III. DEVELOPMENT OF A LARGE SCALE TECHNOLOGY BASE

A. General

Many experts believe synthetic natural gas (SNG) from coal can and should be produced on a commercial scale using the existing technology. Second generation processes for SNG production potentially will improve the economics perhaps by about 20%, but these technologies are not now required to respond to the immediate need for increased productive capacity.

There is also a consensus that the economics of existing Bergius and Fischer-Tropsch processes for liquefaction of coal are so unfavorable with respect to those of the developing processes such as H-Coal and SRC (Solvent Refined Coal) that it will be preferable to build an industry based upon the new technology even if it takes two or three years longer to construct the first commercial scale liquefaction plants.

The technology exists for mining the coal that would be required as a source for a synthetic fuels industry. Work is required, however, to demonstrate techniques for minimizing the impact of strip mining on the environment, improve deep mining technology, and to provide the necessary manpower, materials, and services.

The basic goals of the technology development program are to have one or more commercial scale coal gasification plants operational by 1978-9 and one or more coal liquefaction plants operational by 1980.

The following sections will describe the status of technology for liquefaction, gasification, and mining; summarize the recommended synthetic fuels demonstration program for these areas and discuss government's role in accelerating development. A more detailed process description is found in Appendix B.

Appendix B presents a conceptual design of coal liquefaction plants based on Fischer-Tropsch, H-Coal, SRC and Methanol processes.

B. State-of-the-Art

1. Liquefaction

Present processes for the direct catalytic hydroliquefaction of coal are derived from the Bergius process used during World War II to supply Germany's requirements for aviation gasoline at about 2 1/2 times the cost of gasoline from crude oil. Pyrolysis and Fischer-Tropsch processes were also employed on an industrial scale, but with less success.

Continued development of liquefaction processes sponsored by U.S. Government agencies and private industry has included: (1) development of an improved process (H-Coal) for direct catalytic hydroliquefaction; (2) construction of pilot plants to investigate multistage processes (Consol Synthetic Fuel and

Solvent Refined Coal); (3) construction of a pilot plant to investigate a pyrolysis process (COED); and (4) research on new processes.

(a). Direct Catalytic Hydroliquefaction.

The "H-Coal" process, which involves contacting a coal-oil slurry with cobalt molybdate catalyst in a liquid fluidized bed reactor, was adapted from a process for residual hydrodesulfurization. H-Coal has 60% higher net liquid yields, lower operating pressure, and significantly lower sulfur products than the Bergius process. These technical advantages lead to the prediction that the H-Coal process might be economically competitive in the 1980's. This process is now the most highly developed post-war coal liquefaction process. It has been developed by Hydrocarbon Research, Inc., (HRI) with funds from the Office of Coal Research (OCR) and later from a consortium of oil companies. Since 1966, a unit handling 3 to 8 tons of coal/day has been operated successfully with lignites and bituminous coals. This development work has furnished an adequate data base for design of a large plant.

H-Coal can produce syncrude or boiler fuel fractions. It requires equipment similar to that now used for residual desulfurization. Development needs include equipment for slurry handling and a gasifier for production of hydrogen from char.

HRI and several energy companies have proposed to work with OCR to design, construct, and operate a 300 to 700 ton coal/day prototype plant for production of syncrudes and boiler fuel from coal. The conceptual design of this plant has been completed. The consortium believes this plant could be built with low risk and could be scaled directly to a full-scale commercial plant since it utilizes types of equipment that would be employed in a commercial plant.

This plant is cheaper and more flexible than the usual prototype facility — a single full-scale 6000-10,000 ton/day train.

The prototype plant could be used during the operation of a commercial plant to provide a testing ground for process innovations and effects of a variety of types of coal.

b. Extraction-Hydrogenation Processes.

Another new liquefaction process is derived from the Solvent Refined Coal (SRC) process. This process was developed originally to make a low-sulfur, ashless, pitch-like solid fuel and can be extended to produce liquids by addition of a second hydrogenation stage. This modified process is similar to the two-stage Consol Synthetic Fuel (CSF) process that was pilot-planted at Cresap, West Virginia, from 1967 to 1970. The modified process is intended to produce heavy fuel oils suitable for industrial boilers and power plant use. The difficult separation of fine ash-char solids has yet to be demonstrated at large scale.

A 6-ton/day pilot unit in Alabama and a 50-ton/day pilot in Washington both scheduled for 1974 operation are presently designed to produce the de-ashed, low-sulfur solid product. They should provide an engineering assessment of the solid-liquids separations.

