



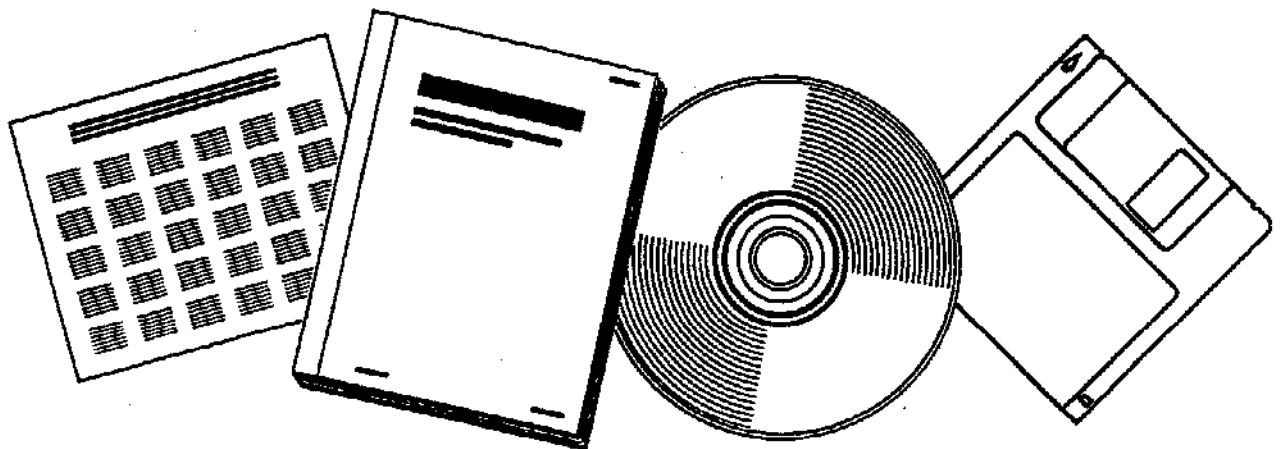
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OVERVIEW OF NATIONAL RESEARCH AND DEVELOPMENT ACTIVITIES IN SYNTHETIC NATURAL GAS FROM COAL

BOOZ-ALLEN AND HAMILTON, INC.
BETHESDA, MD

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U.S. DEPARTMENT OF COMMERCE
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OVERVIEW OF NATIONAL RESEARCH
AND DEVELOPMENT ACTIVITIES
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FROM COAL

FOR

THE GAS RESEARCH INSTITUTE

BOOZ·ALLEN & HAMILTON Inc.
September 1979

I. INTRODUCTION

The purpose of this report is to provide the Gas Research Institute (GRI) with an overview of activities which are related to GRI's Synthetic Natural Gas (SNG) from Coal Subprogram Area. The information presented is intended to assist GRI in guiding its own research activities and to provide an information base for ensuring that its programs are coordinated with the activities of industry and government.

This report has been developed utilizing data provided by several sources, including:

- . The gas industry
- . Private firms active in the development of coal gasification systems
- . Researchers at universities and other research organizations
- . Government officials responsible for funding programs in coal gasification
- . Private organizations active in coal gasification, such as the Electric Power Research Institute (EPRI)
- . Recent literature on research and development related to coal gasification, including:

- GRI's 1979-1983 and 1980-1984 Five Year R&D Plans prepared in 1978 and 1979, respectively
- The Budget of the United States, Fiscal Year 1980 prepared in 1979 by the Office of Management and Budget
- Coal Conversion Technology by I. Howard-Smith and G. J. Werner, published in 1976
- Budget hearing documents for Fiscal Years 1979 and 1980 published by various House and Senate Committees in 1977, 1978, and 1979
- Research and Development Program Plan for 1979-1983 prepared by the Electric Power Research Institute in 1978
- Program documents prepared by DOE and various contractors.

In collecting information and data for this report, a large number of direct interviews were held; however, many of the discussions were conducted by telephone. It is believed that most of the key organizations which fund efforts relating to GRI's SNG from Coal Subprogram Area have been contacted (Appendix A lists these contacts). While it is possible that some projects which may relate to the GRI program were not identified during this assignment, it is unlikely that they would materially change the pattern of activity described herein.

The sections that follow provide:

- . An overview of R&D related to the GRI SNG from Coal Subprogram Area
- . A review of government R&D efforts in the gasification of coal
- . A review of private industry R&D efforts in coal gasification
- . A review of coal gasification programs sponsored by GRI
- . Conclusions and implications which can be drawn from this overview.

II. CURRENT R&D EFFORTS IN COAL GASIFICATION

1. AN OVERVIEW OF RESEARCH AND DEVELOPMENT RELATED TO THE GRI SNG-FROM-COAL SUBPROGRAM AREA

Synthetic natural gas (SNG) from coal is pipeline quality gas produced from the gasification of coal. The first generation technology for coal gasification produced low- and medium-Btu systems utilized throughout the world and in the U.S. until the 1940's. With second generation technologies, the gasification processes are able to use different coals and to produce higher quality gases. This gas could then be converted to SNG by a series of chemical operations that increase the methane content and remove impurities. Some third generation processes produce methane directly in the gasifier without the need for chemical methanation. Improvements in any second or third generation technology could be considered as improvements in SNG from coal technology, therefore, the R&D programs evaluated in this overview include second and third generation coal gasification technologies.

The production of manufactured gas from coal was becoming widespread in the United States in the early 1920's. The peak was reached about 1925 when approximately 11,000 low-Btu gasifiers were in use. Industrial fuel gas demanded about 90 percent of gasifier output at that time with about 10 percent used for town lighting. With the subsequent development of the national gas pipeline system and resulting low-cost natural gas, the development and use of coal gasification diminished. Most low- and medium-Btu coal gasifiers were abandoned in the U.S. during the 1940's and 1950's.

There are six industrial companies in the United States presently gasifying coal or coke to make a low- or medium-Btu gas for commercial use. As shown in Exhibit II-1, numerous gasifiers are in operation, most of which are designed by Wellman-Galusha based on 1930 technology. The only medium-Btu gas units in commercial use are at the chemical companies of Gulf & Western Corporation and Olin Chemical Company. In 1963, these two companies installed coke and oxygen fed Wellman-Galusha gasifiers as sources of carbon monoxide for their chemical processes.

