development, particularly on clean-burning technologies for coal. The Plan is silent on the question of whether similar requirements of capital, manpower, and research for the period beyond 1985 can be superimposed on the short-term requirements without straining the U.S. economy.

The President has proposed to cancel construction of a breeder reactor, partly in an effort to lead the world away from a plutonium energy economy. The decision apparently assumes ample supplies of uranium for at least until the year 2000. If the assumption about uranium supplies is wrong, however, the United States either will be left with a stock of light water reactors in the 1980's for which there is not enough fuel or reactors will never be built because of uncertainties about uranium supplies. In either case, energy supplies in the years after 1985 will be seriously affected.

Oil and Gas Introduction

The share of total U.S. energy resources supplied by oil and natural gas together would drop under the National Energy Plan from about 75 percent to about 60 percent in 1985. Even though coal is expected to be the single most important fuel domestically produced, oil and gas will be a vital element in the national energy pattern for decades to come, and petroleum will remain the sole source of fuel for most transportation.

It is the goal of the Plan to increase domestic oil and gas production, reversing a 7-year downward trend. To meet these production goals, discoveries of new oil must occur at two to three times the annual rate of discovery since 1965. Discoveries of new gas also must exceed the industry's finding experiences since 1965.

As much as one-third of the domestic production of oil on which the Plan counts to meet the overall goals must come from reserves that have yet to be discovered. If the U.S. oil industry falls 50 percent short of the higher new discovery rate that is implicit in the Plan, domestic oil production can be as much as 1.S million barrels per day below the Plan's goal in 1985. Production of natural gas would be short of the goals by about the like amount in barrels of oil equivalent.

The ability of the industry to meet, or approach the plan's goals, depends on whether:

. leases can be made available to industry fast enough for exploration and development on the Outer Continental Shelf, in Alaska, or in other frontier areas under Federal management;

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- the anticipated quantities of oil and natural gas actually exist in areas which geological evidence suggests are the prime targets for exploration.
- enough new oil and gas can be discovered to support a total incremental production of up to **6 million barrels a** day in crude oil equivalent in 1985.
- **the pricing proposals** in the National Energy Plan would provide sufficient investment funds for oil and gas companies to explore and develop new resources.

Given these uncertainties, it seems likely that oil production will fall short of the Plan's goals by as much as 1 million and 1.5 million barrels a day in 1985 and that natural gas production will fall short by a like amount in barrels of oil equivalent.

Higher prices for "new" oil and gas are likely to encourage the incentive and capital that industry needs to explore and develop new areas, at least during the next several years, However, the uncertainties dictate a continuing review of these price policies. In addition, it is not clear how proposed amendments to the Outer Continental Shelf Lands Act of 1953 will affect the pace of offshore exploration and development. As of mid-June 1977, industry analysts believed the proposals could add 18 months to 4 years to the existing lead times of 4 to 6 years for offshore production. An Office of Technology Assessment evaluation of the proposed amendments, conducted independently of the energy plan analysis, concluded that the amendments could reduce some of the delays that now exist and the overall delay introduced by the amendments could be minor.

While these analyses illustrate the range of uncertainty which exists, it is important to recognize that the energy plan depends on a significant portion of new OCS production to meet its goals. Delays in the OCS development will create shortfalls.

Because of these uncertainties, contingency plans should be included in any national energy plan which would go into effect if oil and natural gas production falls short of the Plan's goals. Alternative pricing policies, more rapid expansion of coal production, higher import levels, and further reductions in energy demand may be considered, Nuclear power is not an alternative because production of electricity by nuclear plants probably cannot be increased beyond the 1985 goal.

Issue 1

Oil and Gas Production

Can domestic oil and natural gas production be increased fast enough to meet the goals set by the National Energy Plan?

Summary

The estimated base of undiscovered resources is large and could support not only the 1985 **levels of production envisioned in the Plan but a substantial** flow of petroleum after that. But the rate of discovery and development may not occur fast enough in the next few years to reverse the present decline in production. Industry can add to petroleum reserves only if it has systematic access to unexplored areas. In order to match production with the Plan's goals, the schedule for leasing in frontier areas must be accelerated. Because of lead times of up to **6** years between exploration and production, discoveries of new oil and gas must be made in the next **2** to 4 years in order to produce the **3** million barrels per day of new oil, and equivalent of new gas from new discoveries that the Plan requires to meet its 1985 goals.

Questions

1. At what rate must reserves be added to reach the Plan's goals?
2. Which areas are most likely to yield important amounts of new oil and natural gas ?
3. Can geopressurized gas reserves, Devonian shale deposits, or other new sources provide significant amounts of new natural gas within the time covered by the National Energy Plan?

Background

There is no serious question as to whether resources are available to meet the goals of the **National Energy Plan. There is, however, a serious question about** whether new oil and gas can be discovered early enough to reverse the trend in domestic production which is a key element of the plan. The following table shows the range of "best estimates" of ultimate renewable resources.

	Oil (including NGL) Billions Bbls.	Gas Trillion CF
production in 1976	3	19
Cumulative production through 1975	126	497
– Proved reserves, end 1975	39	228
– Estimated probable additions to known fields	30–60	60-1 00
Total remaining known fields	69–99	288–328
Undiscovered fields	72–1 28	400–800
Total estimate remaining	141 –227	688–1 128

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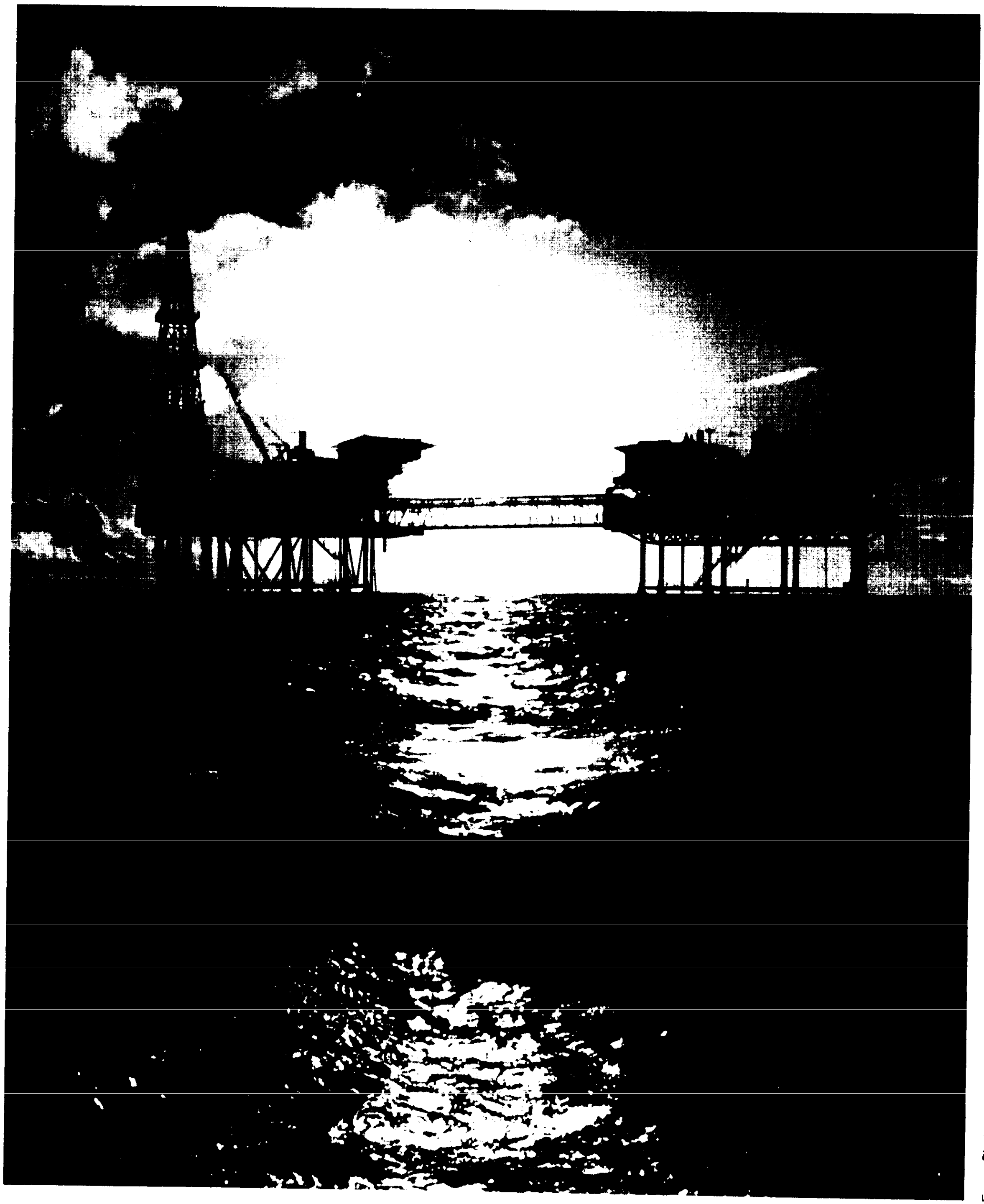

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U.S. Oil and Gas Production
(Million barrels per day oil equivalent)

Production	From Existing Fields		From All Fields Plan Goals	New Field Requirements
	1976	1985	1985	1985
Oil	9.7	7–7.5	10.6	3.6–3.1
Gas	9.5	5–5.5	8.8	3.8–3.3

Although geologists differ in their assesss-ment of the amount and location of new resources, the prime targets are the offshore areas of the Atlantic and Pacific coasts and offshore areas in Alaska. Exploration continues on the Alaska North Slope as well as in the lower 48 States and the Gulf of Mexico.

These reserves, if confirmed, appear sufficient to support the present rate of production well past 1985. For the near future, the possibility that production will fall short of the Plan's goals involves a conflict between leasing schedules and lead times for production. As shown in the table above, oil production from existing fields containing the known reserves will drop significantly by 1985.

This means that enough new reserves must be discovered and developed in the Plan period to make up the difference between production from known reserves and the Plan's production goals.

Given overall lead times of 4 to 6 years or more between the beginning of exploration and actual production, at least two-thirds of the above deficiency (about 2.5 million barrels a day) would come from new discoveries made during the period of the Plan. However, it is probable that by 1990 more than so percent of all crude oil and gas production will depend on the success of exploration between now and 1985. Under these circumstances, the performance of the supply sectors of the oil and gas industry throughout the period of the Plan is of critical importance to the goals of the Plan, and of even greater significance to U.S. total energy supply in the years immediately thereafter,

The rate of discovery of new reserves of oil and gas during the period of the Plan must be two to three times the rate of discovery between 1965 and 1975. This would be an optimum performance and the expectation that it can be done is justified largely by the fact that there are still unexplored areas of Alaska and the Outer Continental Shelf which are judged to have the necessary reserve potential.