A consortium formed by Old Ben Coal Company has recently proposed to join with Electric Power Research Institute (EPRI) and Office of Coal Research (OCR) to build and operate a 900 ton coal/day extraction-hydrogenation prototype plant at a SOHIO refinery. This plant will test commercial type process equipment and provide sufficient product to test in large utility boilers.

Exxon Corporation has also announced plans to construct and operate a prototype plant for converting 300 tons/day of coal to liquid products by a dissolution process at a refinery site. Exxon currently is testing the process at 0.5 tons of coal/day.

c. Pyrolysis Processes.

The COED process for multistage, fluidized bed pyrolysis of coal has been developed in a 36-ton/day pilot plant under OCR sponsorship. Although the pilot plant has run well only about 20% of the products are liquid. Over half the product is high sulfur char; it cannot be burned directly as a utility fuel. The process has potential economic viability only if a companion process for economically gasifying the high-sulfur solids is developed. Other pyrolysis processes are being developed independently by TOSCO, Garrett Corporation, U. S. Steel and Union Carbide Corporation.

The Union Carbide process, however, may be well enough developed to permit immediate scaleup to a precommercial plant.

d. Methanol Processes.

Fuel-grade methanol as a substitute automotive fuel could be produced by coupling existing commercial scale coal gasifiers (Lurgi, Winkler, or Koppers-Totzek) with existing commercial scale synthesis processes such as the Imperial Chemical Industries (ICI) process. Accelerated construction of a pioneer commercial plant for methanol production is recommended as part of Project Independence subject to the provision that further study supports the commercial scale viability of methanol as a substitute automotive fuel. Methanol production from coal is discussed in a separate demonstration project report. Cost studies made on a common basis with other coal liquefaction processes are included in Appendix B for comparison.

e. Fischer-Tropsch Process.

A Fischer-Tropsch process for the catalytic production of gasoline from a coal-derived synthesis gas does not appear to be competitive with the methanol process in the United States. The process has the advantage of established technology but requires a very large capital investment and yields only one bbl. oil/ton coal.

f. Newest Processes.

Processes for liquefaction in turbulent fixed beds in molten chloride salts and in flash heated reactors are also being investigated at the bench scale.

2. High BTU Coal Gasification

The El Paso Natural Gas Company and the Western Gasification Company (WESCO) currently are seeking authorizations to complete engineering and construct 250 million standard ft^3/day Synthetic Natural Gas (SNG) plants in northwest New Mexico. Initial production of SNG in these two plants is expected in late 1977. Other similar commercial plants are planned by these companies as well as by other utilities. The synthetic gas is expected to cost $1.45 per 1000 cubic feet.

The WESCO and El Paso plants will utilize the Lurgi high pressure coal gasification process. Since 1936, the Lurgi process has been used commercially in 19 plants (60 gasifier units) in many parts of the world, including Germany, Scotland, South Africa, and South Korea. Adaptation of the basic Lurgi technology requires the addition of a "methanation" step (catalytic reaction to upgrade the BTU level) to produce 970 + BTU/SCF gas required in the United States. Although there are no current commercial plants practicing large-scale methanation of coal gas, the technology of methanation has been widely practiced in other applications. Lurgi engineers have made extensive studies of coal gas methanation technology and catalysts on a pilot-plant scale. They are confident that the successful extension of these studies to commercial practice is technically and economically feasible at this time. To supplement Lurgi work in this area, WESCO, in combination with several major gas companies, has undertaken independent pilot plant and engineering studies for large-scale coal gas methanation.

3. Coal Mining and Plant Siting

In both U.S. and European countries conventional earth-moving equipment is used in surface mining of coal. Very little equipment technology has been developed specifically for coal mining. Restoration of mined lands has depended primarily on techniques borrowed from agricultural research. Very little foreign technology has been developed which can be directly applied to U.S. conditions.

Productivity figures for surface mining are generally good at this time but future outlook is clouded. Depending on the legislative direction chosen by Congress, certain classes of surface coal mining may be banned for environmental, social, or economic reasons. In addition, today's equipment may not meet the needs of tomorrow's industry. A commonly used figure is that surface mined coal will suffer a 30% increase in cost when pending regulatory actions have been effected.