Since the 1950's, there has been renewed interest in coal gasification, particularly to produce medium- and high-Btu gas. However, many of the efforts to build SNG-from-coal plants early in the 1970's have been terminated. This has not been due to technical problems, but due to the high cost of the SNG produced and the capital cost of the system. Among the principal barriers to commercialization are the limited availability of capital for plants, market-related uncertainties about price, and Federal regulations. For example, construction of two coal gasification plants, one for Panhandle Eastern Pipe Line Company and one for Pacific Gasification Company is being held in abeyance pending availability of government loan guarantees; El Paso Gasification Company needs lease and water-use permits; and the Great Plains Gasification Company proposal is undergoing extensive evaluation by the Federal Energy Regulatory Commission.

Currently, efforts being expended on the generic technology of coal gasification are generally for system development. Many individuals interviewed during this study expressed the opinion that several coal gasification

EXHIBIT II-1
Summary of Industrial Gasification Projects
Spring 1979

Source	Funding	Operator	Initial Start-Up	Gas	Coal	Facility
Operating	PRV	National Lime & Stone Company (Ohio)	1955	LBG	Bituminous	2 MG
	PRV/DOE	Glen-Gery Corporation (PA) ¹	1953/1977	LBG	Anthracite	7 MG
	DOE	Holston Defense Corporation (TN)	1940	LBG	Bituminous	12 Willputte
	PRV	Hazleton Brick Company (PA)	1953/1978	LBG	Anthracite	3 MG
	PRV	Gulf & Western (N.J. Zinc) (PA)	1963	CO**	Coke	MG
	PRV	Olin Chemical Corporation (Ohio)	1963	CO**	Coke	MG
Start-up	PRV	Caterpillar Tractor Company (PA)	1979	LBG	Bituminous	2 MI
	PRV	General Motors Corporation (Mich.) ³	1979	LBG	Various	Stoic
	PRV	Dow Chemical Company (LA) ³	1979	LBG	Lignite	Texaco
	DOE/PRV	University of Minnesota (Minn.) ¹	1979	LBG	Various	Stoic
	EPA/PRV	Central Power & Light (Texas)	1979	LBG	Lignite	Foster Wheeler
Construction	PRV	Howmet Corporation (PA)	1979	LBG	Anthracite	MG
	PRV	Chemical Exchange (Texas)	1979	LBG	Lignite	MG
	DOE/PRV	Pike County Gasification Project (KT) ¹	1980	LBG	Bituminous	2 MG
	TVA	Tennessee Valley Authority (AL)	1980	MBG	Bituminous	Texaco
	Design	PRV	Carter Oil Company (Texas)	1987*	MBG	Lignite
PRV		Illinois Power Company (Ill.)	1982	LBG	Bituminous	Allis
DOE/PRV		Can-Do Incorporated (PA)	1980	LBG	Anthracite	2 MG
PRV		Southern California Edison (CA)	1980	MBG	Bituminous	Texaco
DOE/PRV		Memphis Light, Gas & Water (TN) ²	1982	MBG	Bituminous	Foster Wheeler
DOE/PRV		W. R. Grace (KT) ²	1982	MBG	Bituminous	Texaco
DOE/PRV		Land O'Lakes, Incorporated (Minn.)	Cancelled			
DOE/PRV		General Refractories Company (KT)	Cancelled			
DOE/PRV		Erie Mining (Minn.) ²	Cancelled			

Key: * = Estimated (in Pre-Engineering)
 ** = Coke Fuels
 MG = Mellman Galusha
 MI = Mellman Incandescent
 MD = Woodall-Duckman
 PRV = Private

1 = Federal Gasifiers in Industry Program
 2 = Federal Fuel Gas Demonstration Program
 3 = Industrial Test/Demonstration

technologies are technically proven and available. The need is to demonstrate that these technologies will operate economically in a commercial-sized plant.

The Department of Energy is the primary source of funds for current high-Btu coal gasification research and development. DOE's programs total approximately \$105 million in FY 1979 with its efforts including laboratory tests, process development, pilot-scale units, and demonstration plants. Areas supported by DOE include:

- . Gasification demonstrations - \$52 million
- . Third generation research - \$24.9 million
- . Special projects and support - \$11 million
- . High-Btu gasification research - \$10.5 million
- . In-situ gasification - \$4 million
- . Technical support - \$2 million.

Estimates derived during this study indicate that industry spent considerable sums within the last 15 years to research the technology. However, current expenditures are minimal because companies are awaiting favorable government actions relative to loan guarantees, cost of service, and other incentives. According to the data collected as part of this analysis, industry is spending approximately \$10 million in these areas:

- . Gasification Processes - \$4 million
- . Associated Technologies - \$3 million
- . In-Situ Research - Less than \$1 million.

Most companies are not willing to assume the risks of such large expenditures and are stopping their programs or seeking outside financial assistance. It is estimated that

industry, primarily the oil and gas industry, is currently spending about \$50 million per year to study environmental aspects, economics, design, etc. of various coal gasification installations, but these are predominately medium-Btu systems and are not expected to proceed to hardware development (expenditures by private industry and the Electric Power Research Institute for medium-Btu coal gasification are discussed in Appendix B).

GRI is the principal source of private funds for developing coal gasification technologies to produce SNG. Almost all of GRI's programs are co-funded with DOE and concentrate on development of third generation technologies. GRI's 1979 budget is allocated as follows:

- . Gasification process - \$10.9 million
- . Associated SNG technology - \$3 million
- . In-Situ coal gasification - \$0.2 million.

The various programs funded by DOE, the private sector and GRI are discussed in the sections that follow.