Federal policies are crucial to accelerated exploration because many of the potential areas for new oil and gas reserves are public lands, either along the Outer Continental Shelf or in Alaska. At present, there is a moratorium on leasing some public lands. Amendments have been proposed to the Outer Continental Shelf Lands Act of 1953 which could significantly add to lead times for offshore drilling and development. Another proposal could extend the lead

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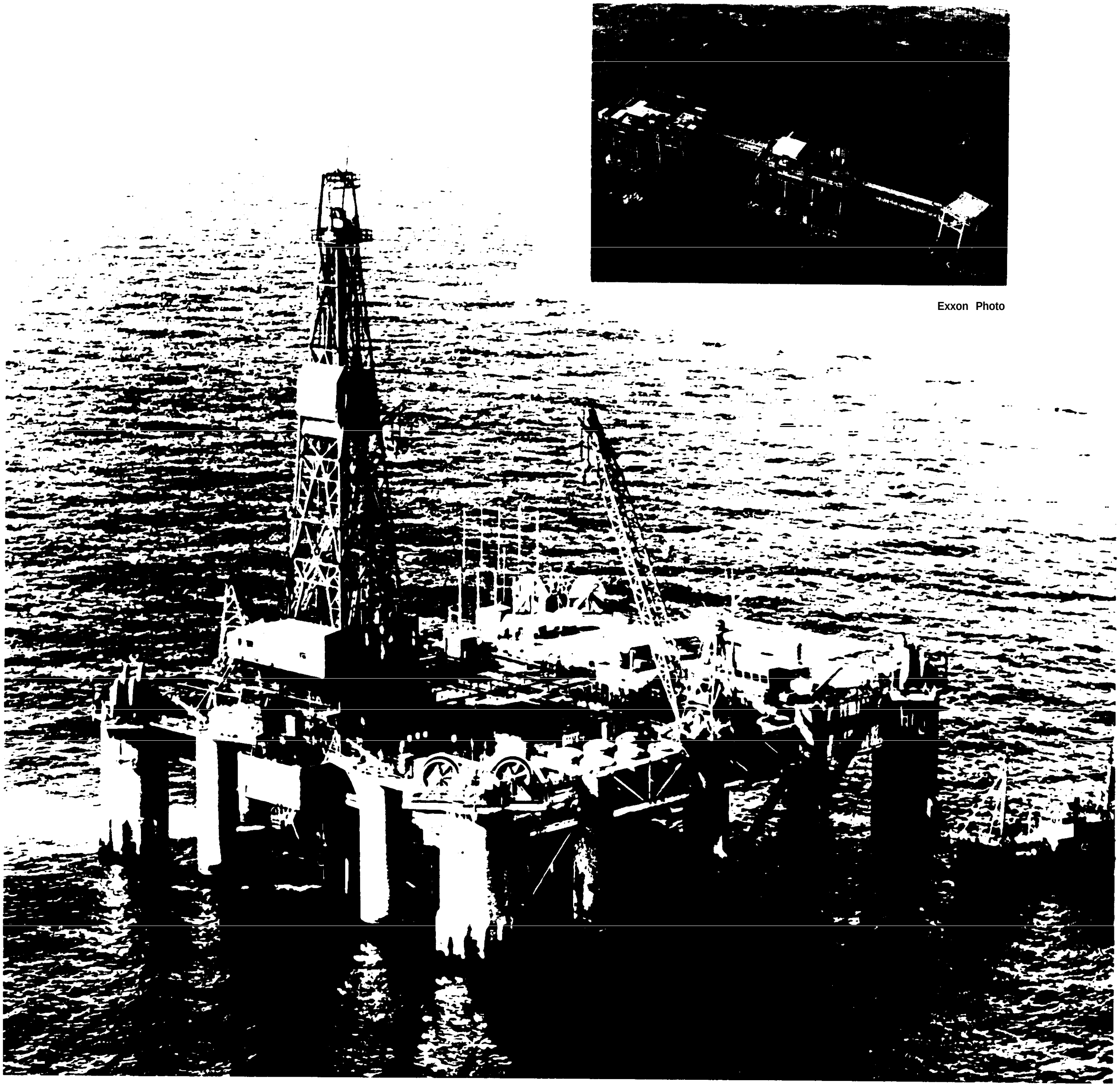

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times further by requiring federally sponsored exploration of at least one structure in any proposed leasing area before bids actually are solicited. Delays of several years could result from these proposals. Another proposal would require a pause between exploration and development for preparation of an environmental impact statement of the effects of development on coastal areas. It can be argued that new environmental and leasing policies would lead to better cooperation between coastal States and the Federal Government and, in turn, to shorter lead times than now exist.

Another uncertainty involves the actual location of new resources. Oil company geologists differ sharply among themselves and with Federal geologists over the location of new resources. Some estimates show the bulk of new resources lying offshore. Others assume that most new oil will be found on land. Until promising areas actually are explored, the United States cannot put together a reliable inventory of its actual oil and natural gas resources.

Tertiary or enhanced oil-recovery techniques could add between 0.5 million and 1.0 million barrels per day to domestic production by 1985. However, these are the most optimistic ranges for tertiary production and they depend on the price of oil and on perfecting equipment and techniques that today are still in the testing stage.

Technical and feasibility studies hold out little hope that major projects to produce natural gas from Western tight sands, Devonian shale, and geopressurized gas in deep water reservoirs will be significant by 1985. Many technological and environmental problems must be solved before these resources can be widely exploited.

Issue 2

Oil and Gas Pricing

The Plan's oil and natural gas price policies may encourage enough exploration and development in the next few years but some mechanism should be included for changing price policies if changes are needed in the long term.

Summary

Increasing supplies of domestic oil and gas are important to the U.S. economy and essential to the success of the National Energy Plan. In an uncontrolled market, there does not seem to be any doubt that steadily rising world prices would ensure that oil and gas companies could generate the capital they needed to develop enough new resources to meet the Plan's 1985 production goals. The same levels of exploration and development are just as likely to occur under the Plan's proposed price for new oil, at least during the first few years. But it is impossible to tell at this time whether the Plan's price policies will support expanded industry activity indefinitely and there is no provision for monitoring the industry's capital position to ensure that incentives and capital remain at high enough levels throughout the life of the Plan. Uncertainty about the future investment climate can be cured by decontrolling oil and gas

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prices or by including in the Plan a procedure that will ensure that future pricing policies will support an adequate exploration and development effort.

Questions

1. Are the Plan's oil and gas pricing provisions consistent with its stated goal of stimulating "best efforts" to develop new supplies of oil and natural gas?
2. Will these policies, in fact, lead to development of the volumes of oil and gas which are entered as goals in the Plan !
3. Would alternatives to the Plan's pricing and taxing policies provide more assurance that the goals can be met?

Background

Under the Plan, increased supplies of domestic oil and gas would, in effect, cover a retreat from the near-total reliance on both of these fuels for energy in the United States. If domestic supplies do not rise to about the levels anticipated by the Plan in 1985, the United States would be forced to increase oil imports or reduce oil and gas demand through more stringent conservation measures.

The price and tax provisions in the Plan would increase incentives for new oil and gas production and for tertiary oil recovery. These are offset to some extent by continued price controls on all oil and by new price controls on intrastate gas. The crucial question is not whether incentives are increased but whether they are increased enough to stimulate production of about 6 million barrels a day of new oil and gas equivalent on which the Plan relies heavily to achieve its goal of reducing imports to 6 million or 7 million barrels a day in 1985.

The answer seems to be yes, at least during the next few years, It is not possible to judge at this point whether the Plan's pricing policies will sustain an indefinite flow of capital adequate for the required exploration and development, For that reason, it seems prudent to devise some procedure as part of the Plan ensuring that the pricing policy will support an adequate exploration and development effort.

The Plan does not treat oil and natural gas consistently. Controls would hold the return to producers of oil below the world market price although it does contemplate a world price for consumers through adjustments in the crude oil equalization tax. Under the Plan, natural gas would be sold to households below world energy prices indefinitely.

One aspect of the Plan's oil pricing policy that deserves closer study is the proposal that the sales price for producers be adjusted annually to account for general inflation in the United States. The Plan proposes to use the gross national product (GNP) deflator as the basis for annual adjustment, which probably will mean that the return to producers will not keep up with real costs. Costs of production have risen much more sharply than general costs since the early 1970's—in the range of 12 to 30 percent. The Plan does not explain why the GNP deflator was chosen as the basis for adjustments rather than the actual cost experience of the industry.

The Plan does recognize that costs may rise in production of old oil and that even adjustments for inflation in the $5.25 price of old oil may not provide incentive to keep oil flowing from old wells. Its requirement for a "case-by-case" adjustment in the price of oil from old wells may be difficult to administer fairly and raises the question as to whether some production may be lost because of delays in responding to requests for adjustments.

The Plan's treatment of natural gas prices raises even more serious long-term questions. Under the formula proposed by the Plan, new natural gas would be sold at a price based on the Btu equivalence of the weighted average cost to refiners of all domestic crude oil. This would be about $1.75 per thousand cubic feet (Mcf) at the end of 1977. Flowing gas that is put on the market when existing contracts expire would be priced at $1.42 per thousand cubic feet. Finally, the new and renegotiated intrastate gas would be set at the same levels as interstate gas.

The end result of the Plan's approach to natural gas is to peg its price indefinitely at levels lower than the price of other competing fuels on a Btu-equivalent basis. The only exceptions would be for gas sold to industry and utilities who would pay penalty taxes for continuing to use gas. This continues a distortion among the price levels for competing fuels which is a major factor in shortages of natural gas that have occurred in recent years. At the same time, it must be noted that the higher prices allowed for natural gas under the Plan should encourage new exploration and development in the near term.

For both oil and gas, the price incentives are limited to "new" properties, defined as locations 2.5 miles away from, or 1,000 feet deeper than, existing wells. This definition is not related to the geologic definition of "new" wells and could discourage development of the inferred reserve base,

One alternative to the Plan's proposal for continued controls combined with a crude oil equalization tax is decontrol, including a plowback provision with a tax on excess or "windfall" profits from existing wells. It might remove uncertainties about future changes in pricing policies that might be made by policymakers with different philosophies, a possibility that makes it difficult for today's investors to assess future market conditions. The past history of major changes in directions that make producers and investors wary of controls includes rollbacks on upper-tier oil prices, loss of depletion allowances for large independents, loss of tax credits for intangible drilling costs for independents, and changing administrative definitions and rules that have a major influence on returns from investments. Decontrol would also largely eliminate the significant cost and effort in the Government and industry required to administer the complex system of regulations inherent in the Plan.

Issue 3
Liquefied Natural Gas

Should the Plan encourage a flexible import policy for liquefied natural gas?

Summary

Any shortfalls in the domestic production of oil' and gas will have to be made up by imported energy sources. One of the most immediately available and least capital-intensive sources of supplemental gas supply is liquefied natural gas (LNG). Import restrictions on fuels such as LNG may diminish the diversity of energy sources that LNG imports help make possible. Decisions to impose restrictions for reasons of national economy or foreign policy should be weighed against the desirability of maximum diversity of energy sources.