"Continuous" and "conventional" room and pillar underground coal mining techniques have reached their highest development and widest application in North America. European and Russian underground coal mining practice is primarily based on the longwall mining system. Some applications have been made of shortwall mining systems in Australia and in the U.S. Because of differences in the economic systems, institutional and geological factors, foreign techniques are not directly applicable to U.S. practice. For instance foreign practice is generally more labor intensive. Recently there has been an increasing disparity between surface and underground mining costs and a dramatic downturn in underground coal mining productivity figures. The sharp downturn was the result of a number of powerful factors including past labor force composition, legislation, strikes, and softening markets. Increasing productivity trends will not be obtained in the near future without a strong coal mining R and D program. In the mining industry there has generally been a lag of 8-10 years between technological improvements and commercial application. Without the impetus of immediate R and D, underground mined coal will not be able to provide its share of the coal the nation would need for a synthetic fuels industry in the 1980's.

C. Accelerated Development Program

Table II lists the industrial coal liquefaction and synthetic natural gas projects now planned in the United States. Any government plans for development of these technologies should certainly consider the possibility of joint government-industry cooperation to accelerate these proposed projects.

Table II

Announced Industrial Plans for Commercialization of Clean Fuels From Coal

Company	Process/Capacity	Startup	Site
El Paso Natural Gas Company	High BTU Gas Lurgi 250 MMSCFD	1977-1978	Four Corners area New Mexico
WESCO	High BTU Gas Lurgi 250 MMSCFD	1977-1978	Four Corners area New Mexico
Peoples Gas (Natural Gas Pipeline Co.)	High BTU Gas Lurgi 250 MMSCFD	1979 (or Later)	North Dakota
Michigan-Wisconsin Pipeline Co.	High BTU Gas Lurgi 250 MMSCFD	early 1980's	North Dakota
Island Creek Coal Co.	High BTU Gas 250 MMSCFD		Kentucky
Transcontinental Gas Pipeline Corp.	High BTU Gas 250 MMSCFD		Northeast Wyoming
Consolidated Natural Gas Co.	COED + Char Gasification 250 MMSCFD	1981-1985	Pennsylvania
Peabody Coal & Panhandle Eastern Pipeline Company	High BTU Gas Lurgi 250 MMSCFD	1978-1980	Northeast Wyoming
Northern Natural Gas Co. & Cities Service Gas Co.	High BTU Gas 250 MMSCFD	1979-1980	Powder River Basin Montana

Table II (cont.)

Company	Process/Capacity	Startup	Site
Colorado Inter-state and West-moreland Resources	High BTU Gas 250 MMSCFD		Southern Montana
The Colombia Gas System, Inc.	High BTU Gas 250 MMSCFD		West Virginia
Texas Gas Trans-mission Corp. & Consolidation Coal Co.	High BTU Gas 250 MMSCFD		Illinois
Eastern Gas & Fuel Associates & Texas Eastern Transmission Corp.	High BTU Gas 250 MMSCFD		Northwest New Mexico
Carter Oil Co. (Subsidiary of Exxon)	High BTU Gas 250 MMSCFD		Northwest Wyoming
Sohio, Old Ben Coal Co., Consol Consortium	Boiler Fuel 2000 bbl/day	1978	Toledo, Ohio
Southern Calif. Edison Consortium	Syncrude 25,000 bbl/day	1979-1980	
CONOCO	Methanol 5000 tons/day		
DuPont	Methanol 5000 tons/day		

Tables III and IV present a summary of many of the important physical and economic characteristics of four types of liquefaction processes that are believed to have significant potential for industrial-scale implementation by the early 1980s. Several conclusions have been drawn from these data, together with other considerations detailed in Appendix B.

1. The processes for production of syncrude or boiler fuel by direct catalytic hydrogenation or extraction-hydrogenation appear to have significant potential for commercialization with relatively low technical and economic risk. For each type of process the recommended next scale of development would be a prototype plant with a capacity of 300 to 1000 tons/day of coal. The prototype scale of development could begin immediately for these two types of processes (and perhaps one other, depending on results of further studies) since:

   a. Such projects already have sponsors who will provide a substantial fraction of private funds.
   b. Machinery exists within the government to begin projects of this scale.
   c. The prototype plants constitute a logical next step in scale before pioneer full-scale commercial plants, but are sufficiently small to minimize environmental impacts, permit flexibility in design, and reduce the consequences of technological failure.

2. It appears that the Fischer-Tropsch process for production of gasoline will be too expensive to arouse industrial interest.