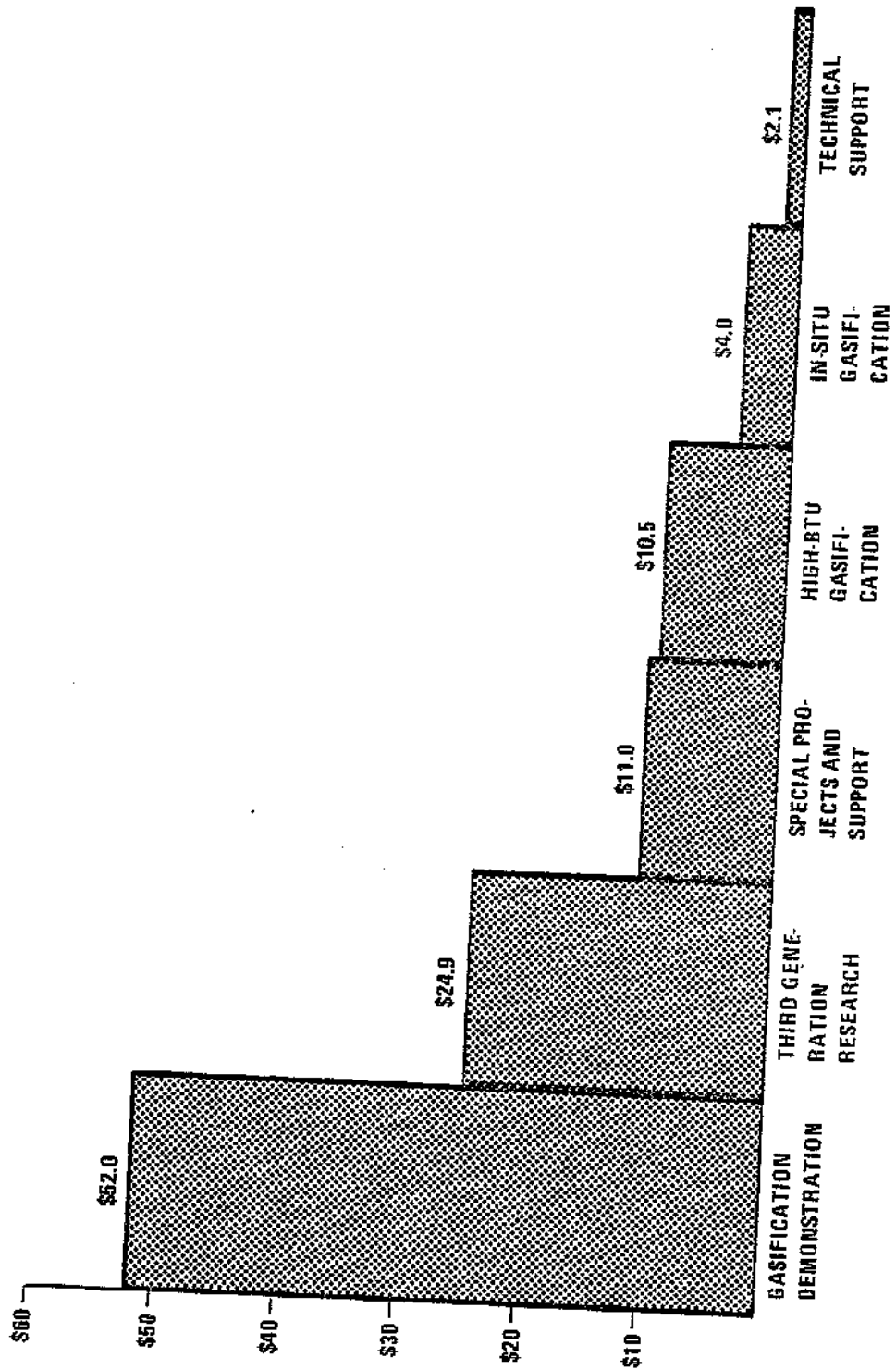
2. FEDERAL GOVERNMENT R&D ACTIVITIES IN COAL GASIFICATION

The Federal Government is the dominant supporter of coal gasification R&D efforts. Its support spans a wide range of activities from those technologies at the design and laboratory test scale stage to technologies in the demonstration stage. The focal point of the Federal Government's efforts is the Department of Energy (DOE), and specifically, the Fossil Energy Program located in the Office of the Assistant Secretary for Energy Technology. The government's activities in this area have grown significantly during the 1970's. In FY 1973 the fossil energy programs in the Federal Government (located during that time period in various organizations, including the Department of Interior and Environmental Protection Agency) totaled \$58 million; in FY 1979, the Department of Energy was appropriated \$830 million for these efforts. Of this, approximately \$100 million is for high-Btu coal gasification research, development, and demonstration; and an additional \$50 million is for efforts which provide support to all of the Fossil Energy Program, including high-Btu coal gasification. This section will focus upon those activities of the Federal Government which are directly related to GRI's coal gasification efforts. Exhibit II-2 presents a graphic summary of these activities.

The overall objectives of DOE's coal gasification program are to:

- . Support and improve first-generation processes being considered for commercial gasification facilities.

EXHIBIT II-2
 Summary of High-Btu Coal Gasification Funding
 Fossil Energy Program, DOE
 (FY 1979, Millions of Dollars)



- . Develop and demonstrate, in cooperation with industry, new and improved second-generation gasification technology necessary for the construction of commercial scale plants for processes that convert domestic coal to SNG.

- . Identify and develop, in an accelerated manner, promising third generation technology, with the goal of implementation of more economical processes on a commercial scale in the 1985-2000 period.

- . Develop at least one underground coal gasification technology to the stage of commercial application by the late 1980's through joint efforts with industry.

While the focus of GRI's efforts is on research and development, a discussion of the Fossil Energy Program's demonstration efforts is included to provide a more complete picture of the Federal Government's program in coal gasification.

(1) The Focus of DOE's Gasification Demonstration Program is to Prove the Viability of Producing Synthetic Pipeline Quality Gas from Coal

Currently, over half of DOE's coal gasification funding is being provided to support high-Btu coal gasification demonstration projects (\$52 million). This support is designed to evaluate the technical, economic and environmental viability of high-Btu coal gasification via a number of different processes.

Within DOE's Gasification Demonstration Program there are two major efforts underway which are supporting three gasification processes.

The first major DOE effort began in FY 1976, when its predecessor, the Energy Research and Development Administration (ERDA) was authorized to proceed with the development of a demonstration plant for the production of a high-Btu gas. In late FY 1976, ERDA issued a request for proposals which had as its goal the eventual selection of a coal gasification process which could utilize eastern caking coals. After reviewing the five responses which it received, ERDA determined that only two proposals were technically and financially acceptable. These two proposals had been submitted by the Continental Oil Company (Conoco), which utilized a slagging Lurgi design; and the Illinois Coal Gasification Group (ICGG) which utilized the COED/COGAS process. In FY 1977 DOE awarded contracts to both of these groups to support both technologies through pilot plant testing and the conceptual design of a commercial plant. At that point a decision was to have been made to fund the construction of a commercial size demonstration plant of one of these processes. This decision, which was originally to have been made in 1978, has been postponed until early 1980.

