D. FOSSIL ENERGY ISSUE PAPERS

1. Fossil Energy Objectives

ISSUE

Almost all of ERDA's programs in fossil energy contain unrealistically optimistic projections of the energy supplies that can be realized from new technologies in the near term.

SUMMARY

ERDA's objectives for 1985 call for 13 to 15 Quads* of fossil energy derived from new technologies. Institutional, environmental, and other nontechnical constraints aside, these objectives cannot possibly be met for the single reason that the time necessary to develop and demonstrate new technologies and to construct a commercial industry based on those technologies exceeds the 10 years between now and 1985. The lack of consistency between ERDA's overall plan in volume I and the specific program projections in volume II raises questions concerning the process by which the objectives were defined and the use served by the objectives in establishing priorities.

QUESTIONS

1. How did ERDA arrive at its objectives for the amount of energy derived from fossil resources?

z. Why are the objectives different in volumes I and II of the ERDA Plan?

3, What purpose is served by the objectives? How have ERDA's programs been determined from these objectives?

BACKGROUND

In volume II, Program Implementation, ERDA specifies the following energy supplies to be made available from new technologies by 1985.

Direct coal combustion (fluidized bed)	1 Quad
Enhanced oil recovery , , ...	2.9 Quads
Stimulation of gas formations	3 Quads
Coal gasification	1 to 3 Quads
Coal liquefaction	(at least) 5 Quads
In-situ recovery of shale	0.1 Quad
Total	13 to 15 Quads

*A Quad is defined as 1 quadrillion Btu's.

If realizable, this increase would represent a truly major contribution to U.S. energy supplies, as it would constitute approximately 2o percent of the country's current annual consumption,

In volume I, Chapter VIII, however, ERDA lists the following as objectives:

Oil and gas-enhanced recovery	over 6 Quads
In-situ oil shale , ...	up to 2.5 Quads
Coal-direct utilization	over 6 Quads
Gaseous and liquid fuel from coal .	beginning in 1985

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Obviously, disparities exist between the two sets of objectives. While the figures for enhanced oil and gas recovery are comparable, those for direct coal utilization and for synthetic fuels are not, As a consequence, the methods used to assign these objectives and their influence in determining the priorities and direction of programs seem to be compromised,

Whatever the origin of these stated objectives, they cannot be considered reasonable in the light of current commercial development. In the opinion of the experts consulted by OTA, the ERDA projections are unrealistic and cannot be achieved with any reasonably designed national energy R, D&D policy. In almost all areas, the arguments are similar. The technology first has to be proved through development and demonstration stages; then a commercial industry must be built to provide the energy. In the case of enhanced oil and gas recovery, field-pilot tests may take five years or more; a similar period is required to begin to produce significant new supplies. Tertiary recovery of oil and stimulation of tight gas formations do not have quick payoffs. Although a proven technology exists for coal gasification, a large commercial industry cannot begin until the economics of the process have been verified. Coal liquefaction is even further removed from commercialization, as is the introduction of pressurized fluidized bed combustion for direct coal utilization. In the near-term, the energy self-sufficiency of the country cannot be based on ERDA's stated objectives for energy supplies from new technologies in fossil fuels.

2. Primary Oil and Gas Recovery

ISSUE

No Federal agency is engaged in a comprehensive research program for primary oil and gas recovery from new sources; the absence of such a program could lead to delays in the development of these resources.

SUMMARY

Exploration and development of oil and gas from new sources, particularly the Outer Continental Shelf, continues to be severely delayed by the lack of planning on the part of the Federal Government. An aggressive ERDA research program would complement industrial efforts. In particular, research is needed on the effects of offshore drilling and on ways of mitigating those which are harmful to the environment. Congress mandated in Public Law 93-577 Sec. 6(b)(3)(Q) that ERDA engage in a program to explore methods for the prevention and cleanup of marine oil spills, but the scope of ERDA's proposed activities is not clear.

QUESTIONS

1. What is ERDA's current schedule for development of the congressionally mandated program on methods for the prevention and cleanup of marine oil spills?
2. What current studies of regional, social, and economic impacts of Outer Continental Shelf (OCS) exploitation is ERDA performing (or monitoring if being performed by other agencies)?

3. What are ERDA's plans for development of a coherent information base to assist potentially impacted areas in coastal zone planning for OCS oil and gas development?

4. What studies are underway at ERDA or in other agencies with which ERDA is cooperating on alternative OCS oil and gas lease management arrangements and compensation provisions in the event of adverse impacts on areas of OCS oil and gas development ?

5. How soon does ERDA anticipate having a comprehensive data base on site-specific environmental conditions of potential OCS lease areas? If the regional data are to be assembled by an agency other than ERDA, what is ERDA's current role in defining the nature and extent of information to be acquired and the time schedule for the program?

BACKGROUND

There are three sources of large quantities of liquid and pipeline gas fuels from domestic resources in the near-term (to 1985): production of oil and gas from the onshore lower 48 States, offshore sites, and Alaska. Estimates of petroleum resources on the OCS (to a water depth of 200 meters) range between 10 and 130 billion barrels (20-50 percent of U.S. resources); OCS natural gas resources are estimated at greater than 100 trillion cubic feet (20-30 percent of U.S. resources). Most of the present production is taking place in the Gulf of Mexico, but there are also sources of oil and gas off the Pacific coast, the Atlantic coast, and the coast of Alaska. Although development in some of the promising areas would be hampered by severe environments, there are no serious technologic obstacles to extracting oil and gas. The basic technology has been well-tested in the Gulf of Mexico, the North Sea, and elsewhere.

The expansion of offshore production to increase domestic fuel supplies has recently been very slow, mainly because of environmental and institutional obstacles. In particular, the problem stems from an inability to lease promising development sites because of public opposition due to uncertainties about environmental and social impacts.

One way to remove development delays is to reduce the likelihood of environmental damage from oil spills by developing better blowout prevention and cleanup technology. In the long run, this would reduce uncertainty and should help to avoid delays in opening up new areas for production. In the short run, and especially over the next several years, other Federal activities are needed as well. Research requirements include the following:

- Geological information on new potential oil and gas resource regions.
- Site-specific studies of environmental conditions well in advance of lease sales.
- Research on the prevention and consequences of oil spills.
- Studies of the regional social and economic impacts of OCS exploitation and possible frameworks for compensation for adverse impacts.
- Support of coastal zone planning.
- Development of alternative lease management arrangements.

The Congress directed ERDA to engage in a program to investigate methods for the prevention and cleanup of marine oil spills. (Public Law 93-577, Sec. 6(b)(3)(Q)), but it is not clear how much of an effort is proposed as part of the Environmental Control Technology program of ERDA—the only place in the ERDA Plan where oil-spill cleanup is treated.

3. Enhanced Oil and Gas Recovery

ISSUE

The proper role for ERDA in enhanced oil and gas recovery is not well defined.

SUMMARY

Enhanced recovery of oil and gas from known reserves holds promise of significantly increasing the supply of these fuels. The need for research and development in the area of enhanced recovery clearly exists, but opinions differ as to the proper role of Government in this endeavor. The present pace of industry R&D could be accelerated by formulation of a detailed workable incentive plan. The present ERDA tertiary recovery program for oil, which involves special joint Government/industry field-pilot testing and demonstration, and the similar research on the recovery of gas from tight formations, will not yield a significant increase in production by 1985. ERDA's projection of an additional annual increase of approximately 6 Quads resulting from enhanced recovery is therefore unrealistic.