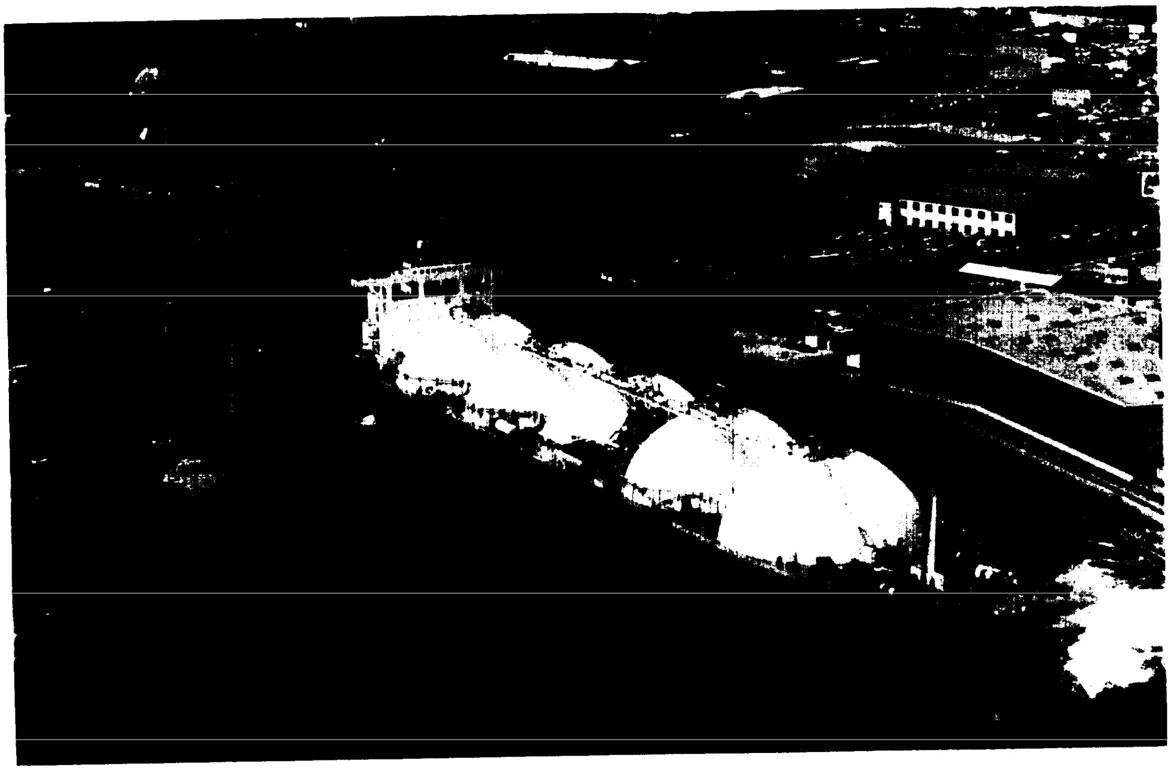
Questions

1. **Can** LNG imports make a critical difference in the event of a serious shortfall in U.S. domestic energy supplies?
2 What import policies might reconcile the need for LNG imports with the need to implement national economy and foreign policy objectives ?

Background

Large reserves of natural gas exist in several producer countries, including Algeria, Indonesia, Iran, Libya, Nigeria, and Abu Dhabi. Imports would come primarily from Algeria and, to a lesser extent, from Iran. Both countries have applications pending or approved by the Federal Power Commission (FPC), and can be expected to dominate the LNG market because they have very high ratios of gas to oil in their reserves.

Based on projects announced to date, and those now in place and under construction, LNG imports could provide nearly 1 trillion cubic feet annually by 1980 and almost 2 trillion cubic feet annually by 1985. This is about 10 percent of projected domestic gas production in 1985. The long lead times inherent in licensing and plant and tanker construction preclude significant additions above these estimates before 1985.



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Issue 4

Synthetic Natural Gas

Are synthetic natural gas (SNG) plants both practical and desirable as sources of supplemental fuel?

Summary

The manufacture of synthetic natural gas from naphtha or other petroleum feedstocks has several advantages for alleviating short-term gas shortages. The conversion process is more efficient than that used to make gas from coal, and plants are flexible and inexpensive to operate. The primary objections to SNG have been that it simply switches from one scarce fuel to another and its possible impact on supplies and prices of naphtha and other petroleum feedstocks. SNG plants, however, account for a small percentage of naphtha used in the United States, and both naphtha and other feedstocks should be available on the world market in the immediate future. All these feedstocks are easier to import than natural gas. Revision of present Federal Energy Administration (FEA) restrictions may encourage construction of SNG facilities and assure adequate feedstock for them. While SNG is expensive, it is competitive with other fuel supplements.

Questions

1. What impact will development of additional SNG facilities have on availability and price of naphtha and other feedstocks ?

2. What contribution can SNG make in alleviation of shortfalls?

Background

Synthetic natural gas facilities using petroleum feedstocks primarily provide peak-storage capabilities for gas utilities with no underground storage capacity. As domestic natural gas supplies have declined, some SNG facilities have been built to provide base-load, year-round service. While SNG is an expensive fuel supplement, it is competitive with other supplemental fuels in residential and some industrial markets.

In 1976, 13 SNG plants produced nearly 0.3 trillion cubic feet of gas. This production consumed only 0.5 percent of total U.S. naphtha supplies. Still, on a regional basis, the price pressure on naphtha, with petrochemical demand included, could become occasionally severe. Nearly 0.16 trillion cubic feet of additional SNG, a 58 percent increase over 1976, could be produced in 1977 if additional use of petroleum feedstocks were permitted, Because of past FEA restrictions, an additional 11 plants with a capacity of more than 0.6 trillion cubic feet of gas per year have been suspended or cancelled.

Naphtha and other feedstocks are now and should continue to be available on the world market in the immediate future, Increased imports of naphtha would help diversify the U.S. petroleum import picture. Notwithstanding the possible availability of feedstocks, synthetic natural gas is not expected to be a significant supplement to our natural gas supply in 1985.

Coal
Introduction

The United States has more control over the production of coal during the next decade than it has over any other energy resource. Unlike oil and natural gas, known coal reserves can meet the production targets of the National Energy Plan without any new discoveries. Lead times for opening new mines and building new transportation systems are short enough that production could, in theory, exceed the goals of the Plan, unlike those for nuclear power and offshore oil development.

According to the Plan's calculations, coal production will increase by about 400 million tons by 1985, even without changes in Federal policy. The National Energy Plan proposes to raise 1985 production by another 200 million tons for a total supply of 1,265 million tons, a 90 percent increase over 1976 production.

The Plan assumes that the higher production rate will be achieved by creating new markets for coal and by lifting restraints on demand, not through any direct incentives to stimulate coal production. It further assumes that the expanded market will result in large part from the Plan's tax and regulatory policies, which are designed to discourage the use of oil and natural gas by industry and utilities and encourage a shift to coal.

Several alternative outcomes are possible under the Plan's coal proposals:

1. production may fall below the 1985 goals because a requirement for installing best available pollution-control technology on all new coal-burning facilities may result in a smaller market for coal.
2. Boiler manufacturers may not be able to produce new coal-burning equipment fast enough to justify an accelerated coal production schedule.
3. Production could fall short of the Plan's goals if strip mining legislation forecloses development of large reserves in the West where leases already have been signed and long-range mining plans have been completed.
4. The Plan's proposal to emphasize Eastern coal production rather than Western coal production could result in capital, manpower, and transportation shortages.

Four other general conclusions result from analysis of the Plan's coal proposals:

1. Mining equipment will not be a constraint at coal production levels either with the Plan or without the Plan.
2. The penalty taxes and regulations designed to force conversion of industries and utilities from oil and gas to coal will expand demand, and, in turn, production of coal up to a point. If not offset by uncertainties noted above involving pollution controls and boilers, this point will probably be close to the goals of the Plan.

3. Transportation should not be a barrier to increased coal supplies except for some regions in the East where roadbeds must be rehabilitated,

4. No single constraint will be a major limiting factor in achieving the Plan's coal production goals. Capital, manpower, access to reserves, transportation, and rising demand all will be necessary in the right combination to reach the goal. A lapse in any of these areas could cause production to fall short.

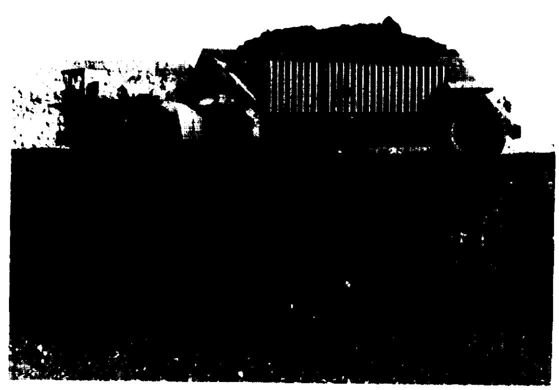
Issue 5

Coal Production and Demand

Are the provisions in the Plan sufficient to achieve the goals for production and consumption of coal?

Summary

The Plan contains no direct stimulus for higher coal production. It assumes that a complex set of related elements will converge to create a market for 1,265 million tons of coal in 1985. (The Plan assumes exports of about 90 million tons of metallurgical coal, leaving 1,175 million tons for domestic use in 1985.) Hundreds of industries and utilities must reactivate coal-burning facilities or buy new equipment before the demand for coal will expand. High costs of equipment or an inability of manufacturers of boilers and pollution-control equipment to fill orders fast enough could retard the growth in demand for coal, The Plan contains no fall back measures for dealing with these possibilities.



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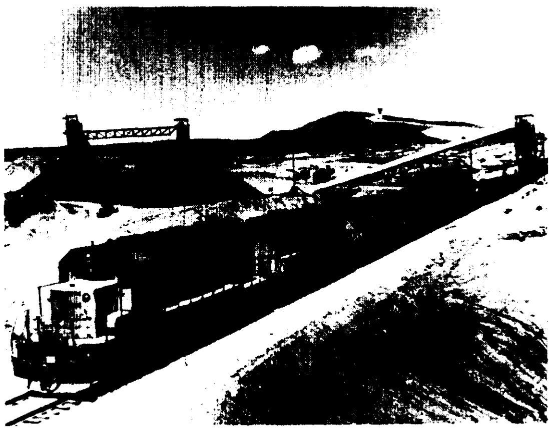
Background

Several conditions must be met before the market for coal will expand as fast as the Plan expects it will. Utilities and factories must buy far more pollution-control equipment than they ever have in the past. Coal costs must remain competitive with other fuels. Potential coal users must be assured that railroads, barges, or coal slurry pipelines can handle increased shipments and that adequate and reliable supplies will be available.