3. The data indicate that methanol from coal as a substitute automotive fuel will be less expensive than gasoline from Fischer-Tropsch but probably will be more expensive than gasoline derived from syncrude produced by catalytic hydroliquefaction of coal. The most important advantage of methanol from coal is that the required technology is available now. Thus production on an industrial scale could proceed with a minimum of delay.

Table III Comparison of Processes Considered for Production of Synthetic Fuels from Coal

All costs expressed in 1973 dollars.

Process or Plant	Direct Hydrogenation		Extraction/Hydrogenation		Fischer-Tropsch		ICI		WESCO	El Paso
Principal Product	Syncrude		Boiler Fuel		Gasoline		Methanol		SNG	
Type of Plant	Prototype	Commercial	Prototype	Commercial	Commercial	Commercial	Commercial	Commercial	Commercial	Commercial
Type of Coal	Bituminous[a]	Bituminous[a]	Bituminous[a]	Bituminous[a]	Subbit.[b]	Subbit.[b]	Subbit.	Subbit.	Navaho	Navaho
Type of Gasifier	Advanced	Advanced	Advanced	Advanced	Lurgi	Advanced	KT	Lurgi	Lurgi	Lurgi
Input										
As-received coal, tons/day	1,040	35,300	1,144	43,800	148,000	97,500	40,800	25,950	25,620	25,950
Electricity, kW	7,450	257,000		400			-	-	28,500	-
Water, gpm	485	14,100		14,500	168,000	111,000	14,800	6,200	5,100	5,000
Total energy, 10^9 Btu/day	23.2	782	27	1,000	2,600	1,710	724	461	440	460
Output										
High Btu fuel gas, 10^9 Btu/day	-	110	6.2	-	-	-	-	176	238	238
Liquid fuel, bbl/day	2,260	82,510	2,100	101,520	100,000	100,000	154,800	38,700	-	-
, tons/day				18,520	12,600	12,600	20,000	5,000	-	-
, 10^9 Btu/day	13.6	470	11.5	627	574	574	391	98	-	-
By-products, tons/day	18	1,566		1,280	8,600	8,600	400	2,200	1,580	
Waste gases, tons/day				77,720	30,700	20,300	-	-	17,400	
Waste water, gpm	130	4,900	100	4,260	28,100	18,500	12,000	1,000	1,000	
Solid wastes, tons/day	120	4,100	150	2,840	30,100	19,900	2,000	4,700	6,400	
Total Capital Investment, \$ Millions	60.5	689	62	832	2,293	1,498	752	521	456	455
, \$/10^6 Btu/yr	13.3	3.58	10.5	4.02	12.1	7.91	5.83	5.78	5.02	5.80
Annual Operating Cost, \$ Millions[c]	9.78	143	7.23	175	261	211	89	47	60.9	49.3
, \$/10^6 Btu	2.15	0.75	1.24	0.85	1.38	0.97	0.69	0.52	0.78	0.63
Fuel Production Costs										
High-Btu gas, \$/10^6 Btu	-	1.57	-	-	-	-	-	-	1.53	1.51
Liquid fuel, \$/10^6 Btu	5.3	1.57	3.70	1.79	4.58	3.07	2.06	1.87	-	-
, \$/bbl	32.1	8.94	20.3	11.0	24.2	16.8	5.60	5.08	-	-
Process Efficiency, %	60	74	65	63	22.1	33.5	45	59	67	63
Manpower										
Engineering, my	96	930	96	1100					635[d]	
Construction, my	390	3,710	390	4500					5,700	
Operation, y/yr	280	840	300	930					612	
Steel for Construction, 10^3 tons	10	96	11	150					50-60	

[a] Midwestern Bituminous Coal at \$7.50/ton.

[b] Western strip-mined subbituminous coal at \$3.00/ton.

[c] Including by-product credits.

[d] Mine requires 96 my for engineering, 1500 my for construction, and 40,000 tons steel.