QUESTIONS

1. On what basis did ERDA make the projection of 6 Quads input to U.S. energy supplies from enhanced oil and gas recovery by 1985?
2. What is ERDA presently doing to ensure that tertiary methods for oil recovery are brought to commercial application in the shortest possible time and with maximum potential for application over the entire U.S. oil production industry?
3. What would be the effect on gas supplies in the 1985-90 period of an increase in Government funding for research on tight gas formations from $5 million to $25 million per year

BACKGROUND

Owing to the convenient form and relative environmental attractiveness of crude oil and natural gas as domestic resources, it is important that the United States extract and use what it has. In fact, the necessary pace of development of synthetic liquid and gas fuels depends largely on the amount of oil and gas that can be recovered. This amount depends partly on the ability to tap sources like shallow oil beds, oil that remains in developed oil reservoirs (secondary and tertiary recovery), and oil that is too viscous to extract with conventional procedures. The National Academy of Sciences has recently estimated that new tertiary techniques might yield 105 billion barrels of oil from old fields. It is obviously important to find out how much is actually recoverable by enhanced oil and gas extraction techniques, an amount dependent partly on the state of technology.

Tertiary recovery methods—as distinct from secondary methods such as water flooding and natural gas injections—include polymer floods, surfactants, miscible recovery processes, immiscible gases and thermal (usually steam) recovery methods. Tertiary recovery methods are at an early stage of development and much work remains, particularly in identification of the most favorable conditions for each method and characterization of the economics and net energy yield from competing methods.

The present ERDA program in enhanced recovery began in 1974 when a joint Government/industry project was initiated between the Bureau of Mines and a private oil company. These experiments are approximately 50 percent supported by the Federal Government. The current program calls for roughly 10 tests of several techniques in different reservoirs over the next three or four years. Three of these 10 tests are currently underway.

Some experts have characterized the problem as one of testing and centralizing information on a variety of techniques (four or five basic types) in a number of reservoir types (perhaps 30 or 40). This process would require a total of 80 to 150 experiments. The total cost of such experiments is estimated at $300 to $400 million. Assuming that half of the cost is borne by the Government over a 4-year test period, the Government cost would be $40 to $50 million per year.

Many support ERDA's present tertiary oil recovery program. On the other hand, critics of the program contend that direct Federal involvement is unwarranted on the grounds that industry can be motivated to develop the necessary technology on its own. However, sufficient price and other incentives would be necessary, since production costs of enhanced recovery are expected to be high.

Expertise in enhanced recovery resides principally with industry, which has already invested heavily in the needed R&D, As the incentive approach does not require the release of proprietary information, it is likely to appeal to industry. However, this factor may also be regarded as a disadvantage, as it may deprive nonparticipating oilfield operators of valuable data, Nevertheless, it is possible that a broad industrywide incentive program could initiate more research and development than a limited number of federally funded projects.

General agreement is that testing of a large number of reservoirs must be pursued. Until a detailed, workable incentive plan is formulated, the present R, D&D program undertaken by ERDA, though insufficient, will yield at least some of the necessary information. In addition, because the stimulation of tight gas reserves involves greater risks than enhanced oil recovery, direct Federal participation in a program to develop these reserves is warranted; ERDA's program in this area is reasonable.

It should be noted that no significant increase in production can be expected by 1985, because of the time required to complete and evaluate enhanced recovery methods for gas and oil, The annual increase projected by ERDA of 2.9 Quads from oil via enhanced recovery is thus unrealistically optimistic.

Similarly, the anticipated increase of 3 Quads from the enhanced recovery of natural gas is unrealistic. The Western United States contains an estimated 600 tcf of natural gas locked in tight rock formations, but there is no developed, economically feasible technology to produce the gas. R, D&D is expensive and too risky for industry to participate independently on a very large scale. Massive hydraulic fracturing and other nonnuclear fracturing methods are currently considered the most promising approaches, taking into account technical, environmental, and social factors, If a chance of using these resources to meet gas fuel demands by 1990 exists, an accelerated research program is needed, but because of the uncertain prospects of success such a program is unlikely to be undertaken by industry. The proposed ERDA budget includes $5 million for R&D on tight gas formations in FY 76. A comprehensive accelerated R&D program, however, would require $20 to $25 million a year. That sum would provide the necessary funds to perform 15 experiments lasting about 4 years and averaging about $6 million a piece.

4. Oil Shale Processing

ISSUE

ERDA's priorities for oil shale R, D&D lack a sense of urgency in meeting the Nation's energy supply needs in the near- and mid-terms.

SUMMARY

ERDA's programs for oil shale development are concerned exclusively with in situ processes, but these processes will make no contribution to liquid fuel supplies in the near-term and have uncertain prospects for the mid-term. The ERDA conclusion that the above ground processing of oil and shale is not economically feasible (or has no need for Federal R, D&D support) has no basis in operating experience. An oil shale demonstration program based on available technologies is needed.

QUESTIONS

1. Why does ERDA's oil shale program fail to include support for demonstrations of surface retorting technologies?
2. What led to the emphasis by ERDA on the Bureau of Mines horizontal in situ retorting concept rather than modified in situ processes or vertical retorting concepts?
3. How serious are the problems of waste disposal and water consumption for surface retorting processes?
4. What basis is there for being optimistic about the projects for in situ gasification of oil shale?
5. How adequate are waste management procedures for the disposal of spent shale?

BACKGROUND

The Administrator of ERDA is mandated, in Public Law 93-577, Sect. 6(b)(3)(G) to "assign program elements and activities. . . (which) shall include. . , research, development, and demonstrations designed. . . to demonstrate the production of syncrude from oil shale by all promising technologies, including in situ technologies." The ERDA Plan includes programs to develop and demonstrate in situ recovery to produce shale oil, but no program at all for above ground research on oil shale production and retorting to shale oil. The ERDA document claims that "adequate technology exists for conventional mining and surface retorting of shale, but the economics of surface processing are marginal at best."

It is appropriate that ERDA should devote considerable effort to in situ shale oil production methods, because of the reduced environmental impacts of this technology, but not to the exclusion of mining and above ground retorting. There is no assurance that a satisfactory and economically competitive in situ technique can be developed. Even among the range of in situ extraction concepts, the horizontal technique, which receives the greatest emphasis in 'the ERDA budget, appears to carry a higher risk of failure than other techniques which are at least as far along in development. ERDA's proposed program for producing gas rather than oil from shale is an even longer term option than producing oil and has potentially serious additional problems; yet this option is supported in the budget, while above ground oil retorting alternatives do not appear in the program. If ERDA has valid reasons for taking this course of development, then better justification should be given for the programs that have been proposed and reasons given for exclusion of other approaches that many consider more promising.

Presently, no commercial above ground oil shale is processed in the United States. It appears that private sector investment sources are unwilling to accept the risks associated with a pioneer commercial facility. The several private projects which currently exist are still at the pilot retort stage. The critical problems associated with shale oil include mining technology for shale extraction, the economics of the total activity, and the management of waste in the form of spent shale. No commercial activity has had to cope with the mining and waste management problems at the level which would be created by a commercially viable shale oil plant, A commercial-scale facility can provide a broad range of opportunities to test procedures, prove technology, and train manpower in the special skills which must be developed. This is an appropriate subject for ERDA involvement at the demonstration level.

5. Synthetic Liquid Fuels From Coal

ISSUE

New and existing projects in coal liquefaction must be carried through the pilot and demonstration stages in order to determine what technical problems remain and to establish the oil price levels at which commercial production will occur.

SUMMARY

Justification of the coal liquefaction program rests primarily on the decline in U.S. oil production and on the need for supplies for those uses of liquid fuels for which there is no ready substitute. A successful commercialization program in the 1980's depends on the results of pilot projects, The existing and proposed development programs of ERDA are judged to be of the proper magnitude and in the correct direction. However, the constraints to commercialization, such as the capital investment, construction time, and development of associated mine facilities imply that the projection by ERDA of 5 Quads per year cannot be overcome by 1985. Thus, ERDA's projection that coal liquefaction will significantly affect fuel supplies by 1985 is-unrealistic.