The cost of converting boilers and powerplants from oil or natural gas to coal will be high. Large industrial boilers, for example, would probably need pollution-control equipment averaging $4 million per installation. One major utility has estimated that it will cost about $4 billion to convert its 6,000 megawatts of generating capacity to coal. The question of whether these costs are *lower* than the penalty costs of continuing to burn oil or natural gas that would be imposed by the Plan must be decided case-by-case.

One potentially serious barrier to increased demand is the production of large industrial coal-fired boilers. About a dozen boiler manufacturers now produce about 200 large boilers— capable of generating between 250,000 and 300,000 pounds of steam per hour— each year. Another group of manufacturers could expand their operations to produce another 200 boilers of that size per year. However, in order to use the additional amounts of coal that the Plan assumes will be used by industry, at least 2,500 new coal-fired boilers must be manufactured by 1985 to replace existing boilers. The increased production capacity must be made available very soon to meet this goal. In the present market, coal-fired boilers are three times as expensive as oil-fired boilers.

If demand falters, whether because of cost or because manufacturers cannot fill orders for new equipment from utilities and factories, production will fall short of the Plan's 1985 goals.



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Issue 6

Accelerated Eastern Coal Production

The National Energy Plan does not take fully into account the capital, manpower, and transportation consequences of its proposal to accelerate Eastern coal production.

Summary

Long-range plans of the coal industry call for mining about two-thirds of U.S. coal in the East in 1985 and about one-third in the West. The National Energy Plan proposes to reduce the Western share of total production and increase the share that will come from Eastern mines. Such a shift would mean higher capital requirements, more intensive manpower recruiting and training, and rehabilitation of Eastern railroads. These changes are not addressed in the Plan.

Background

Most forecasts assume that capital will be available to open new mines in the East-West pattern reflected in industry plans that were drawn before the Administration presented its policy proposals. Those plans assumed a trebling of the coal industry's rate of investment during the past decade. The forecasts also assume adequate manpower and a transportation network that can accommodate increased coal shipments.

The assumptions may not be valid under the National Energy Plan. One premise of the Plan is that, "Coal production and development is most economical when it is near major markets., Although coal production will expand in many areas, there should be large increases in the highly populated Eastern and Midwest regions, where coal use in industry and utilities could grow considerably in the future. " The Plan also states that its requirements for best available pollution-control technology on all plants, regardless of whether they burn low-sulfur Western coal or high-sulfur Eastern coal, "should stimulate even greater use of . . . Midwestern and Eastern coals, "

Such a shift in regional emphasis could cause capital problems. Many Western coal reserves are owned by conglomerates with relatively easy access to capital. If there is a major shift to Eastern mines, more of the development would be undertaken by smaller companies that might find it more difficult to raise money than Western companies. Transportation investments also probably would be higher if Eastern production is increased substantially. In general, more miles of Eastern roadbed would require upgrading for carrying more shipments of coal than is the case with Western railroads.

Manpower requirements would change if the United States placed more reliance on Eastern mines and less on Western mines. Productivity is higher in Western surface mines than in Eastern surface mines and is substantially higher than productivity in Eastern underground mines. Under the coal industry's present long-range plans, 80,000 new underground miners and 45,000 new surface miners must be hired and trained by 1985, Manpower requirements will increase if more coal comes from underground mines. Underground Eastern mines average about 9 tons of coal per man. Western surface mines produce about 100 tons per man. Given this ratio, it takes more than 10 times as many man-days to produce 1 million tons of coal in an underground Eastern mine as it does in a Western surface mine. Another potentially serious manpower problem involves foremen. Federal law requires that each underground crew be led by a foreman with at least 2 years of experience in underground mining. Because miners must give up their union benefits for relatively small increases in pay to become foremen, there is a chronic shortage of crewleaders in Eastern underground mines.

Issue 7

Coal Mining Research and Development

Mechanization of the coal industry with existing technology has reached a point where further increases in productivity are not likely but the plan makes no specific recommendations for assigning a high priority to mining research and development.

Summary

Productivity of underground miners reached a peak of 16 tons per man-day during 1969 and has since declined to a 1976 average of 9 tons per man-day. The downturn in 1969 ended a 20-year pattern of growth resulting from expanded mechanization of mines and reflected, among other things, the beginning of enforcement of the Mine Health and Safety Act of 1969. Underground mining is now so thoroughly mechanized with existing technology that there seems to be no hope of reversing current productivity trends unless a new generation of equipment is deployed.

One example of industry needs is a system to speedup the removal of coal from a mine face. Continuous mining machines are capable of producing coal 10 times faster than existing equipment can move it from the mine. New equipment also is needed to increase the amount of coal that

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can be mined by remote control to reduce the amount of time that now is spent bolting mine roofs. Finally, no equipment exists for mining underground coal in the West where seams run 30- to 70-feet thick, compared with an average thickness of 6 feet in the East.

Because of the importance the Plan assigns to meeting its 1985 production goals, it should designate specific mining research and assign priorities for programs that are most likely to help increase production in the relatively near term.

Issue 8

Accelerated Production of Synthetic Gas From Coal

The Plan's proposal to let market forces determine future development of plants for manufacturing pipeline-quality gas from coal should be reexamined, particularly in light of the potential barriers to expanded direct-burning systems.

Summary

The Plan does not assign a high priority to producing pipeline-quality gas from coal with existing technology. The Plan's apparent willingness to postpone significant expansion of a synthetic gas industry until new technology is available overlooks the fact that inflation probably will more than offset any cost advantages of new technology that will not be commercially feasible for 15 years or more,

Questions

1. **Why wait for the development of new technology when gas can be produced in quantity with existing technology at a** price below that of gas produced by new technology several years from now ?
2. Why does the Plan not consider loan guarantees and other means of accelerating commercial coal gasification projects, some of which could be in production on short notice?

Background

The National Energy Plan states that, "The basic Federal role in this process [conversion of coal to pipeline-quality gas] is research, development, and demonstration of new technologies. In general, the Government seeks to avoid subsidization of existing technologies. "

The gasifier represents only about 15 to 20 percent of the capital investment for a gasification plant. That being the case, any new technology probably cannot reduce the price of synthetic gas by more than 50 cents per thousand cubic feet (Mcf). Increases in the price of natural gas in 1 year probably will offset that cost advantage of new technology and there is no sign that the new technology can be available on a commercial scale in 10 to 15 years.

Possible Government incentives for production of pipeline-quality gas with existing equipment include loan guarantees, long-term Government contracts for purchasing synthetic gas, and direct subsidies.

Nuclear
Introduction

The Plan forecasts 3.8 million barrels per day equivalent energy from nuclear powerplants by 1985, compared with 3.7 million without the Plan. This corresponds to the 141,000 megawatts of generating capacity that is now operating or under construction, with a 65-percent capacity factor. It is quite feasible for industry to install this much capacity because the period from the start of construction to online operation need not exceed 7 years. Production capability is adequate for all components, and uranium ore and enrichment demands are well within present capacity projections. A continuation of financial pressures on utilities, regulatory changes during construction, and uncertainties about growth projections could force some slippage in this schedule, however, and reduce the available output, The 65-percent capacity factor also is attainable but assumes an increase from past experience which averages about 60 percent (possibly less for the large reactors similar to those now coming on line). If either of these factors fail to meet expectations, a shortfall of as much as 15 percent (0.6 million barrels per day equivalent) could occur.

The source of the increased nuclear power generation which is assumed by the Plan is not directly identified. There are references to an enhanced inspection program which could contribute to increased reliability (or to more down time depending on the intent and implementation of the program and the condition of facilities inspected). In addition, the entire licensing process is to be studied to resolve unsatisfactory aspects, but no information is

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given on how this study is to be conducted, or how its recommendations might change the situation, except for a reference to reducing individual licensing requirements for standardized plants.

The midterm future of the industry is in considerably more doubt than is its realization of the 1985 goals. A de facto moratorium on new orders by utilities shows no sign of ending. The chief reason for the lack of orders is the financial risk to which a utility exposes itself when it orders a nuclear plant. Capital costs and licensing and construction schedules have increased so much and become so uncertain that few utilities can carry the financial burden now, even though they may be confident that nuclear power ultimately will be cheaper than its alternatives.

Another critical factor facing the industry is public acceptance. Opposition has been increasing over the years, and a significant fraction of the general public adamantly rejects the technology. Some of the arguments, particularly those centered on technological issues, can be effectively answered or shown to be subject to eventual resolution. others, however, raise philosophical questions concerning the ability of our present institutions, or even of society in general, to cope with nuclear power. This opposition, especially as manifested in lawsuits and interventions in the licensing process, has become an important consideration for utilities planning on nuclear powerplants.

The long term is even cloudier than the immediate post-1985 period. The intent of the industry has been to shift to liquid metal fast breeder reactors (LMFBR) as uranium ores are depleted because breeders essentially eliminate resource constraints. The President, however, has proposed to stop funding the Clinch River Breeder demonstration LMFBR because of the increased risks of nuclear weapons proliferation this technology would entail if it were implemented worldwide. He also has proposed to defer reprocessing of spent fuel from present reactors in order to minimize the exposure of plutonium. Considerable concern has been expressed over the lack of a readily available substitute. Without some sort of breeder, nuclear capacity will be limited to several hundred reactors, depending on the extent and extractability of as yet undiscovered ores. Other breeder concepts that are less vulnerable to proliferation are even less advanced.

In summary, the plan provides only vague suggestions for increasing nuclear energy use and at the same time it proposes to virtually eliminate technologies on which industry has been counting for the long term. If Congress decides that nuclear power is to be an integral part of the Nation's energy future, more positive steps than those proposed in the Plan may be required to help the industry overcome problems.

Issue 9

Licensing Reactors

If nuclear power is to provide a significant fraction of new energy sources after 1985, constraints that have led to a virtual moratorium on contracts for new plants will have to be removed in an acceptable manner.

Summary

Utilities are not ordering reactors to be placed on line after 1985. The main reason is the financial risk that new orders involve: costs are too high and the period before any return can be realized is too long. If schedules can be reduced, costs will decrease because about 50 percent of the capital cost is represented by interest during construction and escalation, both of which are increased by delays. The schedule depends on the licensing process which has been slowing because of increasing caution on the part of the Nuclear Regulatory Commission (NRC); legal delays by interveners; antitrust considerations; Federal/State conflicts; the inclusion of generic issues for specific plants; and new constraints imposed by several recent court decisions.

The licensing process must be stabilized if orders are to resume in quantity. The Plan recognizes the problem and alludes to administrative action to reduce the licensing time. The proposed remedies, however, are vague and may be insufficient to attain the desired ends. if Congress decides it is necessary to ensure nuclear growth, it could consider allowing separate licensing of sites and reactor plants, adopting a resolution declaring that nuclear power is a vital component of the National Energy Plan, and revising antitrust laws and the National Environmental Protection Act (NEPA). Another alternative is to create a Government agency, perhaps similar to the Bonneville Power Administration or the Tennessee Valley Authority, to build and operate nuclear powerplants.