Table IV. Estimated Effects of Type of Process, Type of Coal, Cost of Coal, and Capital Fixed Charge Rate on the Cost of Producing Several Synthetic Fuels from Coal

Product	Process	Coal Type	Coal Cost $/Ton	Capital Fixed Charge Rate %	Product Cost $/10^6 Btu	Product Cost $/bb
Syncrude[a]	H-Coal	Bituminous	7.50	23.4	1.57	8.9
		Bituminous	8.50	23.4	1.63	9.3
		Bituminous	7.50	17.9	1.37	7.7
		Subbituminous	3.00	23.4	1.59	8.9
		Subbituminous	4.00	23.4	1.68	9.4
		Subbituminous	3.00	17.9	1.36	7.6
Boiler Fuel	SRC, Consol	Bituminous	7.50	23.4	1.79	11.0
		Bituminous	8.50	23.4	1.86	11.5
		Bituminous	7.50	17.9	1.56	9.6
Gasoline	FT-Lurgi	Subbituminous	3.00	23.4	4.58	24.1
		Subbituminous	4.00	23.4	4.87	25.7
		Subbituminous	3.00	17.9	3.85	20.3
	FT-BiGas	Subbituminous	3.00	23.4	3.07	16.2
		Subbituminous	4.00	23.4	3.26	17.2
		Subbituminous	3.00	17.9	2.60	13.7
Methanol	KT-ICI	Subbituminous	3.00	23.4	2.06	5.6
		Subbituminous	4.00	23.4	2.16	5.8
		Subbituminous	3.00	17.9	1.74	4.7
	Lurgi-SNG	Subbituminous	3.00	23.4	1.87	5.0
		Subbituminous	4.00	23.4	1.97	5.3
		Subbituminous	3.00	17.9	1.67	4.5
SNG	Lurgi			23.4	1.93	
				17.9	1.61	
				16.7	1.54	

[a]Gasoline produced from this material would be higher in cost by about $2.0 to 2.5/bbl.

The following program is recommended to develop coal gasification, liquefaction and mining to the point where the United States has the technical base, operational commercial scale facilities, to begin a rapid buildup of a coal based synthetic fuels industry. Table V presents the proposed development schedule.