QUESTIONS

1. How did ERDA arrive at a projection of 5 Quads per year of energy from coal liquefaction by 1985?

2. How serious are the environmental and health problems associated with the use of synthetic liquid fuels from coal likely to be? Are the hydrocarbons likely to be carcinogenic? Is chemically bonded nitrogen a problem?

3. What has ERDA done to determine the economic and commercial viability of the product ion of methanol as directed by Congress in Public Law 93-577?

BACKGROUND

Given the growing disparity between the ability of the United States to produce oil and our consumption of this fossil fuel, it is necessary to consider seriously how either the supply and/or the consumption of oil can be modified in ways least likely to do damage to society. Whereas replacement of oil by another fuel (coal) for direct heat and electric power generation is relatively straight forward, in principle, there presently exists no viable substitute for oil used in transportation, particularly in automobiles and aircraft, and chemical feedstock. By restricting oil to uses for which no other alternatives exist, the United States could extend its reserves of oil and provide a longer period to work on possible long-term solutions to the transportation problem. However, the development of an economically competitive synthetic liquid hydrocarbon derived from coal would introduce a valuable alternative strategy to counterbalance the decline of domestic oil supplies.

The technology for coal liquefaction developed during World War II is not directly applicable to economic commercialization under present conditions. Several second generation processes for producing liquid hydrocarbons have been shown to be technically feasible in small-scale testing. Data and experience to date, however, are too rudimentary to permit a prediction as to which, if any, of the several processes can yield a product for large-scale use at an attractive cost. The probability of payoff is sufficiently high, however, to warrant proceeding with a broadly based program. The orderly progression of this technology necessitates continuing it through the pilot and demonstration plant stages. In this regard, three projects are currently in progress: the H-Coal and Synthoil Pilot projects involve direct, high-pressure catalytic hydrogenation, whereas the Coalcon demonstration project covers a version of low-temperature carbonization under hydrogen pressure, These programs should be continued as long as results are promising.

Existing additional approaches to coal liquefaction should also be funded at a demonstration plant level of sufficient size to permit scale-up to a commercial plant. Two-stage “hybrid” liquefaction processes involving extraction followed by hydrogenation are sufficiently well understood to warrant the step up to this plant level. Given the large number of variants of this process being tested on a small scale, two such projects may be justified. If a viable process is identified, it should be possible to proceed to commercial projects at the 50,000 barrels per day level in the mid-1980’s. Such commercial projects would have a small impact on fuel supply in 1985. However, the projection by ERDA of at least 5 Quads per year at that time would require 50 such plants, each involving a capital investment on the order of $1 billion and a construction time of 5 years. The time scale of this ERDA projection is thus totally unrealistic,

Institutional problems do not appear serious in process development at the pilot stage under the present cost sharing procedure of 1/3 industry—2/3 Government, However, on proceeding to commercialization, all the possible problems associated with any process requiring the extraction of large amounts of coal from the ground appear: mineral rights, mining technology, land reclamation, water use, capital availability, and so forth, These problems are discussed in Issue 6 in connection with development of technology for high Btu gasification and, thus, are not repeated here,

6. High-Btu Gasification of Coal

ISSUE

The construction and operation of a first generation, commercial-sized, high-Btu coal gasification plant is a prerequisite to any decision on a coal-based synthetic natural gas industry.

SUMMARY

A pioneer commercial plant, producing 250 million cubic feet per day of high-Btu gas from coal, can be constructed immediately using current technology. Through its construction and operation, the economic, technical, and operating data necessary to assess the desirability of a coal-based synthetic natural gas industry can be determined. The objective of this construction is to determine whether or not high-Btu synthetic natural gas from coal is economically justifiable as a means of using the Nation's coal reserves to replace the declining supplies of natural gas and oil.

While several companies have shown a strong desire to build a commercial plant, they have not done so because of difficulties in financing such a plant, which will cost at least *$1* billion, Incentives of some form, such as loan guarantees or regulatory changes, may have to be provided by the Government if the natural gas industry is to build one of these plants,

QUESTIONS

1. What are the reasons for the uncertainty in the cost estimates regarding high-Btu gasification projects?
2. Why cannot a consortium of gas companies provide the necessary financing without Government assistance?
3. Should steps be taken to change the limitations imposed by the Federal Power Commission in granting certification of high-Btu gasification plants?

BACKGROUND

Although the Nation possesses vast coal reserves, they are not infinite, and the capital required to convert coal to useful energy is substantial. Therefore, it is imperative that utilization of coal be as efficient and economical as possible. High-Btu gasification of coal is but one option which must be evaluated. In this regard the construction of a pioneer commercial plant is important for the following reasons:

- Cost estimates for energy-related construction have been notoriously bad. The costs of high-Btu gas, determined from the operation of a pioneer commercial plant, will furnish a valuable basis upon which to make decisions as to whether to proceed with further commercialization.

- The construction and operation of the plant will provide experience in problems associated with the production and handling of massive quantities of coal, with the development of expertise in fabrication of special equipment, and with the training of personnel to operate and service the plant.

Proven technology, based on the Lurgi gasification process followed by a methanation stage, exists today to permit construction of a plant producing 250 million cubic feet per day. Moreover, since less than 25 percent of the total construction costs of plant and support systems is attributable to the gasification process, likely improvements in gasification technology can have only a minor impact on overall costs. There would appear therefore, to be little reason to delay construction in anticipation of such technological improvements.

Industry has shown a clear interest in constructing pioneer commercial plants. El Paso Natural Gas, WESCO (Pacific Lighting Corporation and Texas Eastern Transmission Corporation), and American Natural Gas Corporation have each filed applications before the Federal power Commission for certificates to authorize construction of commercial coal gasification facilities,

The WESCO plant, which has received certification by the Federal Power Commission, was scheduled to be built in San Juan County, New Mexico and deliver 75 percent of its gas to the Los Angeles area, At oral arguments before the Commission on March 14, 1975, the cost of this plant was stated to be in excess of $800 million and the tailgate price of gas was placed at about $2.45 per thousand cubic feet. Although the gas is readily marketable in Los Angeles, several constraints exist which have prevented WESCO from proceeding with the project. The principal problem is that the capital requirements of an individual plant are more than 50 percent of the total capitalization of the company proposing the plant, while the increment added to their gas supply is only about 10 percent of their total volume. As a consequence, financial institutions are unwilling to finance these plants without some sort of guarantee that the venture will recover its costs.

Central to this concern is the cost of the synthetic gas. The estimated cost of a plant with a daily capacity of 250 million cubic feet has increased from $300 million (mid-1972 dollars) to $800 million (January 1975 dollars) and the cost of coal has increased from approximately 20 cents per million Btu to 40 cents per million Btu. As a consequence the estimated cost of gas produced has increased from $1.40 per million Btu to over $2.40 million Btu.

Under the present energy regulatory structure, the only way the gas companies appear able to get financing on the terms they require to build the plants is to obtain Federal Power Commission approval of the cost of service guarantee concept, The Commission, however, has decided that it cannot grant approval and still maintain its responsibility to the public interest. In effect, the FPC has ruled that such a guarantee would allow an open-ended contract which could “escalate beyond the zone of reasonableness” should gas production drop substantially. The Commission has consistently adopted this view on all requests for a cost of service guarantee and has therefore attached a fixed rate to each certificate subject to filings for rate increase under section 4 of the Natural Gas Act,

The Federal Government can provide industry with the necessary incentives to build one plant having a capitalization of approximately $1 billion, in order to be able to determine whether synthetic high-Btu gas from coal is economically justifiable as a replacement for the declining natural gas supply. The best methods of providing these incentives remain to be determined; the Federal Government might, for example, guarantee the company a loan for plant construction as well as recovery of cost of service plus a reasonable return on investment,

The gas industry advocates construction of many—perhaps 20 or more—plants at the present time, on the grounds that the existing investment in gas transmission and distribution systems should be fully utilized. However, the cost of coal gasification may be so high that other options for supplying this energy demand will prove cheaper and, hence, more desirable, A commercial plant, made possible by offering the necessary incentives, would permit development of the data needed to clarify the relative merit of high-Btu gas from coal versus the other options.