Questions

1. How will the study of the licensing process be conducted?
2. How is the licensing process to be streamlined while maintaining the highest degree of safety and the legal rights of the interveners?
3. How will plant capacity factors be increased ?

Background

The greatest impediment to installing additional nuclear power capacity is the magnitude of the exposure of utilities to financial risk, given present government (Federal, State, and local) policies on licensing and siting of powerplants and related fuel-cycle facilities. Cost estimates for post-1985 plants now are approaching $1,500 per kilowatt capacity (compared with a present $700) and the time from initial decision to operation is approaching 13 years. About half of this cost represents interest during construction and inflation, both of which are increased by delays. The present licensing procedures require a substantial expenditure (in excess of $100 million) for engineering design, environmental studies, and component fabrication for long-lead items (pressure vessels, steam generators, containment steel, etc.) before a construction permit is issued. If a plant is canceled for any reason, penalty charges can drive the total obligation close to $200 million. Thus, a utility incurs a very large obligation even before ground is broken, when it contracts for a nuclear powerplant. This obligation and the massive commitment of funds during construction considerably reduce a utility's flexibility in planning.

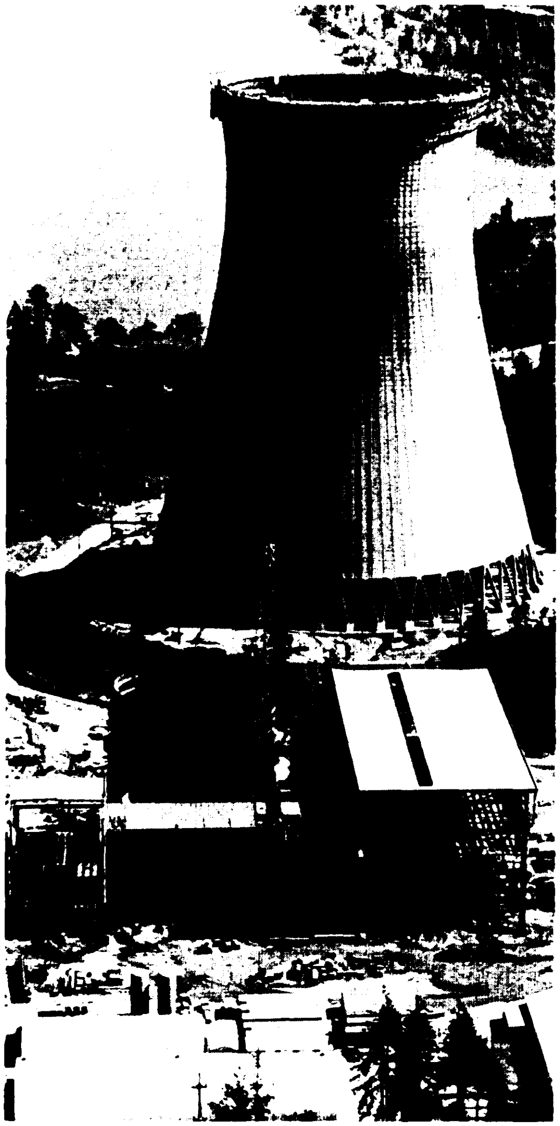
The present Federal licensing procedure is a three-way adversary process before an Atomic Safety and Licensing Board (ASLB) involving a utility, the Nuclear Regulatory Commission (NRC), and interveners. The rules of procedure are spelled out in the Code of Federal Regulations and tend to follow judicial procedures, with a great deal of discretion given to the ASLB Chairman. There are few limits to the issues that can be considered, and the Board itself can introduce issues it considers appropriate. The Board is charged with making a finding as to whether a proposed nuclear powerplant can be operated without a significant adverse impact upon the health, safety, and welfare of the public. Hearings may extend over 3 years, with transcripts resulting in tens of thousands of pages. Any party can appeal any aspect of a decision to an Atomic Licensing Appeals Board (ALAB) and ultimately to Federal courts. Issues as diverse as emergency core-cooling systems, the need for power, and evacuation procedures, are considered, with prepared testimony submitted by all parties before the hearing and cross-examination of witnesses during the hearing. In addition, NRC, with the assistance of the Justice Department, must determine that an applicant has not engaged in any anticompetitive practices and that building a plant will not disturb the relative competitive position of an applicant with respect to neighboring utilities.

Often NRC and the Justice Department require that an applicant share ownership of or the output of a plant with neighboring utilities as a condition for avoiding an antitrust hearing and/or allowing a construction permit to be issued.

A recent appeals court decision holding that NRC procedures for review of the nuclear waste disposal issue are inadequate to meet the requirements of NEPA have introduced serious questions as to whether NRC can license any nuclear powerplant until this issue has undergone a complete generic review. The Supreme Court is now reviewing the appeals court decision and a final ruling probably is many months away. Another appeals court recently declared the "limited liability" aspect of the Price-Anderson insurance to be unconstitutional, and this issue is also being appealed to the Supreme Court.

Historically, NRC (formerly the Atomic Energy Commission) has assumed jurisdiction over all nuclear and radiological safety matters under the Atomic Energy Act of 1954, and was supported in this by the U.S. Supreme Court. However, certain provisions of NEPA now allow States to set more stringent environmental conditions than those of the Environmental Protection Agency and recent disagreements between EPA and NRC and other agencies over the regulation of environmental radioactivity increases the uncertainties,

President Carter's plan offers only a "review" of the licensing process with a view to administrative changes. An alterna-



Portland General Electric Photo

tive that involves more fundamental revisions is to separate the licensing process into two stages: 1) that part associated with the plant, and 2) that associated with the site.

The plant portion of the licensing procedure could be similar to that used to approve a "license to manufacture" floating nuclear powerplants. Design approval would be basically a matter for extensive negotiations between the Federal Government (NRC, EPA, etc.) and the vendor/architect-engineer to secure approval or certification of a nuclear "island" and its associated balance of plant, with the specification of an appropriate relationship with the environment. Periodic reviews of the design might be undertaken at 5-year intervals with modification during this period limited to safety-related issues and based on value/impact analysis. Once a nuclear steam-supply system with its balance of plant has been approved, no further licensing would be required for a utility to undertake the contractual arrangements and begin the construction of such a plant on a certified or licensed site.

Siting legislation might provide for joint Federal, State, and local certification of nuclear powerplant sites. Precertification of sites for periods up to 10 years might also be provided, with the only basis for reconsidering a precertified site being a substantial change in the site characteristics. Specific provisions could be made to avoid the application of rules and regulations imposed subsequent to the site certification. Such a procedure would provide for a thorough airing of the environmental and site-related issues well ahead of construction. Site certification might be for a specified number of megawatts without regard to reactor type or individual unit size, thereby providing a utility with a maximum flexibility at decision time.

If such a procedure were fully implemented and a utility had both a certified site (with a certification good for 10 years) and an option to buy any of several preapproved nuclear powerplants, the time from initial decision to operation would be only that required for mobilization and construction. Since designs would be standardized, there should be substantial savings in cost as well as improvements in quality associated with the "learning curve" and prefabrication of components in a factory environment. Above all, the uncertainty associated with the licensing procedure and the attendant financial risk would be reduced to manageable levels.

Consideration might also be given to revisions of the antitrust review required by the 1970 amendment of the Atomic Energy Act (Public Law 91-560). Its objective of assuring that the benefits of nuclear energy, developed at public expense, are shared by smaller utilities, might better be accomplished through some form of preferred tax treatment (tax-free bonds for that fraction of the plant equivalent to the power sold to local utilities or perhaps some form of extra tax investment credit). Such revisions would reduce delays which would otherwise be unaffected by streamlined licensing procedures. Delay clearly is as burdensome to smaller co-owners or purchasers of power as to principal owners.

All of these proposals involve relatively minor modifications to present arrangements. It is possible, however, that the rapidly rising costs of construction of both nuclear and large coal plants will put them beyond reach of all but the biggest utilities. If it is deemed necessary to build plants for the Nation's energy system, new arrangements would have to be considered. This could involve mergers or consortia of even large utilities or public ownership of generating stations. The Bonneville Power Adminstration is a possible model; no single utility could have built Bonneville's dams, but all in the region benefited from the project's low-cost electricity. Even with this approach, however, the problems of the licensing process would have to be solved for nuclear energy to be produced at reasonable cost.

Issue10

Public Acceptance of Nuclear Expansion

There are growing indications of the possibility that expansion of nuclear power will be unacceptable to the public.

Summary

Opposition to nuclear power has become an important factor to consider in assessing the future of the industry. Public support is still broad, but changeable. The arguments used by opponents have shifted over the years, and many have been satisfactorily addressed. A fundamental difference between supporters and opponents is that the former see problems as solvable and generally bounded by conservative design, so that risks are very low. The latter point to a variety of unanticipated problems and have little faith in the institutions performing the analyses and imposing regulations. The truth probably is generally in between. Industry tends to neglect some scenarios while opponents emphasize worst-case possibilities which are much less probable than risks in other areas which are accepted with equanimity.

The public is confused, especially by contradictory scientific testimony. Opposition is likely to continue to grow because opponents can muster cataclysmic arguments, and the performance of the industry has been less than totally reassuring. This trend might be countered by a policy of public debate of the full range of problems involving the technology with critics invited to join in an exhaustive analysis. This might satisfy many opponents and moderate the views of others, but there would be a risk of providing ammunition to opponents who will not be satisfied until the industry is closed down.

Questions

1. What are the plans for addressing the causes of opposition?
2. How is the general public to be supplied with credible information on nuclear energy?
3. Will light water reactor safety research be augmented?

Background

in the past 5 years, significant opposition to nuclear power has developed within the United States. Specific topics of controversy have moved from one subject to another with time. Early opposition was directed at the environmental and health effects of radiological releases. In turn, the emphasis shifted to thermal pollution, to catastrophic accidents associated with possible failure of emergency core-cooling systems, and to waste disposal and proliferation. Early opposition took the form of adversary participation in nuclear plant licensing hearings, but more recently the arena has shifted to the courts, the ballot box, and demonstrations. Opposition initially came from a few environmental groups, but it is now more broadly based.

While the results 01 referenda on nuclear moratoria in six States during 1976 showed a 2-to-1 majority in support of nuclear power, the base for this support may be more closely related to economic need than to any intellectual commitment to nuclear power. There has been no nationwide plebiscite on the desirability of nuclear power. Indeed, the general public seems confused by the technical nature of the issues involved and the disparity between what equally well-qualified adversaries seem to be saying.