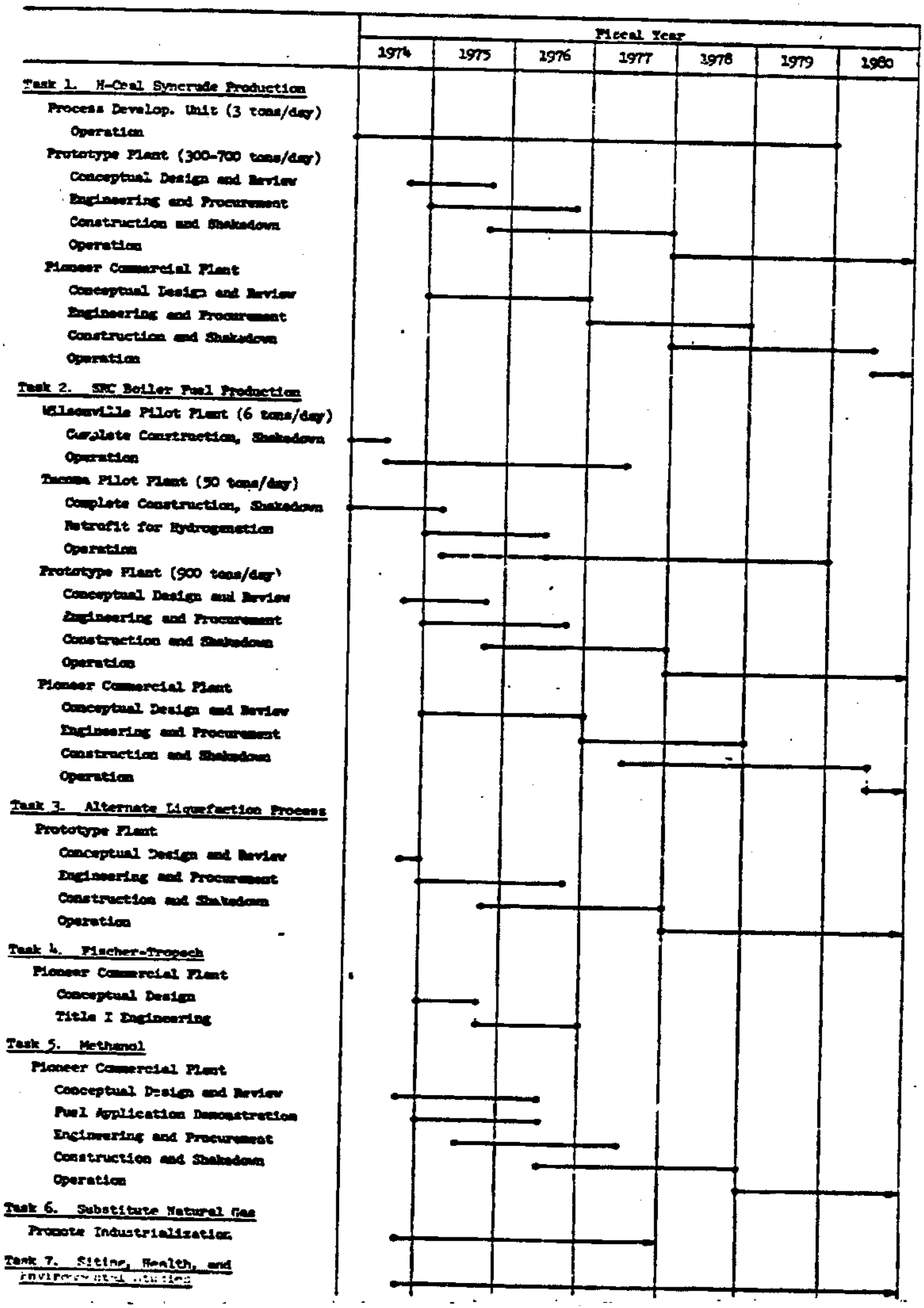
1. Liquefaction

Objectives of the accelerated liquefaction program are as follows:

a. Conduct joint programs from 7/74 to 7/77 to design, construct, and shake down three prototype (capacity 300 to 1000 tons coal/day) plants: (1) H-Coal Syncrude, (2) SRC-Hydrogenation for boiler fuel, and (3) a third type such as a modified CSF or hydrocarbonization. These plants are believed to represent the optimum size to provide the fastest and least risk path from present development work to commercial plants. Such prototype plants are generally favored by industry and substantial (perhaps 1/3) investment of private funds can be expected because of the relatively low (about $60 million) capital costs of these plants.

The present plan is that these prototype plants would be built at sites that are already highly industrialized (petroleum

Table V. Recommended Schedules



refineries, petrochemical complexes, or large power plants) and, thus, will have small incremental environmental impact. These sites will have (a) trained personnel, (b) technical services, (c) supplies of coal and/or other raw materials, and (d) facilities for testing of the products.

b. Conceptually design, collect base line data on sites, and prepare generic environmental impact statements for two pioneer hydroliquefaction plants (about 50,000 TPD of coal) in the period 7/75 to 7/76. Design, construct, and shake down these two pioneer plants in the period 7/76 to 12/79. Government funding of about 20% of the capital costs of these plants may be required because there is some risk that engineering funds would be wasted since the engineering would begin before operation of the prototype plants. It may also possibly be necessary to waive the normal environmental impact review for these plants.

c. After validating the methanol fuel application and performing a market analysis, engineer, construct, and shake down a pioneer commercial (about 5000 tons MeOH/day) plant in the period 1/75 to 1/78.

d. Conceptually design and perform Title I engineering of a commercial Fischer-Tropsch gasoline plant in the perior 7/74 to 7/76 for reference and standby contingency construction.

e. Accelerate the pace of supporting research and development of liquefaction as a coordinated extension of the $10 billion energy R and D program.

2. Coal Gasification

The recommended supplemental synthetic fuels development program aims at acclerating the development of the industry for the production of SNG from coal. The recommended activities include: a) engineering development of a slagging Lurgi gasifier with highly swelling and cakin coals; (b) engineering development of a high-pressure Koppers-Totzek gasifier (also to permit wider use of coals); (c) site studies (collect base line data on potential commercial sites); (d) preparation of gener environmental impact statements; (e) accelerated research on environmer effects; (f) development of advanced materials, catalysts, and equipmer components; (g) additional development of the methanation step; (h) institutional research; (i) development of services and capabilities fc process vessel manufacturing; and (j) development of standards to minii the routine design requirements. The costs of this program are present in Table VI. The key features of this supplemental program would be fı scale test units of Lurgi and Koppers-Totzek gasifiers. These would be used for experimental optimization studies to guide operation of th first production plants and as test beds for a variety of U.S. coals.

3. Mining and Plant Siting

Mining companies and mining equipment manufacturers believe it is physically possible to double coal production by 1980 using today's technology provided many strip mines can be opened soon to boost production. The assumption was made in this projection that there would be no environmental restrictions on opening new strip mines.

There are adequate plant sites with sufficient coal and water to build a coal based synthetic fuels industry capable of producing several million barrels per day oil equivalent. However, if such an industry is to grow, environmental restrictions can not severely limit the availability of these plant sites.