In FY 1979, \$2 million has been allocated for the testing, trade-off analyses, and conceptual design phases of this program; and \$42 million has been allocated for the construction of a plant utilizing one of the processes. DOE anticipates making a decision on which of these technologies it will fund based upon the

feasibility of the designs which are developed, economics, and compatibility of the process with agglomerating coals:

. The British Gas/Slagging Lurgi effort supported by DOE is being performed by Conoco's Coal Development Company and has as its objective the verification of the technical, economic, and environmental acceptability of the British Gas/Slagging Lurgi process which utilizes steam and oxygen in the gasifier. This process is a modification of the existing commercial Lurgi process, and is designed to accept caking coals and operate at higher temperatures. DOE awarded a contract to Conoco in FY 1977 for the development of the conceptual design and analysis for a commercial size plant, conceptual design for a demonstration plant, and tests of the process in its pilot plant.

. The COGAS process is being developed by the Illinois Coal Gasification Group (ICGG) which is comprised of a number of gas companies (see Appendix A). DOE funding of this group also began in FY 1977; although a pilot plant, utilizing a portion of the COGAS technology began operation in 1970 at FMC Corporation supported by the Office of Coal Research (OCR). This process is based upon the COED coal pyrolysis concept and the air-blown gasifier concept developed by the COGAS Development Company (see Appendix A for owners). As with the Conoco project, ICGG is developing the conceptual designs for

a demonstration size plant and a commercial sized plant; performing economic analysis of a commercial sized plant; and performing tests at its pilot plant.

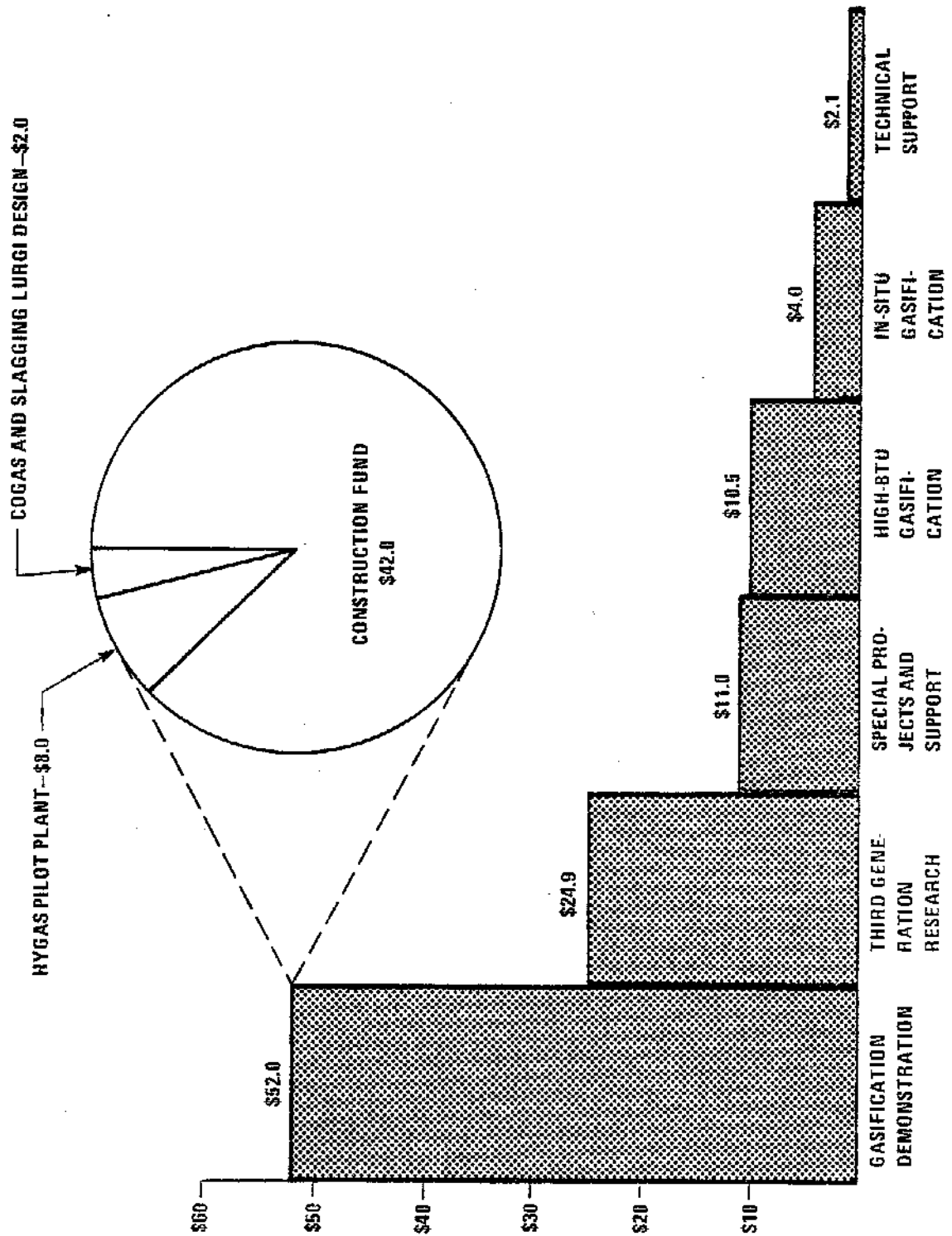
The second major DOE effort in its Demonstration Program was initiated in 1977 by its predecessor, ERDA, and involves the HYGAS process. This process has been under development since 1944, when the Institute of Gas Technology (IGT) began its coal gasification studies. Process demonstration unit (PDU) studies were performed from 1964 to 1967 with support provided by the American Gas Association (AGA) and the Office of Coal Research (OCR) of the Interior Department. An 80-ton-per-day pilot plant was designed and constructed from 1968 to 1971 and has been in operation since that time. Funding for the operation of this pilot plant has been provided by the Joint Gasification Program of DOE/GRI, and their predecessors in this program, OCR and AGA. Technical support for this project has been provided by the following research institutes and private companies:

- . IGT - Plant operation
- . Bechtel - Preliminary plant design
- Oxygen system construction
- . Procon - Pilot plant design and construction.