By contrast, opponents feel profoundly threatened by nuclear technology and are dedicated to stopping it. Their arguments can be very effective. Worst-case scenarios can indeed be horrifying, and the best-informed and most ardent support is hard pressed to flatly deny that the worst case will happen. The issue is probability, a complex and subtle consideration that has not yet even been resolved by the experts. Most agree that a serious radiological release is very unlikely at any particular plant, but that if it did occur, the consequences could be devastating. The degree of risk which the public should be expected to bear is an issue which needs thorough discussion and public involvement. The relative risk from nuclear power and its alternatives also needs considerably more study and comparison.

Critics and proponents react very differently to problems, and this often leads to a breakdown in communications between them. Proponents believe that problems are solvable, and they want to believe that their solutions are adequate. The "defense-in-depth" concept, for example, is intended to ensure designs so conservative that unforeseen problems will be accommodated by the system. Thus proponents see risks to the public as negligible. Critics are more likely to want to believe that design problems are insurmountable. Some feel that the long list of expensive retrofits and safety design changes prove that the technology is not mature, and that accidents always will find a way to happen. These very different points of view mean that proponents will argue that they have already gone beyond what is necessary to assure safety, while opponents can overemphasize worst-case scenarios that have only the remotest probability of occurring.

Many critics agree that some problems have been satisfactorily addressed and that new plants are substantially safer than older ones. Proponents admit that some of the problems raised in earlier debate were real and that many improvements have resulted. Technological problems that remain include waste disposal, reactor safety (including vulnerability to sabotage), and safeguards against plutonium diversion.

Nuclear power may not be a viable source of energy if public acceptance continues to erode. A massive public relations campaign certainly is not the answer. Industrial programs have been modestly successful in special situations (e.g., during referendum campaigns), The promotional roles played by the Joint Committee on Atomic Energy and the Atomic Energy Commission were important in bringing the industry into existence, but overoptimistic promises and heavy-handed tactics may have helped create the present crisis of credibility, There is now no Government agency with an assigned role of promoting nuclear power.

What may be required is heavy involvement of critics in a total analysis of nuclear problems and regulatory procedures. This might reassure many critics that legitimate concerns were being addressed; it also might identify new issues that should be addressed. Some critics, however, will not accept nuclear energy on any terms. Some would use access to the system to obstruct it. Others would find new, possibly stronger, arguments. Nevertheless, critics are sufficiently numerous and sophisticated to require satisfaction in some way.

Another useful step would be to improve techniques for evaluating risks and for measuring the costs and benefits of measures to reduce the risks. This would contribute to establishing criteria for safety requirements for nuclear power and other energy sources. The Reactor Safety Study (Rasmussen Report) was an important first effort to quantify probabilities. It has been subject to charges of bias, however, providing one illustration of the consequences of failure to involve critics in such studies.

Issue 11

Breeder Reactors

Nuclear generation of electricity can be virtually freed from resource constraints, but the technologies that will allow this (breeders and plutonium recycle) increase the opportunities for proliferation of nuclear weapons among nations and terrorists.

Summary

The Energy Research and Development Administration estimates uranium reserves at 1.9 million tons, enough to fuel about 375 light water reactors for 30 years. Other, less firm, reserves might fuel another 315 reactors. Reprocessing and plutonium recycle would expand these numbers by 20 to 40 percent and breeder reactors would effectively remove uranium supply constraint, Both technologies would, however, involve plutonium in a form which is relatively easy to convert to material that can be used for nuclear explosives by governments or terrorists. The President has proposed a worldwide indefinite deferral of the use of recycled plutonium, along with a delay in the construction of breeders, including this country's Clinch River Breeder Reactor demonstration plant. Other governments are strongly resisting such moves because they have fewer alternatives and they want to be less dependent on imported uranium and enrichment services. Some argue that the link between commercial plutonium and proliferation can be kept so small that other, less-controllable routes to weapons would be easier. Alternatives of

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varying practicality have been proposed to ameliorate the situation, but none, not even a nuclear power moratorium, can eliminate the risk of proliferation.

Questions

1. What will be the U.S. policy towards plutonium recycle and the liquid metal fast breeder reactor (LMFBR) if other nations continue to refuse to defer development of the technologies?
2. What would be the midterm and long-term strategies for nuclear energy if reserves prove to be lower than expected?
3. If alternative fuel cycles prove more attractive with nonproliferation as a major parameter, how will they be implemented both in this country and abroad ?
4. How much money and time are required to bring such alternate fuel-cycle technologies to the present level of light water reactor technology or to the present level of LMFBR technology?

Background

Present-day reactors extract about 1 percent of the total potential energy from uranium ores, so the total resource base can supply no more energy than what is available from remaining oil and gas resources. Breeder reactors and spent-fuel reprocessing can extract so to 70 percent of the energy in the uranium and make economical use of thorium and vast quantities of low-grade uranium ore.

The proliferation dilemma stems from the fact that fissile material can be used for nuclear explosives as well as for reactor fuel. Plutonium is produced in existing light water reactors but very little of it is now being recovered from spent fuel. If reprocessing does take place, about 400 pounds of plutonium would be obtained from a large light water reactor each year. A nuclear explosive requires between 10 and 20 pounds. The liquid metal fast breeder reactor, which is the focus of most breeder research here and abroad, would require reprocessing of about 3,000 pounds of plutonium per year, although there is a net breeding gain of only about 300 pounds after refueling the reactor.

Unlike low-enriched uranium, which requires expensive and demanding enrichment, plutonium can be purified for weapons manufacture by relatively simple chemical means. Nations which possess spent fuel today (whether from LWRs or breeders) have the necessary material for nuclear explosives but reactor safeguards probably are adequate to detect significant diversions of spent fuel. In addition, very few terrorist groups could either secure spent fuel or reprocess it to manufacture weapons.

The situation is quite different for a nation which in the future routinely reprocesses its spent fuel and recycles the plutonium. So much separated plutonium would be flowing through the system that significant diversions might not be detected. An abrogation of safeguards agreements could put the entire output of the plant and its stockpiles at the disposal of weapons makers.

The President apparently hopes to set an example for the rest of the world. By refraining from plutonium development, the

United States may avoid charges of setting double standards. Nonproliferation would clearly be easier to maintain if no government reprocesses. If the United States alone refrains, however, the effort may backfire by increasing economic incentives for other nations to reprocess. The Governments of Britain, Germany, Japan, France, and the U.S.S.R. are proceeding with construction of LMFBRs and, at least so far, have strongly resisted efforts to delay their reprocessing because they believe they have no realistic energy alternatives.

Other fuel cycles and reactors have been proposed which are less vulnerable to diversion (e.g., denatured uranium–233 in a double security system, coprecipitation, and self-sustaining reactors such as the gas core and molten salt reactors). Some of these proposals have real promise and should be studied. The opportunities for diversion can be reduced and the time required to accumulate an arsenal can be lengthened. It should be recognized, however, that none are totally resistant to diversion, though some could be virtually terrorist-proof. Most will also require a lengthy and costly development period.

Cancellation of the Clinch River Breeder Reactor demonstration plant has been proposed as part of the President's energy plan. There may be, however, nonproliferation advantages to proceeding with construction. The plant is flexible enough to demonstrate some of the alternative fuel cycles, such as the use of thorium and uranium–233 in a fast breeder, and its construction would allow U.S. breeder technology to influence world safeguards.

If nuclear power is to be a long-term option, some sort of breeder, or near breeder, and reprocessing will be necessary. The schedule for introduction depends on uranium resources and LWR growth. Based on water-reactor development experience, demonstration and prototype breeder plants should be online 15 and 10 years respectively before commercial breeders are required to meet U.S. energy demand.

About 5,000 tons of uranium are required during the 30 years of operation of a typical light water reactor. The ERDA nuclear power forecasts adopted in 1976* and 1977t and uranium requirements (0.25 percent tails) are:

Year	Nuclear GWE		uranium Committed (tons)	
	1976 ERDA	1977 ERDA	1976 ERDA	1977 ERDA
1975	39	39	234,000	198,000
1980	67	60	402,000	305,000
1985	145	127	870,000	646,000
1990	250	195	1,500,000	992,000
2000	480	380	2,880,000	1,932,000

● Edward A. Hannahan, Richard H. Williamson, and Robert W. Brown, "World Requirement; and Supply of Uranium, " presented at the Atomic Industrial Forum, "International Conference in Uranium, " September 14, 1976, Geneva, Switzerland.

tAccording to the brlefing charts in the July 7, 1977 testimony of James R. Schlesinger before the Subcommittee on Fossil and Nuclear Energy, Research, and Demonstration of the Committee on Science and Technology.

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The ERDA estimate of uranium resources based on costs of extractions are:

U.S. **Uranium Resources—January 1, 1977—Tons U_3O_8**

$/lb. U_3O_8 Cost Category	Reserves	Potential Resources: Probable	Possible	Speculative	Totals
$10	**250,000**	**275,000**	115,000	*100,000*	*740,000*
$10-$15 Increment	160,000	310,000	*375,000*	*90,000*	*935,000*
$15	410,000	**585,000**	*490,000*	*-190,000*	*1,675,000*
$15-$30 Increment	*270,000*	*505,000*	*630,000*	*290,000*	*1,695,000*
$30	*680,000*	*1,090,000*	*1,120,000*	*480,000*	*3,370,000*
Byproduct	140,000	—	—	—	140,000
Total	820,000	1 *,090,000"*	1,120,000	*480,000*	*3,510,000*

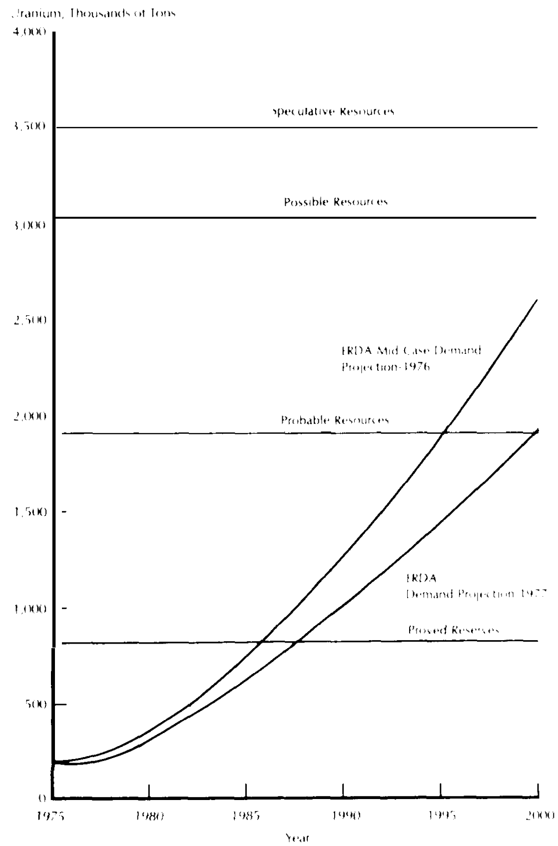
Note: Uranium that could be produced as a byproduct of phosphate and copper production during the 1975-2000 period is estimated at 140,000 tons U_3O_8.