Several development efforts should be initiated now so that growth of a synthetic fuels industry is not inhibited by environmental constraints. With regard to strip mining in the East and Mid-West it is important to demonstrate what is necessary to return strip mined land to productive use and what this reclamation costs. There is a very large difference between government and industry estimates for reclamation costs, and the size of the reserve of economically recoverable coal for a synthetic fuel industry is a strong function of the costs of reclamation. A program should be initiated at a number of representative Eastern surface mine sites to put aside and restore various depths of topsoil to determine the minimum depth necessary for reclamation. This is particularly important as the demand for mine sites forces utilization of productive agricultural lands. The restoration demonstration should be done at mines using scrapers, drag lines and shovels so the basic unit cost ($/foot of topsoil/acre) of reclamation can be determined for all areas with adequate rainfall. Other more site specific costs such as seeding, watering and fertilizing should be monitored to establish a normal range of costs.

In the area of plant siting it would be wise to identify some more promising potential sites, determine the necessary data (including environmental) for obtaining required construction permits and actually obtain the data. This could smooth future site acquisition proceedings. In particular, establishing now some base line data at a number of potential plant and mine sites would be useful.

In the next decade much of the expanded coal production for a synthetic fuel industry would come from Eastern and Mid-Western deep mines. Mining companies believe that considerable development of deep mine technology would be needed to maintain into the 1980's the rate of increase achievable by rapidly opening strip mines in the 1970's. To most rapidly advance the state of the art in deep mining, the concept of a "demonstration mine" has been widely proposed. In this concept a new mine or a portion of an operating mine would be acquired for the purpose of empirically testing advanced mining technology at full scale under actual mining conditions.

The accelerated mining program would require five year funding above the proposed program in the AEC's December 1 report to the President, as follows: 1) 225 million dollars for increasing the program goals to the faster "orderly" rate recommended by Chairman Ray's mining study panel; 2) 70 million dollars for early procurement and operation of demonstration deep mines; 3) 5 million dollars for Eastern and Mid-Western strip mining and plant siting studies. In the supplemental deep mining program, emphasis would be on accelerating development of equipment and mining systems studies assuming the basic program was adequately supporting research in methane control, ground control, longwall mine development, material, etc. The heavy government involvement in mining development is felt necessary because recent coal profits have not been adequate to give the industry sufficient capital for extensive R&D efforts.

It is assumed that similar activities for Western strip mining and siting would be carried out by the "Reclamation of Arid Western Lands" demonstration project. (There have been a number of studies detailing the R&D needs for strip and deep mining, including 1) "An Assessment of the Research Needs to Enhance the Utilization of Coal," Carnegie-Mellon University Workshop on Advanced Coal Technology, S. William Gouse, Jr., Chairman, September 1973, Sponsored by National Science Foundation; 2) Underground Coal Mining in the United States - Research and Development Program, prepared by TRW for Office of Science and Technology, June 1970; and 3) Report of the Cornell Workshops on the Major Issues of a National Energy Research and Development Program, Cornell University, December 1973.)

D. Government Role in Technical Development Phase (Now to 1980)

Industry is in favor of government-industrial cooperation in implementing a clean fuels from coal program. This represents a change in corporate attitude for many firms. Until recently many companies preferred to do their own R and D, demonstration projects, and commercial ventures without Federal assistance. Now the belief is that the capital required to get sufficient quantities of clean fuel from coal into the economy is too large for industry to finance alone.

Government participation in the initial phases of a synthetic fuel industry can be in the form of 1) partial funding of high risk accelerated R/D programs and 2) allowing interim relief from non technical restraints to promising development projects.

The approach of granting interim relief from environmental impact problems has been recommended by a number of environmental consultants. In this concept the first few pilot and prototype plants are allowed to be built without rigorous proof that no environmental degradation will occur during plant operation. Pre-operational base line data are established and the plant is operated with readily available, state of the art control equipment. Careful monitoring is done to measure any adverse local environmental impact. Subsequent environmental impact restrictions are based on interpretation of the empirical data from these first plant tests.