7. Low-Btu Coal Gasification for Industrial Use

ISSUE

The ERDA program on low-Btu coal gasification does not give attention to the fuel needs of industrial furnaces, kilns, and ovens.

SUMMARY

Many users of natural gas and oil in the industrial sector (ferrous and nonferrous meta llurgy, glass, lime, cement, refractories, stills, etc.) could shift to low-Btu gas from coal if suitable gas producers were available, This shift would make an important contribution to the conversion from the use of oil and gas to the use of coal, and it would help to ensure against production cutbacks due to curtailments. There is much room for R, D&D supported by ERDA with a focus on assessment of the potential demand for low-Btu gas by the industrial sector, means for increasing this potential through modification of equipment or operations, and the development of gas producers having performance characteristics suitable for modern industrial use,

QUESTIONS

1. How does the potential demand for low-Btu gas in the industrial sector compare with that for use with combined gas turbine/steam turbine powerplants?
2. What fraction of the present use of natural gas and oil in the industrial sector could be shifted in the near-term to low-Btu gas?
3. Would the low-Btu gasifiers being studied by ERDA for other applications be suitable for use in the nonelectrical industrial sector?
4. What steps are being taken to supply fuel for those parts of the industrial sector now facing natural gas curtailments?

BACKGROUND

Gas producers, devices in common use 50 years ago for making low-Btu nitrogen-diluted gas, have almost disappeared from use. They were once used primarily in close coupling to the furnace to which they supplied fuel, thereby allowing effective delivery of the sensible heat content of the hot fuel gas; but they were sometimes used to produce cleaned cold gas. A variety of technical and economic factors led to their disappearance, the most dominant factor of which was the increasing availability of cheap natural gas. With our present declining natural gas reserves and our increasing dependence on foreign oil this situation has changed, and the desirability of again being able to make industrial gas from coal arises.

Although many industrial users of natural gas and oil could shift to low-Btu gas produced from coal if suitable gasifiers were available, the ERDA Plan does not address the problem. This shift to coal by the industrial sector has the potential to make an important contribution to solving the Nation's energy problem in the mid-term,

Since changes in labor, economics, size, environrnenta1 concern, etc., make the old gas producers unacceptable by today's standards, a strong R, D&D program is needed now. Much of the work being carried out by ERDA on low-Btu gasification will have application to the production of industrial fuel, but unless specific attention is given to the industrial sector, its special problems and requirements may be overlooked.

8. Mining Technology

ISSUE

Research on underground mining technology is required if coal production is to double in the next 10 years as projected.

SUMMARY

Government and industry are expecting coal production to double to 1.2 billion tons annually by 1985. To help assure that these projections can be met, coal mining R&D will require priority support. The productivity per miner in underground mines has decreased in recent years, principally because of improvements in health and safety standards; technological progress has been unable to offset the decline. Improvements in mining technology have the potential for making significant contributions sooner than most R&D projects in fossil energy, Although Federal responsibility for coal mining rests with the Bureau of Mines in the Department of the Interior, ERDA has a responsibility to ensure that the research necessary to improve the technology of underground mining of fossil fuel resources is carried out,

QUESTIONS

1. What importance does ERDA place on R, D&D in underground coal mining technology in meeting its objectives for coal use in 1985?
2. What action is ERDA taking in its role as lead agency in energy R, D&D to ensure that the proper programs are in progress on mining technology?
3. What does ERDA view as the major priorities for R&D in mining technology and what are the projected benefits from such R&D?

BACKGROUND

The 1985 coal consumption projections, based on industry and Government estimates, are in the *1.1* to 1,2 billion ton range, of which two thirds are expected to be consumed by electric utilities. To meet 1985 projected demand, coal production capacity will need to be doubled, an increase of 600 million tons capacity in *10* years. In addition, a minimum of *100* million tons of replacement capacity will be required to offset mine depletion or exhaustion, for economic and other reasons.

These large increases must be contrasted with the pattern of the past 5 years, over which total production of all coals remained stable,

Underground coal mining is expected to increase in actual output but to decline as a percentage of total production. Traditional room and pillar mining systems are the most widely employed methods for underground coal extraction. Equipment used is either conventional (mechanical loader, undercutting, wheel mounted shuttle cars, drills, roof bolters) or continuous miner (which eliminates undercutter and drill). To a lesser extent, the longwall system of mining has been introduced as a means of improving recovery, particularly in deeper seams. Expansion of this type of mining has tended to be inhibited by higher capital investment and a degree of inflexibility in layout introduced by the 1969 safety legislation, as well as by downtime experienced during transfers of equipment from panel to panel, Where applicable, the higher production generally offsets the system limitations.

A relatively new system of mining for pitching or inclined coal seams has been successfully introduced in Canada. Hydraulic or jet mining has been used in Russia and Japan for a number of years. There is reason to believe that many of the steeply pitching coal seams in the Western United States can be mined economically by this method. The science of hydraulic mining is not new; however, its application to coal in the United States would be,

There was a significant increase in the work force in 1970 following the enactment of the Mine Health and Safety Act; employment jumped from 124,000 to 140,000 workers. Although production volume has remained stable during the period from 1970-74, the number of miners increased by an additional 10,000 employees to 150,000.

Overall industry productivity declined from 19.9 tons per man day in 1969 to 17.3 tons per man day in 1974. More pertinent is the decline in underground mining productivity from 15.6 tons per man day in 1969 to 11.4 tons per man day in 1974, Strip mine productivity has remained about the same, at 36 tons per man day.

Research and development in underground coal mining technology has the potential of making important contributions to increased productivity and overall production, Advanced scientific and technological developments of the past decade have not yet been transferred to coal mining but hold considerable promise of being applicable,

Research is needed on a wide range of problems:

- high speed mine development to decrease the time necessary to bring new mines into productivity,
- automated longwalling systems to increase productivity through automation,
- machine reliability improvement to reduce delays,
- continuous roof support to reduce the time required for installation of roof support,
- haulage systems to speed the movement of coal from the operating face to the surface plant,
- methods for full extraction from thick and multiple seam western coal,
- control of mine subsidence and waste discharge, and
- preparation techniques for upgrading the quality of coal,

The Bureau of Mines presently has R&D programs covering most, if not all, of these subjects. Assurance is needed, however, that the level of effort in coal mining research is commensurate with the importance of the increased production of coal to meet the Nation’s energy requirements. In reviewing and modifying overall R&D strategies for problems relating to fossil energy, ERDA must cooperate to ensure that improved mining technologies are developed for underground operations.

9. Direct Coal Utilization

ISSUE

ERDA's near-term program for direct coal utilization by utilities and Industry is narrowly oriented toward fluidized bed combustion.

SUMMARY

The use of fluidized-bed combustors with sulfur-absorbing beds to provide gas cleanup is unlikely to make a significant contribution in the near-term (to 1985), as predicted by ERDA, due to technological barriers to implementation, Two major coal combustion problems whose resolution would have major near-term impacts are:

1) the technical difficulties of substituting coal for gas and oil in presently existing utility and industry applications (retrofit), and

2) the direct use of coal in a way which will meet environmental requirements.