Because the schedule for the breeder is so dependent on the rate of discovery and exploitation of uranium reserves, the level of confidence in the potential reserve estimates is a crucial factor. ERDA considers the proven reserves at $15/lb. (410,000 tons) to be accurate to within 20 percent, plus or minus, Confidence levels are not assigned to any other figures, except to say that the uncertainty is greater than 20 percent for the $15-$30 increment and continually higher for the subsequent categories. The ERDA estimates are not universally accepted. Arguments are made for both much higher and somewhat lower figures. Even the geologic origins of uranium in sandstone deposits, the most abundant U.S. source, are in dispute. Proponents of higher estimates point to a lack of exploration in many areas of the country, the experience with other ores which have shown a continual expansion as exploration and technological development progressed, and the possibility of using higher cost ores (ERDA has recently estimated an additional 800,000 tons at $50 per pound). Others caution that no major uranium districts have been identified for many years despite intense exploration and note that the rate of discovery per foot of exploratory drilling is falling rapidly.

Uranium commitments for both ERDA LWR projections are shown in figure 1, together with the ERDA estimates of reserves. The probable resources of 1.9 million tons will be committed by 1995 for the higher projection and by the year 2000 for the lower. The uncertainty surrounding these resource estimates, however, is so great that there may be a severe uranium shortage affecting utility decisions to order reactors even by 1990. Other possible outcomes would involve slipping the breeder schedule substantially, as the President proposes. If LWR sales do not resume, the breeder may never be needed. Slippage does involve a substantial risk, however, if nuclear energy is to play an increased role as suggested by the Plan. It also should be noted that both domestic and foreign consequences will be great if the breeder is needed but not available, This risk must be defined and included with proliferation concerns.

Alternative strategies have been proposed to increase the efficiency of uranium use without resorting to the LMFBR. The denatured U^{233} cycle referred to above is a dual-security concept in which one set of domestic burner reactors uses denatured fuel (a mixture of U^{233}, U^{238}, and thorium) which is produced in a second set of closely guarded, perhaps internationally controlled, breeder reactors (fueled with plutonium, U^{238}, and thorium). The burner reactors would be very similar to present LWRs with different fuel. The breeders could be LMFBRs with different fuel than presently planned. Such concepts deserve considerable study before a commitment is made to commercialize the LMFBR. These alternate fuel concepts could be tested in the Clinch River reactor or the Fast Flux Test Facility. An essential element of this strategy is a large proven reserve of thorium. Reliable data on U.S. thorium resources are not now available, however, and estimates must be assigned a degree of uncertainty even larger than that for uranium resources. Other concepts for using thorium could also extend fuel resources for at least so years. For example, the advanced Canadian deuterium uranium reactor (CANDU) is a near breeder, but it could operate with only evolutionary changes in present designs.

Figure 1. Uranium Resources and Demand



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Nonconventional Sources Introduction

The National Energy Plan projects that contributions of solar, geothermal, fusion, and other nonconventional energy sources will be negligible through 1985. The "other" category of supply in Table IX-l, which rises from 1.5 to 1.7 million barrels per day of oil equivalent with or without the Plan, is virtually all hydroelectric power, a conventional source.

The only explicit goal for any of these technologies is to "use solar energy in more than 2.5 million homes" by 1985. The type of use is not specified, but presumably most installations will be solar water heating, with some space heating and other applications. Although this goal will not have a significant impact on national energy patterns, it does call for a rapid but feasible expansion of the industry.

The Plan's consideration of solar energy raises several concerns:

- There is a lack of emphasis on technology capable of producing energy in the long term. The Plan identifies three "inexhaustible" energy sources, but does not define any one of them as suitable for eventual commercialization. The Plan questions the breeder reactor's future, considers fusion a high-risk option for the long term, and acknowledges that solar electric systems, while promising, have not reached the stage of development where their economic viability can be demonstrated. The Plan does not evaluate alternative technologies in terms of technical and economic feasibility, social benefits, or undesirable impacts. As a result, it does not identify priorities, schedules, or the role of the Government.
- No coherent attempt has been made to link short-term goals to a long-term strategy. It may be that miscalculations about resources or the potential of new energy technology will mandate a shift to inexhaustible energy resources faster than the forecasts contemplate. Planning should be underway now for this contingency.
- Decentralized energy systems must be integrated with utilities. Solar- or wind-energy systems require auxillary energy sources for backup power. The Plan calls for such systems, but it does not directly address the central-station load-management and integration problems,
- The solar incentives do not go far enough. The Plan's solar goal is to be met through the use of special tax credits, a 10-percent conservation tax credit, a public education program, and a $100 million Federal Government demonstration program. These are productive measures, but they do not devote enough attention to system maintenance, replacement, improvement, and industrial and electric generation tax credits. The Plan does not call for direct assistance to manufacturers who could be encouraged to enter the large potential foreign market for solar energy equipment.

- The Plan does not address the need for a unified standardization program for solar equipment. Such standards are crucial to the wide acceptability of solar by builders and lenders.

- There are no specific goals for geothermal energy. Legislation is proposed to give geothermal producers parity with oil producers in the tax treatment of intangible drilling costs. Parity in other important areas, such as leasing, licensing, and preparation of environmental impact statements, is not addressed. The Plan states that Federal agencies and States will be encouraged to streamline review of leasing activities, but there is no estimate of likely impact on production or the environment. The Plan's proposal for research may accelerate development of new types of geothermal resources.

- Geothermal energy is available only in certain regions such as California and the Gulf of Mexico. Even between wells of the same category there are wide differences in temperature, pressure, well depth, fluid composition, and other geologic factors. This makes standardization of recovery equipment much more difficult than it is for oil and gas development and raises problems for its application.

- Fusion will not be a significant energy source in this century no matter what the research budget in the near future, and the final costs of a program will be very large indeed. Nevertheless, the promise of the technology warrants a large research investment. Fusion reactors could be inherently safer from a proliferation point of view than the liquid metal fast breeder reactor and from a safety point of view than any solid-core nuclear reactor. Although they still would produce highly radioactive waste, they need not involve nuclear fission weapons materials during normal operation (though they could produce great quantities of plutonium or uranium–233 if desired).

- The research and development philosophy of the Plan is too limited. The stated realinement of priorities "to meet the country's real needs" is commendable, but does not address the problem of basic research. Too narrow a focus on near-term "practical" goals could have serious consequences for future economic growth, which may depend on new science and technology. The cost of basic research on both near-term and far-term goals is microscopic compared with annual U.S. energy costs, and long-term programs should be fully funded and well staffed.

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Issue 12

Nonconventional Energy Goals

The goal of 2.5 million residential solar installations by the year 1985 understates the capability of the technology.

ERDA Photo

Summary

The goal of 2.5 million residential installations of solar heating/cooling systems by 1985 is ambiguous. It appears to be unnecessarily limited to space and water heating, ignoring potential industrial and agricultural uses of solar heat and opportunities for solar generation of mechanical and electrical energy. The Plan is silent on other advanced energy systems which could make a contribution to energy supplies by 1985.

Considering the large percentage of U.S. energy consumption which is used for residential heating and low-temperature industrial process heat, the goal is overly modest. Solar energy could make a significant contribution in these areas. The environmental benefits of advanced energy technologies make them attractive alternatives to increased dependence on fossil fuels.

The Plan does not address the need for a set of performance standards for measuring the output of these advanced energy systems. Care should be taken in the design of such standards to ensure they do not discriminate against promising technologies.

Questions

1. Why was a goal specified for solar energy and not for other advanced energy sources such as geothermal?
2. Why does the goal address residential installations and ignore industrial and farm applications?
3. Why is the goal limited to the solar production of thermal energy, ignoring the production of electric and mechanical power?
4. How was the goal of 2.5 million homes generated? What is the relation of the goal to plans for implementation of solar systems after 1985 ?
5. What is a solar installation? How much energy will the proposed installations produce?
6. Does the Government propose to establish a system of standards to ensure that consumers will have adequate knowledge about solar systems available in the market?

Background

The National Energy Plan sets a goal of 2.5 million residential solar energy installations by the year 1985. The goal, stressing application of one solar technology (low-temperature thermal), is limited for three major reasons:

- It ignores other advanced energy sources which could make a measurable contribution to U.S. energy needs by 1985. For example, technologies for utilization of wind and some forms of geothermal energy are sufficiently developed to be economic in some regions of the country.
- The potential savings possible from the application of solar energy to industrial process heat is overlooked. Twenty-eight percent of all process heat is used at temperatures below 550°F. Solar collectors are capable of producing temperatures up to 1000°F. in these applications. The Plan sets no goals for the use of solar energy in agriculture where needs such as crop-drying and heating animal barns are easily met by present technology.
- No goals are set for the advanced use of solar energy. While technologies for conversion of solar energy to mechanical and electrical energy cannot make as great a contribution as thermal systems in the next 8 years, they should not be ignored. They represent possible building blocks for very significant energy production after 1985. The Plan recognizes the value of research and development in these areas but does not define needed programs.

The goal of 2.5 million residential installations of solar energy is ambiguous because residential installation is not defined. It could mean small water heaters or large complex heating and cooling units. The possibilities of meeting the goal and the potential for displacement of fossil fuel are very different for those technologies.

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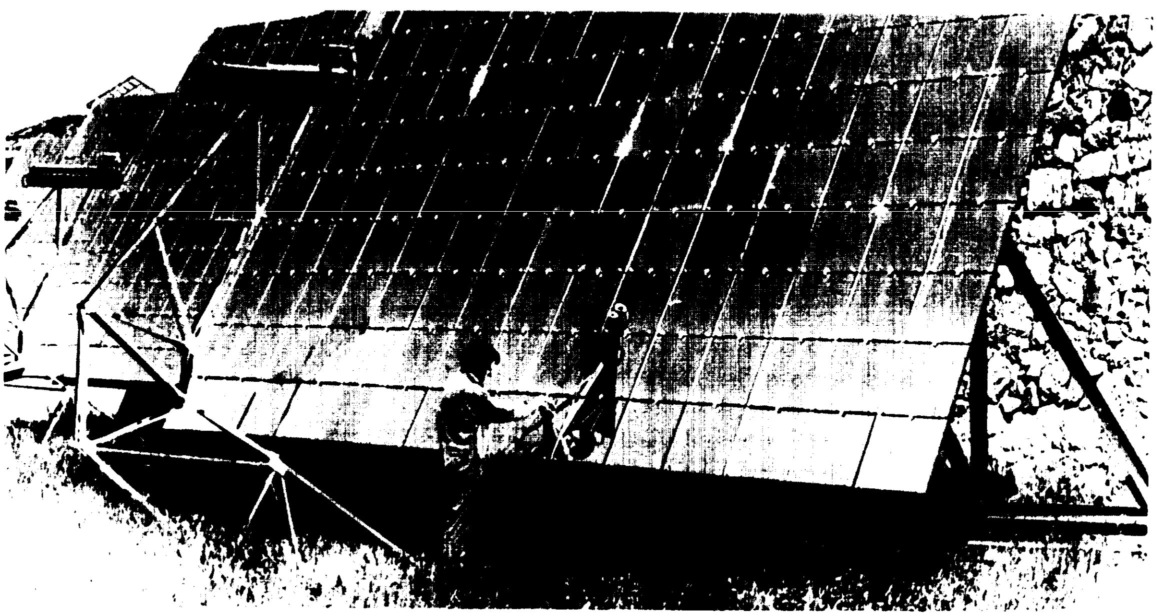
The absence of reliable standards for solar equipment and the lack of manufacturer performance guarantees have made some lenders hesitant to provide capital for solar installations. Establishment of performance standards for measuring the energy production of unconventional technologies may be the most useful remedy for the problem. These performance standards must not be used to discriminate against "passive solar" technologies. While "passive systems" may not generate as much energy per installation as the more complex "active" systems, their low cost and simplicity make them suitable for rapid commercialization, and the energy savings which they generate can be substantial. Proper protection for passive systems in evaluating performance may call for use of an energy budget approach.