In FY 1977, DOE awarded Procon a contract for the development of conceptual designs for a commercial and a demonstration plant. The funds for this work came from the DOE High-Btu Gasification Program. In FY 1979, DOE transferred the funding for the HYGAS project from its High-Btu Gasification Program to its Gasification Demonstration Program because of its assessment that the technical feasibility of the process had been proven and that a demonstration effort is now needed. (In conjunction with this transfer, GRI terminated its funding of the HYGAS Process on June 30, 1979.) Funding of \$8.0 million in FY 1979 is being provided by DOE from its demonstration budget to support the current HYGAS pilot plant operating activities. (A graphic presentation of DOE's current funding level for this program is presented in Exhibit II-3.)

The current HYGAS activities consist of continuing tests at the IGT pilot plant utilizing different types of coal, including washed and unwashed Illinois and Kentucky bituminous coals. The development of conceptual designs for both a demonstration plant and a commercial plant by Procon was supported by DOE, although these funds came from prior years' appropriations.

EXHIBIT II-3
 Summary of High-Btu Gasification Demonstration Funding
 Fossil Energy Program, DOE
 (FY 1979; Millions of Dollars)



(2) DOE's Support for Third Generation Processes Is Focused Upon Accelerating the Development of Promising Technologies With High Efficiencies

At the current time, DOE is providing \$24.9 million in funding for five types of third generation, high-Btu gasification processes (Exhibit II-4 provides a graphic summary):

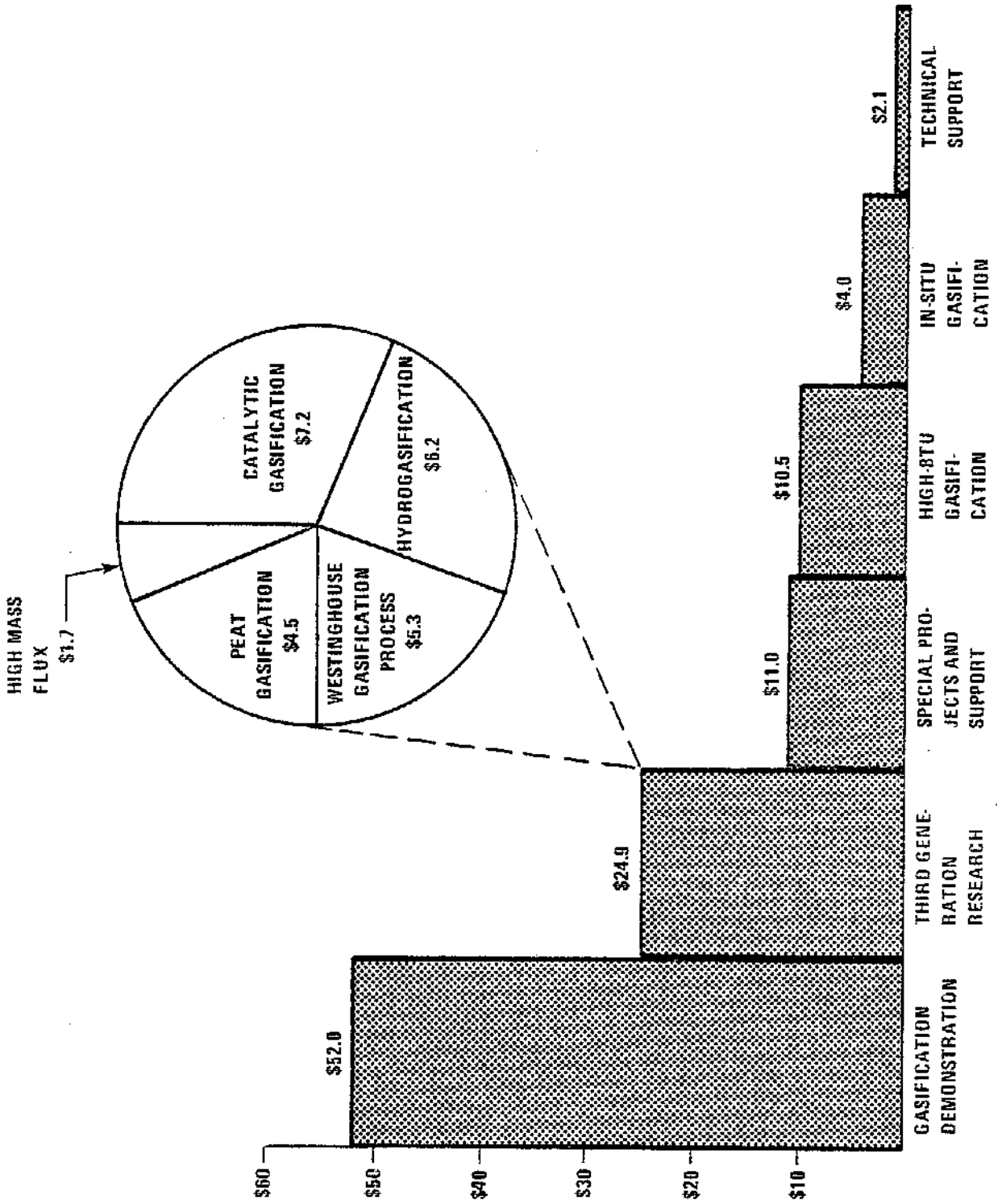
- . Hydrogasification
- . Catalytic Gasification
- . Westinghouse Gasification
- . Peat Gasification
- . High-Mass-Flux Gasification.

These third generation processes are believed to offer better operating economics than other processes and, therefore, are receiving significant amounts of support from DOE. Each process is discussed in the following sections:

- . The Hydrogasification Process. The hydrogasification process has been under development since the early 1960's with the principal advantage of high thermal efficiencies which makes it potentially an inexpensive way to gasify coal. In this process, almost all the product gas (methane) is produced in the gasifier by the direct reaction of hydrogen with coal, thus producing the high thermal efficiencies of the process.

Work on this process began at the Pittsburgh Energy Research Center which developed the two-stage Hydrane proces and was

EXHIBIT II-4
 Third Generation Processes Program Funding
 Fossil Energy Program, DOE
 (FY 1979, Millions of Dollars)



supported by the Federal Government. In the early 1970's, Cities Service Company demonstrated a laboratory scale single-stage hydrogasifier which utilized an entrained bed with a short residence time requirement. In this same period, Rocketdyne developed a technique for utilizing a rocket combustor to achieve improved mixing in the reactor.