Other technologies which hold promise of providing solutions to these problems are pulverized fuel firing, and precombustion cleanup; both of these need research and development support in order to enhance their contribution to direct coal utilization by utilities and industry, There is also a need for more basic research in coal chemistry. The present division among three Federal agencies of responsibility for coal cleanup causes variations in the criteria adopted by the agencies as well as in the size and effectiveness of their programs. By assigning the funds and responsibility for managing these programs to one agency, the development of a balanced coal cleanup program could be facilitated. In all areas, the energy program could be set back by a failure on the part of ERDA to recognize the needs of the industrial sector such as the ferrous and nonferrous metal fabrication industries, the glass and ceramics industries, and manufacturers of cement and lime.

QUESTIONS

1. On what grounds does ERDA exclude R, D&D on improved pulverized coal combustion?

2. What improvements in pulverized coal technology are necessary in order to make this technique a viable option for future coal burning plants?

3. What are the problems to be solved prior to commercialization of pressurized fluidized bed combustion?

4, How do the projected costs for solving the problems in pressurized fluidized bed combustion compare to the costs of achieving improvements in pulverized coal burning?

BACKGROUND

ERDA's program in direct coal utilization is narrowly focussed on fluidized bed combustion. Pressurized fluidized bed technology is probably at least 15 years away from becoming a commercial competitor with present pulverized fuel firing. The arguments for fluidized bed combustion are as follows. The combustion equipment is compact, possibly involving a lower capital cost; the opportunities for cleaning during combustion are great; and the technical understanding of fluidized bed operation at atmospheric pressure will spring-board the development of pressurized fluidized bed combustors. It is postulated that these later generation equipment, by the inclusion of sulfur-absorbing media in the bed, will be an ideal method of providing hot gases to drive gas turbines. The future use of fluidized bed combustors requires the resolution of several technical problems. These difficulties include the product ion of large quantities of waste (up to 300/0 of the amount of coal burned), hot gas cleanup problems, and materials problems associated with boiler tubes submerged in the bed. The emission of sulfur compounds from coal combustion systems must be prevented or reduced in order to make this source of energy environmentally acceptable. Until now, sulfur emission has been controlled by post combustion cleaning, i.e., stack-gas scrubbing. Unfortunately, stack-gas scrubbers are expensive to build and operate, and have been unreliable in use. Alternatives are being sought and the ERDA plan chooses an intracombustion method, i.e., the inclusion of a sulfur-absorbing medium within a fluidized bed combustor, Because of the technical problems mentioned previously, additional options should also be pursued. Precombustion coal cleaning techniques can make a significant contribution toward the reduction and control of sulfur emissions,

Precombustion methods have been in operation since the 1930's in various parts of the world. They fall into two groups; physical and chemical. The former are the most tried and, with some coals, have proved entirely satisfactory in service to remove up to 80°/0 of the sulfur present, although usually less than 500/0 is removed by this technique,

Research is needed to examine other precombustion cleanup methods and to study the fundamental mechanisms of the combustion process.

The division of Federal responsibility among three agencies presents an obstacle to the development of a balanced program in coal cleanup. Presently the Bureau of Mines oversees Government support of R&D in precombustion cleanup, while post combustion cleanup falls within the jurisdiction of the Environmental Protection Agency and intracombustion cleanup has been taken up by ERDA.

Under these circumstances, adequate tradeoff evaluations or balances among these alternative approaches may not occur. Furthermore, the criteria used to evaluate each option vary with the lead agency, and there is no place where the entire profile of criteria (environmental, economic, institutional, efficiency) is applied across the board to all options. Furthermore, the size and effectiveness of programs devoted to each technology by different agencies are likely to be quite variable with no guarantee that the most promising approach will be properly emphasized, It would appear to be desirable to have the funds devoted to these various approaches allocated and managed by one agency even if these funds were then passed to other agencies.

Finally, ERDA's program in fossil fuels must consider the needs of industry, which consumes 40 percent of the Nation's energy. Failure to prepare for industrial needs for an acceptable substitute for oil and gas in existing facilities could lead to reduced production to the detriment of the economy and society.

10. Low-Btu Gasification, Combined Cycle Powerplants

ISSUE

The present ERDA program to develop integrated low-Btu gasifier, combined cycle powerplants has underestimated their potential.

SUMMARY

In terms of both efficiency and economics, the integrated low-Btu gasifier, gas turbine/steam turbine, combined cycle electrical generating system promises to become one of the best methods of using coal in an environmentally acceptable manner that is likely to be developed, Commercialization of such a system, which would have an overall efficiency of 37 to 38 percent (coal pile to bus bar), should be achievable in the mid to late 1980's if a balanced research and development program is conducted. The ERDA documents give no indication that planning for such a program is taking place.

QUESTIONS

1. On what schedule and at what funding level are pilot and demonstration plants for integrated low-Btu gasifier, combined cycle systems included in the ERDA program?

2. What is the schedule and funding level for development work on high temperature turbines for improving cycle performance?

3. What plans has ERDA made for research and development on gas cleanup systems that are applicable to low-Btu gasification, combined cycle systems?

4. Of the different types of pressurized low-Btu gasification, clean gas processes, (e.g., fixed bed, fluidized bed, and entrained bed):
   a. What are the different probabilities of technical and commercial success?
   b. Will the construction of demonstration plants for all three gasification processes be funded in order to assess their relative economics?
   c. What are the probabilities of success of hot gas cleanup versus cold gas cleanup via scrubbing?

BACKGROUND

The lowest cost, environmentally acceptable, coal-fired, base load electric powerplant in the foreseeable future may be an integrated, pressurized low-Btu gasifier, high temperature gas turbine, and steam turbine plant. Such a system could be built today but it would be limited to particular (noncaking) kinds of coal and to efficiencies comparable to conventional coal-fired steam plants. The operating features and requirements of the gasifier and the combined cycle plant complement one another, the turbine producing compressed air and steam for the gasifier and the gasifier producing gas turbine fuel, This integration offers the possibility of significant gains in overall plant energy efficiency and reduction in plant costs by the common use of large major components as contrasted with freestanding fuel and powerplants. There is a clear technical path by which such systems could be developed in stages so as to use a wide variety of coals and reach overall efficiencies (coal pile to bus bar) of above 40 percent, One path which appears to have the least severe technical barriers includes the following developments: (1) improved pressurized fixed-bed gasifier capable of handling caking coals and having higher capacities than today's units; (2) improved gas cleanup systems; (3) plant integration to optimize the synergism between gasifier, gas turbine and steam turbine; and (4) advanced gas turbines with firing temperatures well above 2000° F, growing eventually to near 3000°F.

The integrated low-Btu gasifier, combined cycle system could be developed via no more than two to four generations of precommercial demonstration plants. Each plant would lead to another round of technical advances; the final goal would be achievable in the late 1980's. If the likely technological developments occur, the system may generate electricity at a lower cost as well as more efficiently than conventional coal-fired plants with stack-gas scrubbing and, in addition, would present a minimum of byproduct problems. The system costs would appear to compare favorably with those of a nuclear light water reactor of equivalent size.

A program of the type described above does not appear as a line item in ERDA's Plan. Rather, the technological components of the low-Btu gasifier, combined cycle system are distributed among sever al o f the proposed ERDA programs. The turbine portion of the system appears under "Advanced Power Systems" and "Electric Conversion Efficiency, " while the low-Btu gasifier portion is located under "Coal Gasification." The low-Btu gasification programs would appear to be better placed under "Direct Coal Utilization, Utilities/Industry" since the latter describes their functional objective—quite a different objective from those of the high-Btu and 1iquefac-t ion programs. In addition, the low-Btu gasification program should be carefully watched to take into account progress in advanced turbine development.