There would be significant environmental and social advantages from fostering a more rapid development of advanced energy sources. The environmental benefits of many advanced technologies are well known, as are the benefits of reduced dependence on fossil fuels. In addition the manufacture and installation of small-scale advanced energy systems would be a relatively labor-intensive industry which could create a large number of jobs, and contribute to a reduction in unemployment.

Even under the most optimistic scenarios, advanced energy systems will make a relatively small contribution to our energy requirements between now and 1985. However, there is a very real possibility that they will be significant after that time. Consumer confidence in new products must be increased. This can only be accomplished by a strong commitment to advanced energy sources now.



ERDA Photo

Issue 13

Solar Incentives

The incentives provided for in the plan are not sufficient to ensure the widespread deployment of advanced energy technologies.

Summary

All the incentives for new technologies in the plan are focused on increasing demand. There are no provisions for directly assisting the industry in setting up large, efficient manufacturing plants. Nor is there a mechanism for encouraging foreign sales of solar energy equipment.

The National Energy Plan includes both residential and industrial tax credits which are designed to encourage a conversion to advanced, inexhaustible energy sources. These incentives should provide a significant assist to the industry, but they cannot protect a homeowner against unexpected maintenance, replacement or improvement costs of solar heating equipment, which are still largely unproved. The Plan prices distillate oil and natural gas used for home heating below their replacement cost, which probably will discourage commercialization of nonconventional technologies.

It seems to be the intent of the proposed National Energy Act that advanced energy equipment loans be covered under the energy conservation loan provisions, but the wording of the draft legislation is somewhat vague. Further, there is some question as to whether the incentives provided are sufficient for primary lenders to become active in this market,

It is not clear whether solar equipment is eligible for the "normal" 10-percent plant equipment tax credit (under the Internal Revenue Act of 1954). Solar equipment appears not to be eligible for the cogeneration tax credit, nor does it appear in the definition of an "alternative energy property" which is the necessary qualification for industrial oil and gas conservation rebate.

Replacement cost pricing of oil and gas for industry and the imposition of industrial oil and gas consumption taxes make solar energy relatively more attractive to the industrial sector. However, the exemption of the farm sector from the consumption tax makes solar energy relatively less attractive for crop drying, a technology that could be implemented within the timeframe of the Plan.

Questions

1. What evidence is there that the residential solar tax credits are sufficient to induce installation of this equipment in view of the Plan's artificially low prices for home-heating oil and gas?
2. Is the Federal National Mortgage Association authorized to become a buyer of solar energy and other advanced energy system loans on the secondary market?
3. What incentives will be given to primary lenders to encourage them to make conservation and advanced energy equipment loans?

4. Is advanced energy equipment eligible for all business energy equipment tax credits for which coal energy conversions are eligible?
5. Why are advanced energy system cogenerators (specifically geothermal) excluded from the cogenerator tax credit ?
6. Why is advanced energy equipment ineligible for the industrial oil and gas conservation rebate?
7. In view of the exemption of the agricultural sector from the oil and gas consumption tax, is some further incentive not needed to encourage the use of solar energy in this sector?

Background

Incentives provided by the Plan for the introduction of advanced energy technology fall into three broad categories: 1) those provided for residential installations; 2) those provided for industrial use; and **3)** the federally financed demonstration programs:

Incentives to Homeowners.—Initially, tax credits begin at 40 percent of the first $1,000 expenditure and 25 percent of the next $6,400 expenditure on "authorized solar equipment" (to be defined by Internal Revenue Service after consultation with the Federal Energy Administration). The maximum credit would decline to $1,2IO in 1984 and be eliminated thereafter. The effectiveness of this incentive is diminished by the pricing policy on home-heating oil (distillate) and natural gas. Under the provisions of the legislation accompanying the Plan, the price of home-heating oil will be controlled at a level approximately 10 to 12 percent below the cost of oil sold for other purposes; the price of natural gas is controlled at a price per Btu below home-heating oil. These controlled prices for home-heating fuels reduce the incentive to convert to solar.

The Plan designates utilities as lenders under the National Housing Act, and further authorizes the Federal National Mortgage Association (FNMA) to become a buyer of loans made for the purpose of installing energy conservation equipment. While it seems to be the intent of the act to include solar energy equipment in the category of "energy conservation equip merit," the wording is not sufficiently clear to resolve this point. The opening of the secondary loan market is vital to the commercialization of solar technology. The high initial cost of this equipment makes obtaining credit a prerequisite for purchase. The entrance of FNMA into the market will considerably ease the reluctance of both lenders and borrowers.

The Plan calls for the "prohibition of discrimination against solar and other renewable energy sources by electric utilities," but there is no mention of this in the accompanying legislation. Further, there is a feeling among some lenders that the completion of the necessary forms and reports necessary to qualify for Federal loan guarantees coupled with the relatively small dollar value of the individual loans may make these loans unprofitable for the primary lenders. This problem deserves careful consideration and further action may be necessary to provide access to the loan market for purchase of advanced energy systems.

Industrial Tax Incentives.—Credits are included for the installation of solar equipment for plant heating/cooling and industrial process heat. Solar equipment is included in the category of business energy property and is eligible for a 10 percent investment tax credit. It is unclear whether solar energy is eligible for the cogeneration credit. Under the tax laws of 1954, equipment contained within a plant building is eligible for a 10 percent investment tax credit; therefore, "business energy property, " which also qualifies for the 10 percent equipment investment credit, receives a 20 percent total tax credit. It is unclear what kind of solar installations, if any, would qualify for this double credit. However, it seems clear that in order to encourage the use of advanced energy systems they should be made eligible for at least the maximum credit that a conventional system (e.g., coal) would receive if installed for a similar purpose. Advanced energy systems are not eligible for the oil and gas conservation tax rebate which is designed as an offset to the oil and gas consumption tax. This rebate is allowed for investment in coal-fueled equipment, and logically should also be allowed for installation of solar and other advanced energy systems.

The policy of raising the prices of natural gas and refined oil products and the imposing of industrial oil and natural gas user taxes will make solar power relatively more competitive in the industrial sector. However, the legislation controls the price paid for oil and natural gas by the agricultural sector at artificially low levels. This provides a disincentive for the use of solar energy for crop drying and barn heating. Also technical breakthroughs are necessary for the commercialization of these devices and the resulting energy saving could be substantial.

There could be a further sizable incentive to U.S. solar equipment manufacturers in foreign sales. Current prices for fossil fuels, particularly in many developing nations, are considerably higher than in the United States, and in many of these nations solar heating systems are already economically competitive. Availability of U.S.-built solar power systems could also help defuse overseas resentment over U.S. moves to reemphasize plutonium as a nuclear fuel. Another potential area for solar equipment which could serve as an incentive to manufacturers is its integration with prospective cogeneration, district heating, or total energy concepts for utilizing waste heat.

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Issue 14

Long-Term Planning

Does the National Energy Plan give sufficient consideration to the development of long-term (post-1985) supply options?

Summary

The main thrust of the National Energy Plan is properly directed toward solving the short- to mid-term energy supply problems. However, long-term planning is needed to prevent even more severe problems in the future. Fossil fuels must eventually be replaced by "inexhaustible" energy sources. Of these, only the breeder reactor has received sufficient development funds to bring it to the precommercial stage. However, the breeder involves proliferation questions which threaten to limit its widespread commercialization. Since the alternatives are in a less-developed state, their funding may have to be raised considerably if the breeder is rejected.

Questions

1. What mechanisms does the Plan set up to ensure the orderly development of long-term inexhaustible energy sources ?
2. What criteria will be used to decide the allocation of research and development funds among available energy projects?
3. What target dates and decision points have been set in the development programs for various long-term energy sources to ensure that they will be developed in time to replace fossil fuels in the latter part of this century?

Background

The National Energy Plan properly stresses the implementation of short- and mid-term energy supply problems because of the present drain on world oil supplies. However, it should be recognized that long-term planning will be necessary to avoid other crisis situations in the future. Coal is planned as a transition fuel to reduce U.S. dependence on petroleum fuels until after "inexhaustible" energy sources can be brought to commercialization. The long-term use of coal as a major fuel source poses serious environmental questions, even with the use of "best available" pollution-control technology and reclamation of strip-mined land.

Presently contemplated "inexhaustible" energy sources include the liquid metal fast breeder (LMFBR) or other breeders, fusion, and solar electric. The LMFBR, however, poses sufficiently serious problems for nuclear weapons proliferation that the President has recommended deferring it pending a search for alternatives. Neither the technological feasibility nor the economic practicality of fusion has been demonstrated, and it is extremely unlikely to be a major power source in this century.

There are many promising advanced solar technologies, most of which concentrate on the generation of electricity. However, none of these systems has been demonstrated to be economic. Of the advanced systems under consideration only ocean thermal and space-based solar energy stations are by themselves suitable for base-load generation. However, central-tower solar-thermal-electric and photovoltaic, two systems which are much more likely to be brought to commercialization within this century, can be adopted to base-load requirements by the development of advanced energy storage systems. Presently available geothermal technology, while well developed (and suited to base-load requirements), is limited to specific geographic regions, Advanced systems currently under development promise to expand the geographic areas in which this form of energy can be utilized.

The present plan places so much emphasis on short-term solutions that the orderly development of far-future options may be endangered. Should the Plan's stated reemphasis of the fission breeder program come to pass, the only remaining base-load option which currently receives adequate budgetary considerations is nuclear fusion, which is at best a high-risk program. Since the Plan clearly identifies the desirability of satisfying an increasing fraction of energy demand in the future by electricity (e.g., electric automobiles, p. 101), early planning and R&D for alternative base-load options is essential. The high costs and long-lead times of these programs necessitate considerable attention to their performance and to the question of how the technologies would be implemented.