In FY 1976, DOE-supported engineering evaluations of the two-stage Hydrane process determined that it was too complex for commercial applications and that a single-stage, short residence time hydrogasifier utilizing the rocket combustor concept was more promising. In FY 1977, a hydrogasification feasibility study utilizing this conceptual design was initiated. During FY 1978, bench scale engineering on a one-quarter-ton-per-hour unit was performed, and testing initiated.

In FY 1979, testing of this unit by Rockwell International continued. In addition, the design of a four-ton-per-day pilot plant was initiated. Further research on this process is being performed by the Pittsburgh and Morgantown Energy Technology Centers and at Carnegie-Mellon to reinforce the hydrogasification data base with studies on a modified (single-stage) Hydrane concept which utilizes a recirculating bed gasifier. Funding for these studies is \$6.2 million in FY 1979.

The Exxon Catalytic Gasification Process.

The Exxon Catalytic Coal Gasification process has been under development since 1968. Like Hydrogasification, the potential of high thermal efficiencies exists because of a reduced need for high level heat input to the gasifier and reduced heating and cooling of various gas streams. Also similar to the Hydrogasification process is the fact that the process converts coal directly to SNG within the gasifier in a single processing step. During FY's 1976 and 1977, bench scale studies were performed by Exxon at its Baytown, Texas facility. In FY 1978 and 1979 a process development unit (PDU) was built by Exxon at their Baytown, Texas facility. At the current time this PDU is in the start-up phase with funding being provided by DOE and GRI. In FY 1979, DOE is providing \$7.2 million for these efforts.

The Westinghouse Coal Gasification Process.

Research on this process was begun in the late 1960's by the Westinghouse Electric Corporation at its Research and Development Center in Pittsburgh, Pennsylvania. The process consists of two dense-phase fluidized-bed reactors arranged in counter-current series. The stages are in separate vessels or reactors and either can be operated alone. The upper stage, where the coal enters and from which the raw product gas emerges, is called a devolatilizer. The lower stage is

called the gasifier-agglomerator. It is fed with interstage char and an oxidizing gas (air or steam-oxygen) and discharges agglomerated ash and an interstage gas.

The FY 1979 DOE/GRI plan was to operate this process first with air in the single-stage mode, then in the integrated two-stage mode. This work has been completed. Oxygen operation also began this year in the single stage mode at low pressure (130 psig). By the end of the year it is planned to be operating with oxygen in the integrated two-stage mode at high pressure (225 psig).

The Peat Gasification Process. The DOE Peat Gasification Project consists of a joint DOE/Minneagasco evaluation of the potential of using peat from three representative regions of the country. This evaluation will focus upon:

- Assessing peat resources available in the United States
- Determining the socio-economic impacts of utilizing this resource
- Performing an environmental impact analysis
- Assessing collection and dewatering problems

- Identifying alternative gasification processes which could be used.

This evaluation is intended to create a data base sufficient for an assessment to be made of the potential value of the peat resource base and the merit of a pilot program for peat gasification. Research on this resource is being coordinated with six states and bench scale research is being performed by IGT under a subcontract to Minneagasco. Future funding of this program will use the evaluation as a basis for decision. FY 1979 funding of \$4.5 million will permit the evaluation to be completed and decisions regarding the future of this project to be made.

The High-Mass-Flux Gasification Process.

The final process which is to be funded by the Third Generation Process program of DOE is the High-Mass-Flux process developed by the Bell Aerospace Corporation. DOE/GRI co-funding of this project is to begin in FY 1979, with the purpose of evaluating the process using a coal/steam-oxygen mixture in the gasification chamber as opposed to the coal/air mixture which had been previously tested. DOE program funding is proposed to be \$1.7 million in FY 1979, however, these funds have not yet been obligated due to DOE procurement problems. If funding this year is initiated, efforts will focus upon the

development of data at the PDU stage and the conceptual design of a commercial facility so that a preliminary economic evaluation of the process can be made.

(3) The Special Projects and Support Studies Program Supports Projects Which are Related to a Number of Coal Gasification Programs

At the current time, DOE is providing support to two projects in this program area:

- . Gasification System Test Facility
- . Hot-Gas Clean Up Project.

Total FY 1979 funding for these two projects is \$11.0 million with most of this money (\$10.0 million) being provided for the Test Facility. Each are discussed as follows:

- . The Gasification System Test Facility. DOE is planning to construct a central facility where components of various coal gasification systems can be tested and evaluated on a commercial scale. Funding for this project was initiated in FY 1979 and systems requirements and preliminary design of the facility are in progress. The initial facility will include a state-of-the-art gasifier and one or two second generation gasifiers. The facility will be constructed so that new equipment can be easily added to respond to new concepts and changes in programmatic emphasis. Subsequent phases will include more advanced gasifiers, cleanup

systems, methanators, test materials, and other new equipment. A site for this facility has not yet been selected although several are under consideration.

Hot Gas Cleanup. DOE terminated its efforts on hot gas cleanup in FY 1979. This work was performed at the Morgantown Energy Research Center and the Battelle Pacific Northwest Laboratories. The recent focus of the project has been upon the cleanup of low-Btu gas, but research on high-Btu gas cleanup has also been performed. Final reports regarding this project have been issued and the associated equipment mothballed.

(4) Funding of Second Generation Coal Gasification Pilot Plants is Being Provided by DOE's High-Btu Gasification Program