11. Advanced Fossil Fuel Combustion Programs

ISSUE

Frequent evaluation of progress in **magnetohydrodynamic (MHD) and other high-efficiency energy R&D programs will be necessary to ensure maximum energy yield over the long term.**

SUMMARY

The ERDA Direct Coal Utilization program contains both the Direct Combustion (i.e. fluidized bed) and Advanced Power Systems (i.e. gas turbine) programs. MHD research is a separate program, even though MHD is a direct combustion process. Fuel cell R&D is not included in the Fossil Fuel Division of ERDA, though it has more in common with the fossil programs than with the non-combustion Advanced Division in which it is housed. Relative fu ding of these programs indicates heavy ERDA emphasis on fluidized bed and MHD, much less emphasis on advanced gas turbine research and an almost total disregard of fuel cell technology.

A portion of the present ERDA emphasis is well placed, given that fluidized bed combustors and MHD systems can burn coal directly, while the advanced gas turbine and fuel-cell technologies require liquid or gaseous fuels which over the long term will have to come from coal conversion. Thus, while the advanced gas

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turbine and fuel-cell technologies can probably be brought to commercial application much sooner than MHD or pressurized fluidized beds, their fuel deployment will depend on progress in the commercialization of synthetic fuels.

In many applications, these technologies are mutually exclusive. Funding and program decisions about each will be affected by progress in the other programs. The MHD program in particular has several major technology hurdles to overcome prior to commercial application using coal. While the MHD program appears to be adequately funded and structured, continuous assessment of progress in MHD development relative to the other technologies will be necessary to ensure that research expenditures yield the maximum benefit. By comparison, fuel-cell technology development deserves more support than it is currently receiving in ERDA. Both recent industrial progress in developing commercially feasible fuel-cell technology and the Congressional mandate in Public Law 93-577, Section 6(b) (3] (N) "to commercially demonstrate the use of fuel cells for central station electric power generation" indicate a need for more ERDA attention to fuel-cell technology,

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QUESTIONS

1. What is ERDA's projection of the MHD/combined cycle contribution to U.S. electrical energy production as a function of time?
2. What are the technical problems which must be solved before coal-fired open cycle MHD power plants can be considered for commercial operation?
3. What is ERDA's view of the relative merits of MHD, Rankine topping cycles, organic bottoming cycles, and fuel cells in terms of their potential for energy generation efficiencies and fuel savings as a function of time?
4. How does the ERDA program in fuel cells relate to the private industry commitment to this technology?
5. What will be achieved with the FY 76 budget of $500,000 for fuel cells? How would a greater expenditure on fuel-cell technology improve the program. ?

BACKGROUND

The MHD generator is a direct energy conversion device which transforms the kinetic energy of ions entrained in a high-speed gas flow into electrical energy by passage of the flow of gas and entrained ionized particles through a strong magnetic field. There are two basic types of MHD generators:

- Open-cycle, in which the working fluid is produced by the combustion of a fossil fuel and is passed once through the cycle.
- Closed-cycle, in which the working fluid is recirculated, the heat input being supplied via a suitable high temperature heat exchanger.

Since open-cycle systems utilize the combustion products as the working fluid of the cycle, they do not need any solid surface interposed between the heat source and the conversion device, and the temperature is fundamentally limited only by the heat source.

The primary utility of the concept lies in its potential use as a topping cycle for extending the upper temperature limit on conventional electrical generating systems, thus increasing the efficiency of energy conversion of the overall system from the presently achievable 38-40 percent up to 55-60 percent.

The MHD concept has been in development at the laboratory research level since the late 1950's.

Primary interest in the United States in MHD is based on the concept's projected ability to operate with direct coal combustion. The Soviet Union has a working demonstration system, but the Soviet U-25 facility is fired with natural gas.

There are presently three critical questions relating to the feasibility of MHD, the answers to which will determine whether the present research efforts should be continued. ERDA's program is pursuing the answers to those questions, which are described below.

The first problem area relates to the efficiency of enthalpy extraction, or the transfer of energy from the moving gas stream to the electrical circuit. The efficiency of this transfer is dependent on the orderly linear motion of the ionized gas through the magnetic field created by a superconducting magnet. What data are available indicate that efficiencies on open-cycle MHD achieved to date are in the vicinity of 8 percent, rather than the 20 percent which will be required for feasible application of the MHD concept. Over *20* percent enthalpy extraction has been achieved in closed-cycle MHD experiments. These percentages, however, were not obtained at the flow conditions and magnetic fields contemplated for commercial service. The open cycle enthalpy extraction was obtained in supersonic flow with a magnetic field of about two tesla. Commercial open-cycle generators are expected to operate in subsonic flow with magnetic field strengths of about six tesla. The closed cycle extraction was achieved at higher temperatures and lower magnetic field strength than are considered appropriate for commercial equipment.

A second major area of inquiry relates to the feasibility of preheating the combustor inlet air by exchange of heat from the gas exhausted from the MHD duct. The efficient and durable heat exchanger configuration required to accomplish this has not been demonstrated. (Such a high temperature heat exchanger, if successfully developed, would also be applicable to a wide range of advanced heat generation and fuel conversion processes).

The third critical area of inquiry relates to recovery of the ion "seed". The entire MHD process rests on the seeding of the combustion gases with a potassium salt, which both ionizes easily and preferentially combines with the sulfur in the coal to form potassium or cesium sulfate. The economic feasibility of the MHD concept requires virtually total recovery of the seed, which is then chemically processed for reinfection. The high recovery rate required has not yet been demonstrated in the slagging environment of a coal-burning MHD generator.

Assuming successful laboratory scale demonstration of these three critical processes, the further development of the MHD process to the commercial level will require many years. This fact is reflected in the schedules for the program in the ERDA documents.

Fluidized bed combustors and advanced gas turbines are described elsewhere in this chapter (Issues 9 and *10)* and will not be further discussed here.

Fuel-cell technology holds great promise for electrical energy generation at efficiencies comparable to those claimed for the MHD/combined cycle technology. Industry has made significant contributions in fuel-cell R&D and has advanced the state of the art to the point where fuel cells using methane or natural gas are now competitive with standard steam generator systems in terms of efficiencies, There is need for continued research to further improve both the efficiency and the economics of fuel-cell systems. Fuel-cell technology can be a natural complement to low-Btu synthetic gas production from coal, and has further advantages in the potential for generation of electricity at the neighborhood or district level. The Congress, in Public Law 93-*577,* Section 6(b)(3)(N), directed the Administrator of ERDA to ". . . assign program elements and activities (including) research, development and demonstrations designed. . . (N) to commercially demonstrate the use of fuel cells for central station electric power generation." The amount budgeted for fuel cell R&D ($500,000) for FY 76 seems so little as to represent a token response to this mandate.

12. Interagency Coordination: Coal Cleanup

ISSUE

Coordination between ERDA and other agencies appears to be inadequate in activities relating to research and development of fossil energy. This is particularly evident in coal cleanup.

SUMMARY

The responsibility for many programs important to the successful development of increased fossil fuel supplies lies outside ERDA. While this division of responsibility acknowledges the scope and expertise of other agencies, ERDA, in its capacity as lead agency in formulating Federal R, D&D strategy, has a responsibility to participate in the design, development, and coordination of these outside activities and to evaluate their progress. This is necessary to ensure that no serious omissions or delays occur because of problems in non-ERDA programs on which ERDA programs are dependent either in their development or their implementation. Further, when policy decisions are made concerning alternative technologies, it is important that the criteria used in assessing the options do not vary among the decisionmaking agencies. In some cases, a redefinition of responsibilities may be desirable, A case in point is the problem of coal cleaning. Precombustion cleanup research is performed by the Bureau of Mines, during combustion cleanup by ERDA, and post combustion cleanup by EPA.