In the supplemental funding approach we have estimated the government support required (above the 10 billion dollar national energy R/D program) which would be needed to achieve the Project Independence goal, i.e., acquiring the potential to build a coal based synthetic fuel industry by 1980. Table VI shows the portion of the $10 billion funding slated for coal. The incremental funding recommended for accelerated coal liquefaction, gasification and mining shown in Table VII. The second Table assumes that government pays 2/3 of the cost of high risk early development efforts. However, only 20% government funding is assumed for the first prototype plants, because minimal government support will be needed in 5 years if the international price of oil remains high. In reality, the government-industry funding split will have to be negotiated on a project by project basis in light of the then existing international and domestic fuel situation.

We have distilled the following recommendations from numerous discussions with industry about the most productive approach to a joint industry-government synthetic fuels development program.

1. Recommendations - Prototype Pilot Plants

(1) We believe a single company or member company of a consortium should be selected overall project manager for each pilot project and should be given flexibility to get the job done. Good management is

TABLE VI
RECOMMENDED GOVERNMENT ENERGY R/D FUNDING
FOR DEMONSTRATING THE PRODUCTION OF SYNTHETIC FUELS FROM COAL[a]

	Fiscal Year Costs, $Millions					
	1975	1976	1977	1978	1979	Total
Coal Liquefaction	75	75	75	75	75	375
R&D, Other Operating Expenses	(57)	(45)	(43)	(46)	(55)	(246)
Construction-SRC Pilot Plant	(4)	--	—	—	—	(4)
Direct Hydrogenation Prototype Plant					—	(49)
Advanced Process Prototype Plant						(53)
Multiple Process Pilot Plant					—	(23)
Two Synthetic Fuel Pioneer Plants	100	100	55	50	50	355
High Btu Gasification	35	75	92	81	57	340
R&D, Other Operating Expenses	(14)	(25)	(47)	(49)	(53)	(188)
Construction-Hygas Pilot Plant	(2)	(2)	(4)	(2)	—	(11)
- CO_2 Acceptor Pilot Plant	(2)	—	—	—	—	(2)
- Synthane Pilot Plant	(8)	(7)	(2)	—	—	(17)
- Bi-Gas Pilot Plant	(9)	(12)	—	—	—	(21)
- Demonstration Pilot Plant		(28)	(39)	(30)	(4)	(101)
Mining	45	57	64	77	82	325
Direct Combustion	30	35	40	44	51	200
Low Btu Gasification	30	37	42	48	43	200
Environmental Central Tech.	70	50	42	45	53	260
Supporting R&D	20	22	24	27	27	120
TOTAL	405	451	434	447	438	2175

[a] Program recommended to the President on December 1, 1973, by Dr. Dixy Lee Ray

TABLE VII
RECOMMENDED INCREMENTAL FUNDING FOR
SYNTHETIC FUELS DEMONSTRATION PROGRAM

	Fiscal Year Costs, $Millions					
	1975	1976	1977	1978	1979	Total
Construction						
Direct Hydrogenation prototype Plant[a]	2	5	-13	-3		-9
Extraction/Hydrogenation Prototype Plant	10	25	5			40
Third Prototype Plant	10	23	-3	-23	-20	-13
Methanol Pioneer Plant	0	0	0	0	0	0
Second Pioneer Plant	0	0	150	0	0	150
Third Pioneer Plant	0	0	150	0	0	150
Fischer-Tropsch Design Studies	5	15	—	—	—	20
First Generation SNG Production	5	20	20	10	10	65
Supporting R&D, Operations	15	20	27	35	25	120
	47	108	336	19	15	525
Mining & Siting R/D	42	55	62	74	67	300
	89	163	398	93	82	825

[a] Total cost the same - funding shifted to earlier schedule

essential if the prototype projects are to be successfully, quickly, and cost-effectively designed, built and operated. Management has, in fact, been a matter of concern to many companies contacted. Rigidity and overmanagement of many government-sponsored programs has been repeatedly mentioned. A company may subcontract for design and construction of the pilot plant but should be expected to operate the plant and market the products.

(2) Financing should be in part by the project managing company so that there is incentive for efficient design and operation. It is believed that this kind of management would provide the flexibility for on-the-spot decisions that would be necessary in such new processes

(3) Selection of the companies would be by competitive bid, using as criteria: the process the bidder proposes to demonstrate, the site proposed for the pilot plant, the proposed coal feed stock, the patent position proposed, and the amount of funding to be supplied by the bidder.

(4) It is recommended that each pilot project maintain its own analytical facilities, shop facilities, maintenance and repair facilities for operation of the demonstration trains. Down time in a demonstration project is unavoidable. It must be minimized and the way to do this is for the projects to have in-house diagnosis and repair capability.