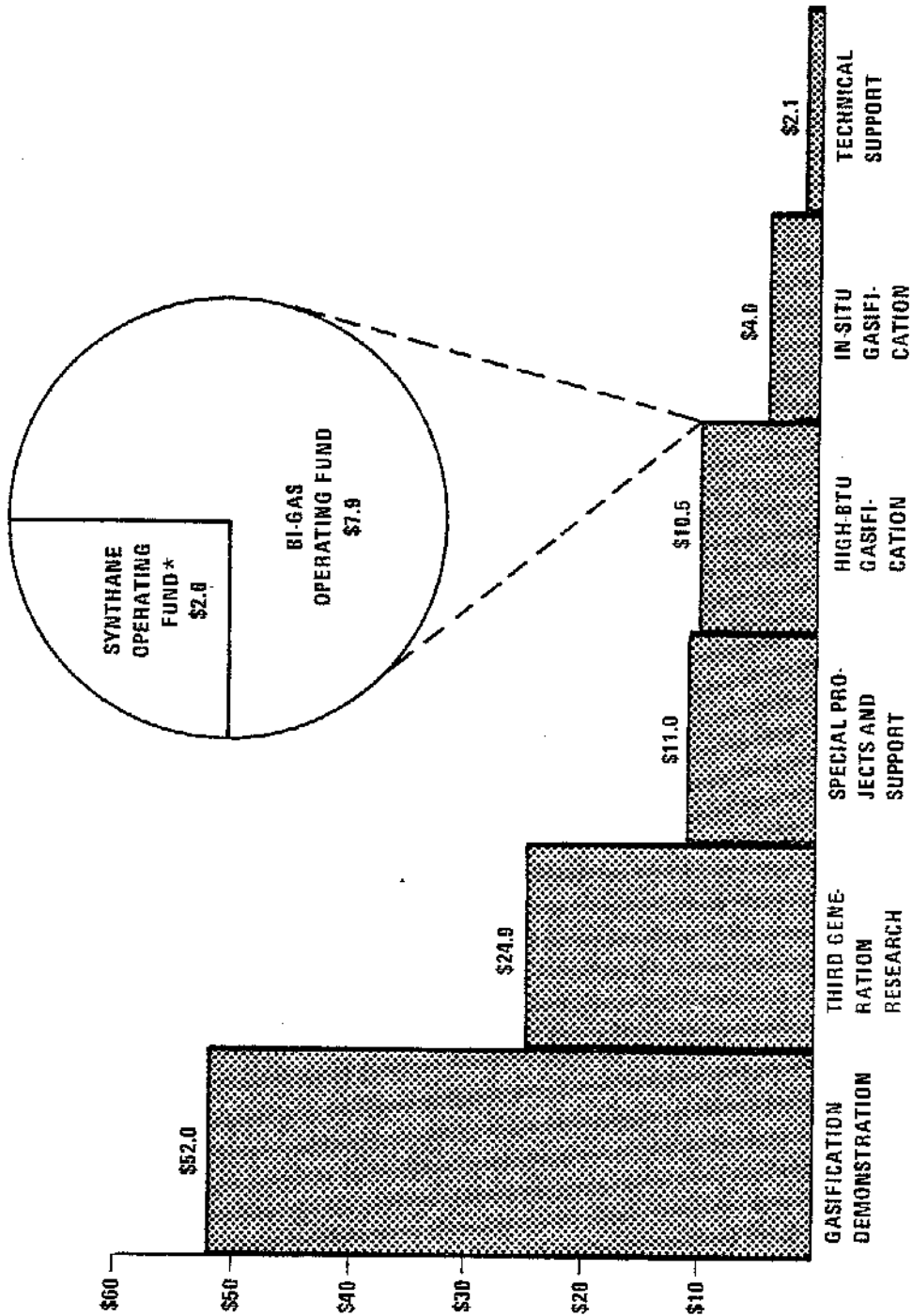
A critical step in the development of commercially acceptable coal gasification processes is the successful operation of a pilot plant where controlled testing of the process can take place and where various parameters affecting the process's efficiency can be examined. Over the past several years, DOE and its predecessor, ERDA, have supported the operation of numerous pilot plants through the High-Btu Gasification Program. These have included pilot plants for the Synthane, CO₂ Acceptor, Self Agglomerating Burner, Steam Iron, HYGAS and Bi-gas processes.

As of January 1, 1979, the pilot plants for the Synthane, Self-Agglomerating Ash and Steam Iron plants were closed down. The CO₂ Acceptor process also was shut down, having successfully met its pilot plant objectives, but not pursued further because of the relatively high cost of the product gas. As discussed earlier, the HYGAS pilot plant is still in operation to generate data for use in designing the demonstration and commercial plants. Two other pilot plants have received DOE funds in FY 1979. The Bi-gas pilot plant in Homer City Pennsylvania, is currently being supported by DOE. The Synthane pilot plant received support only in the first quarter of FY 1979 and was shut down in December, 1978.

Total funding for the operation of these two pilot plants in FY 1979 is \$10.5 million as shown in Exhibit II-5. A discussion of these projects follows:

The Bi-gas Process. The Bi-gas process has been under development by Bituminous Coal Research, Inc. (BCR) since 1963. Bench scale testing was completed in the early 1970's and construction of a 120-ton-per-day pilot plant was completed in FY 1976 at Homer City, Pennsylvania by Stearns-Rogers. BCR and Phillips Petroleum began startup activities in FY 1976, but numerous, unanticipated problems occurred which caused the delay of the first successful run until November, 1977 (early FY 1978). In February 1978, an operating accident at the pilot plant forced operations to be terminated for four months.

EXHIBIT II-5
 High-Btu Gasification Program Funding
 Fossil Energy Program, DOE
 (FY 1979, Millions of Dollars)



* THE SYNTHANE PILOT PLANT WAS OPERATED DURING THE FIRST QUARTER OF FY 1979 ONLY.

Last fall, an analysis of the hazards involved with operating this facility was performed for the DOE/GRI Joint Gasification Program. In addition, an audit regarding the objectives, current status, potential for achieving the developmental goals, and the technical merits of the program was initiated. These analyses served as the basis of a reevaluation of the project by GRI and DOE. DOE is continuing its funding (\$7.9 million for FY 1979); while GRI has decided to terminate its funding at the end of CY 1978.

The Synthane Process. Research on the Synthane process began in the early 1960's at the Pittsburgh Energy Research Center. In FY 1970, a preliminary design contract was awarded to the M.W. Kellogg Company to determine whether there were sufficient data to design a pilot plant. Upon the determination that sufficient data existed, a contract was awarded to the Lummus Company in late FY 1971 for the design of a 75 ton-per-day Synthane pilot plant. Construction of this plant was performed by Rust Engineering and completed in early FY 1977. Start-up of the plant was initiated in FY 1977 with sub-bituminous coal. The focus of the research at this plant was the collection of data regarding solids handling, pretreatment and gasification.

In FY 1979, DOE provided \$2.6 million in funding to mothball this pilot plant. This work was completed in the first quarter of FY 1979 and the project was terminated in December 1978. Results from this plant indicated that this process does not produce a pipeline quality gas at an economically competitive price.

- (5) DOE's In-Situ Coal Gasification Program Placed Little Emphasis on the Production of Gas Which Can Be Upgraded to SNC.