QUESTIONS

1. What mechanism is ERDA using to coordinate its programs with those of other agencies?
2. How are relative priorities established in program areas that involve several agencies?
3. Does ERDA believe the present level of R&D techniques matches their potential benefits?
4. Is the distribution of R&D responsibilities in fossil energy among the Federal agencies the most effective for achieving the national energy goals?

BACKGROUND

Important segments of the Nation's R, D&D programs in fossil energy are administered by agencies other than ERDA. For example, mining technology and ore beneficiation are located in the Bureau of Mines, fossil resource assessment in the Geological Survey, stack-gas cleanup in the Environmental Protection Agency but precombustion cleanup in the Bureau of Mines, and coal transportation in the Department of Transportation, This division of responsibility evolved from the previously existing agency charges and acknowledges the basic interests and expertise of the various agencies.

This separation of R&D programs among different agencies poses problems to successful implement at ion of overall energy strategy. ERDA, in its position as the agency directly responsible for formulating and implementing

Federal R, D&D policy, is charged by its legislative mandate with an oversight responsibility relative to energy programs which are not under its authority. It must participate in the design and development of important programs and provide the coordination to insure that no gaps or wasteful overlaps in programs occur; it must also continually monitor the progress of outside activities to avoid unnecessary delays. The size and effectiveness of programs devoted to energy-related problems by different agencies is likely to be quite variable, with no guarantee that the level of effort will match the needs. The criteria used to evaluate competing options can also be expected to vary depending on the agency. ERDA has a mission in reducing these problems.

One example of a division of responsibility important to the increased use of coal is the problem of coal cleaning. Precombustion cleanup research (e.g., magnetic desulfurization) is performed by Bureau of Mines, during combustion cleanup (e.g., fluidized bed combustion] by ERDA and postcombustion cleanup (e.g., stackgas scrubbing) by EPA. Are the relative levels of effort of these various research programs adequate in proportion to their potential contributions to the different technologies for the use of coal in utilities and industry? An answer to this question cannot be obtained from the ERDA documents. The present distribution of research programs must be carefully examined to determine whether it provides the best approach to solving environmental problems associated with coal combustion. Some reassignment of responsibilities may become desirable.

13. Environmental, Social, and Political Impacts of Mining

ISSUE

Even if mining technology is adequate to support an expanded use of coal and oil shale in the United States, there are potential obstacles associated with environmental, social, and political impacts of a massive increase in mining.

SUMMARY

A major increase in electricity y generation from the direct combustion of coal or the conversion of coal to synthetic gas and liquid fuels at a commercial scale will require a significant expansion of coal extraction, For example, a 250 million cubic feet per day plant for producing pipeline gas from coal will require a coal mine as large as any presently operating in the United States. The plant will consume more coal than is now mined in Utah. An activity of this scope will almost certainly encounter resistance from groups in society that are especially concerned about environmental quality; these groups may have considerable influence at State and local levels. If these concerns are not to become a serious constraint to the use of improved fossil fuel technologies, ERDA must be sure that necessary programs are established to reduce uncertainties about environmental and social impacts and to mitigate serious negative impacts,

QUESTIONS

1, Are the research activities of Federal agencies, other than ERDA, sufficient to avoid future environmental and social constraints on the application of improved fossil fuel technologies?

2 What are the options—and the pros and cons—for accommodating the concerns of States about potential negative environmental and social impacts of an expansion of coal- and oil-shale mining?

30 How large a community must be established to build and operate a commercial-sized synthetic fuel plant and its associated mining activities?

BACKGROUND

Coal, as our largest domestic fossil energy source, and oil shale, as a sizable resource for liquid fuels, are certain to increase in importance in the national energy picture; for example, the current goal is to double coal production to 1.2 billion tons a year by 1985. Along with the technological challenge of mining at such a scale, there will be major concerns about mineland reclamation, waste disposal, protection against water pollution, “boom and bust” urban growth, water consumption, and other environmental and social impacts of the mining activities.

Opinions differ as to the seriousness of these problems. Some believe that they are major impediments, likely to block a rapid increase in coal- and oil-shale utilization. Others believe that they are not serious problems and that the opposing view is misinformed. But representatives of both points of view agree that a better base of information about these impacts would help to reduce delays in applying improved fossil fuel technologies. Thus broad and detailed studies are in order on environmental problems associated with coal and oil shale mining, such as waste disposal, reclamation and revegetation, watershed protection, and water supply and conservation, to increase as rapidly as possible the range of options for mitigating negative impacts. Also, improved understanding of the social and economic impacts of locating new, large communities in sparsely populated regions will assist in planning for these communities and satisfying the legitimate concerns of local residents,

A special concern of many coal or oil-shale rich States is that they will have to bear the burden of negative impacts for the sake of meeting the energy needs of consumers in unaffected States. This introduces important questions in Federal-State relations. In some respects, the increased use of coal and oil shale will be a process of political accommodation, and ERDA can accelerate the process by such activities as the preparation of regional programmatic impact statements and the collection of data to buttress them,

The proposed ERDA budget does not appear to include sufficient funds for the kind of effort that is needed,

14. Manpower

ISSUE

ERDA's program for massive expansion of the use of coal will require far more trained personnel at various levels than can naturally be expected to enter those sectors of the labor market.

SUMMARY

ERDA estimates of increased coal production will require a significant increase in the number of underground coal miners, including first-line supervisory personnel and coal mining engineers. The fluctuating production levels of the coal mining industry over the last 25 years has resulted in a current work force composed principally of miners over 50 or under 30 years of age. Simultaneously, advanced mining techniques and machinery impose a requirement for more education and special training. Coal research and mining engineering programs at the university level are few and thinly staffed. Significantly more faculty are needed to expand and multiply these programs. The development of gasification and liquefaction plants will also increase demand for both university-trained professionals and for subprofessionals with special skills. Failure to support the development of the necessary manpower pool in these and other areas requiring critical skills could result in failure to achieve the goals which ERDA has set, even if the technology and other required inputs are available.

QUESTIONS

1. What special ski lls are critical to the success of the proposed fossil fuel programs, and how many 'trained personnel will be needed?
2. What information is available concerning the ability of existing professional and trade educational facilities to provide the necessary trained personnel?
3. What impact will o her energy programs have on manpower available for the fossil fuel industries?
4. What level of ERDA support for educational programs is planned to provide the necessary manpower, and over what period of time?

BACKGROUND

The future in fossil fuel production and consumption envisioned in the ERDA program consists of a continuing decline in the supply of petroleum and natural gas from primary sources, with the difference between supply and demand being replaced primarily by coal, either in direct use or via conversion to liquid and gaseous synthetic fuels. The projected massive increase in coal extraction and processing will require a comparably massive injection of newly trained manpower into industries which either have languished for decades or are now in their infancy.

The manpower supply situation for the required increase in coal production may become severe. There are certain special skills required by underground miners which can only be gained by experience. The recession in the industry that reduced production during the post-war years curtailed recruitment, so that the average age of skilled miners is now in the upper 40's. Young people are being recruited in increasing numbers, but there is a missing generation and the continuity has been broken. The father-to-son tradition and local community spirit have largely disappeared, Moreover, there has been a significant increase in the technical training required to operate and maintain the sophisticated machinery that is now in use. Supervisory personnel who would normally be drawn from the middle generation are not available, and intensive education and training are necessary to assure a stable skilled work force.

Strip and auger mines have fewer problems in recruiting personnel, provided job, wage, and living conditions are comparable, since they can draw on general construction skills. Strip mining is capital intensive; a large dragline or shovel may cost more than $15 million fully installed, requiring full utilization and operation by highly trained personnel.

There was a significant increase in the mine work force in 1970 following the enactment of the Mine Enforcement and Safety Act; employment jumped from 124,000 to 140,000 workers. During 1970-74, manpower increased by an additional 10,000 employees to 150,000.

Because of a decline in underground mining productivity y, overall industry productivity declined from 19.9 tons per man in 1969 to 17.3 tons per man in 1974. Strip mine productivity remained about the same at 36 tons per man, and auger mining increased from 40 to 45 tons per man. The effects and the measures required by the 1969 Mine Health and Safety Act have now been absorbed by mine operators and may not cause any major additional impact on future mining manpower or costs, although their effects will escalate steadily in step with other mining costs .

Projections of production, manpower, and productivity for 1985 are:

Product ion	1.0 to 1.2 billion tons
Work Force:	
IJnderground mines	160,000 persons
Strip and Auger Mines	75,000 persons
Total Estimated	235,000 persons
Productivity Per Employee Shift:	
Underground Mines	13 to 15 tons
Strip Mines	40 to 45 tons

In general, the following developments can be anticipated:

- The labor force will be composed of highly skilled technicians, electronic and hydraulic experts able to operate and maintain sophisticated and costly equipment.
- Underground and strip mine workers will be more highly skilled, younger, and better paid.
- There will be an increasing demand for mining engineers and other engineering skills to maximize system performance.
- There will be increased need to upgrade the educational level of the work force through trade schools and adult education facilities.

The requirement for university-trained personnel raises an additional set of problems. There are at present only three substantial university coal research programs and only 5 schools which teach coal preparation technology. The number of students in these programs is quite small, The opening of new college and university programs and the expansion of existing departments is likely to distribute more sparsely an already small faculty base unless special attention is paid to this area. The support of university training programs via R&D contracts does not appear to be an adequate response to the problem for two reasons. First, universities that are under pressure to produce competitively in R&D programs often compete for professional manpower and neglect their educational role. Second, universities may be unwilling to undertake long-term educational programs in support of R&D because of past experience in which abrupt cancellations of support left them with unsupported educational programs. Direct support through fellowship and traineeship programs at both graduate and undergraduate levels will probably be required in the educational areas where a future shortfall of personnel is identified.

15. Transportation Systems

ISSUE

The application of fossil fuel technology research will require improved transportation systems in the United States.

SUMMARY

A shift from the use of crude oil and natural gas, imported or domestic, to the use of coal and synthetic fuel products from coal will make heavy demands on existing transportation systems. The rail network, which moves most of the Nation's coal, will be especially affected. In order to avoid major constraints on the application of improved fossil fuel. technologies, ERDA needs to anticipate the commodity movements that may be required and to assure that necessary additions to or changes in present transportation systems are brought about.

QUESTIONS

1, What are the interregional transportation requirements of ERDA's scenarios in volume 1, and how do they compare with the present capacities of transportation networks?

2. In ERDA's opinion, what are the prospects for an increased use of coal slurry pipelines?

3. To what extent are the needed changes in transportation capabilities a problem of Federal regulatory policy rather than a problem of technology development?

BACKGROUND

Whenever an energy product is produced at a location other than where it is to be consumed, it must be moved, We are well aware of the importance of pipelines for oil and natural gas in the United States today, and we are increasingly aware of the need to move large quantities of coal from mines to the locations of electrical generation plants, industrial users, and other consumers.

As a larger portion of the energy in the United States is made available from domestic resources other than oil and natural gas, the demands on our transportation systems will grow rapidly, and the present systems will certainly prove inadequate. For example, 44 percent of the electricity in the United States in 1972 was generated by burning coal, and 69 percent of the coal was moved by rail, If new technologies for the direct combustion of coal allow the 44 percent to be increased to 70 percent, replacing most of the portion now fueled by oil and natural gas (37 percent in 1972), the impact on the Nation's rail system will be massive: congested rail lines, a shortage of coal cars, pressure for revised tariff structures, etc. This will be especially true if much of the increase is based on western coal, because the distances from mine to market will usually be greater and the rail network in the West is much less dense, adding to the chance of bottlenecks and posing a problem of national security.

Other transportation systems may be problematic as well. Demands for barge transportation will increase, with the same dangers of congestion, equipment shortages, and pressures for price increases. Slurry pipelines, an alternative to the rail or barge transport of coal, presently require negotiations for easements with each State to be traversed, and they are significant users of water. The production of synthetic oil and gas will in many cases require either new pipelines or the reversal of directions of flow in existing ones. And there are numerous questions of fuel or energy storage configurations and regulatory responsibility. For example, coal slurry pipelines are the responsibility of ERDA; natural gas pipelines and electrical transmission are regulated by the Federal Power Commission; and rail transportation is overseen by the Department of Transportation and the Interstate Commerce Commission.

If coal utilization and conversion technologies are to be used to meet national energy needs, ERDA must assure that transportation systems will be capable of meeting the new demands on them. This calls for a wide-range study of the relative locations of resources and users, the capacities of transport networks that link them, and strategies for mitigating anticipated problems. The effect of tariff structures in transportation on the development and use of fossil fuels also needs to be studied.

16. Water Availability

ISSUE

ERDA has not established a systems-oriented study of water availability related to its energy program.

SUMMARY

ERDA has defined programs for extensive development of U.S. coal resources, for oil shale, and for increased electrification as part of its overall strategy for supply of energy in the United States, These programs all imply a greatly increased demand for water, in terms of both withdrawal and consumption. When these programs are viewed in the context of the total ERDA program, including nuclear and geothermal energy programs, it is apparent that the availability of water to supply commercial level energy production activities is uncertain, especially in the fossil fuel area. A large percentage of the fossil fuel development programs relate to the use of low-grade coal, generation of low-Btu gas, processing of oil shale and other activities which involve fuel sources or product streams which are not economically transportable. These activities may be located primarily in the resource-rich but water-short Northern Great Plains and Colorado River Basins. There is no evidence in the ERDA Plan of any coordinated water-resource planning activity to facilitate the implementation of the technologies for fossil energy production which ERDA has defined as critical to future energy supply.

QUESTIONS

1. Which division of ERDA has primary responsibility for maintaining an overview of water availability for ERDA's projected fossil fuel supply strategy?
2. Which division of ERDA has primary responsibility for maintaining an overview of water availability for ERDA's total energy supply strategy?
3. What is the nature and extent of ERDA's cooperative activities with other Federal and State agencies in the areas of water availability, allocation of water rights, and regional water quality maintenance?

BACKGROUND

There is widespread concern in the Western States about the water consumption requirements of coal gasification and liquefaction, oil shale liquefaction, and electrical power generation from coal. Every comprehensive energy supply plan for the United States calls for siting new facilites in the Northern Great Plains and the Upper Colorado River Basin, and these are areas where water is considered a precious commodity, a resource to be allocated with care, Present water consumption in these areas is well short of average supply levels, and representatives of the energy industry believe that adequate water is available for a commercial fossil fuel-based energy industry. But as long as there is considerable uncertainty in the minds of citizens of States like Montana and Colorado, the water question can be a focus for political resistance to new commercial facilities. Consequently, it is vital that water resources for western fossil fuel development be assessed carefully, clearly, and publicly—and compared with water consumption requirements for commercial developments that would be the result of ERDA-supported R&D. An adequate assessment will have to include water rights law, the economics of water resource development and use, seasonal and annual variations in surface water availability, interstate compacts for the downstream delivery of water, preferential treatment for (and the definition of) "beneficial" uses of water, and groundwater resources available for use without long-term depletion of underground water reservoirs.