DOE's In-Situ Coal Gasification Program is providing \$15.0 million in funds in FY 1979 for in-situ projects. Of this amount, \$4.0 million is related to GRI's efforts. In fact, the Western Medium-Btu Gas project is co-funded by GRI and DOE. Other DOE projects, including its Steeply Dipping Beds, Supporting Research, and Environmental Support Projects, may have some limited relation to GRI's efforts.

- (6) DOE's Technical Support Program Provides Funding for the Engineering Evaluations Associated With the Joint Gasification Program.

As part of the DOE/GRI Joint Gasification Program, DOE is providing \$2.1 million for engineering evaluations through its Technical Support Program. The purpose of these evaluations is to provide continuing support to the joint program. Activities to date include:

- . Pilot plant and PDU surveillance
- . Review and evaluation of pilot plant and PDU data
- . Unit operations process studies
- . Engineering studies in the area of safety assurance, materials and plant efficiency
- . Mechanical development studies of commercial scale components
- . Commercial concept designs, including cost calculations.

This section has discussed DOE funding efforts in high-Btu coal gasification research and development. Industry's efforts are presented in the next section.

3. INDUSTRY EFFORTS IN COAL GASIFICATION

Currently, coal gasification research funded by industry is limited. Over the past 15 years, the private sector (private companies and GRI/AGA) has spent considerable sums on coal gasification research. Out of these efforts have come the previously discussed coal gasification processes, such as Lurgi, HYGAS, COGAS, Exxon Catalytic Gasification, and others. Many of these processes have been patented and developed to the level of pilot scale operations. Interviews with the major developers indicate that most of them believe that technically-proven technologies are available, but that complete systems need to be proven in commercial-size operations, particularly for pipeline quality synthetic natural gas. Major barriers to commercial gasification are high capital cost, unknown production costs, and uncertainty of market price for the gas.

Because of the high cost of commercial sized coal gasification facilities and the inherent risk in any new process, no company, to date, has chosen to build a large-scale demonstration plant. Most companies are waiting to see the outcome of further government funded research or are grouping with other companies to share in demonstration projects partially funded by DOE and GRI. The companies that are not engaged in such ventures tend to be watching and waiting the outcome of the demonstration programs.

It is estimated, from interviews conducted with the major contributors to coal gasification technology, that less than \$10 million annually is being spent by private industry directly on coal gasification research. When

elements such as feasibility studies, environmental impact analyses, economic analyses, design studies, and other contingency planning functions for potential facilities (primarily by gas and oil companies) are included, the sum spent is estimated to be about \$50 million per year. Although these analyses are necessary to the development and implementation of a commercially viable process, they are not considered to be research and development in the context of the GRI program.

For the purposes of this study, the private sector was divided into two segments: natural gas companies and other private companies. The major coal gasification programs for each segment are discussed in the following sections.

(1) There is Little Current Independent Coal Gasification Research Being Conducted by the Natural Gas Industry

In an attempt to provide gas for their systems in the face of apparently declining resources, many gas companies have been involved in coal gasification over the last 15 years. These activities can be divided into three general areas:

- . Feasibility studies of first generation coal gasification plants
- . Specific second generation technology development activities
- . Other gas company activities.

1. Feasibility Studies for First Generation Coal Gasification Plants

Much of this effort has focused on feasibility studies of first generation technologies producing medium-Btu gas with some firms proceeding through process selection, site selection and design studies. These efforts were expended to determine the feasibility of building facilities, but most have been abandoned because of the large capital investment, cost of production, and risk associated with a new process. The organizations in the most advanced stages of the planning process include:

Great Plains Gasification Co. (American Natural Resources Co. project), a consortium of five pipeline companies:

- Michigan Wisconsin Pipeline Co.
- Natural Gas Pipeline Co. of America
- Columbia Gas Transmission Corp.
- Tennessee Gas Pipeline Co.
- Transcontinental Gas Pipe Line Corp.,

which plans to complete a 125 million cubic feet/day plant by 1983 in Mercer County, North Dakota. The company's proposed plant, which will use a Lurgi gasifier, was turned down by a Federal Energy Regulatory Commission administrative law judge this year and briefs are currently being prepared for presentation to FERC's commissioners.

- . El Paso Gasification Co. plans to complete a 69 million cubic feet/day facility using a Lurgi gasifier by 1983 without Federal loan guarantees and without noncompletion guarantees. The company still needs a business lease and water-use permits.

- . Pacific Gasification Co. (formerly Wesco) is studying several sites for a 250 million cubic feet/day plant using a Lurgi gasifier. The availability of loan guarantees is needed before construction at the selected site will begin.

- . Panhandle Eastern Pipe Line Co. has plans for a 125 million cubic feet/day plant in Wyoming using a Lurgi gasifier. Operation is expected by 1987 if tariff or loan guarantees become available.

2. Specific Second Generation Technology Development Activities

Interviews with gas companies indicate that most are maintaining an arms-length relationship with one of the potential DOE demonstration programs (COGAS or British Gas/Slagging Lurgi) to keep abreast of the advances in coal gasification technology. As these techniques are proven for commercial demonstration, the companies will decide on a participation and funding position.

Participation is expected to depend on government actions relative to loan guarantees, cost of service, and other government incentives; and, in most cases, these participation decisions have not been made by the companies. As an example, several gas companies are preliminarily involved in the British Gas/Slagging Luri demonstration project currently being considered by DOE. These companies will be decided as to their degree of participation after the preliminary design and economic analysis phase is completed.

Some gas companies are funding the development of demonstration programs. As discussed previously, the Illinois Coal Gasification Group (ICGG) has been developing a gasification demonstration project in conjunction with DOE. Currently, the ICGG is preparing preliminary designs for a demonstration project using the COED/COGAS process. The ICGG is made up of five gas utilities:

- . Northern Illinois Gas Company
- . The Peoples Gas Light and Coke Company
- . Central Illinois Public Service Company
- . Central Illinois Light Company
- . North Shore Gas Company.

This project has an estimated cost of \$1.3 billion, with 50 percent funded by DOE and the remainder from the ICGG participants. A decision regarding the funding of this demonstration will be made in FY 1980 by DOE as discussed above.

Construction of the plant is planned for 1980-1981 and it will be a facility to demonstrate the commercial feasibility of the COED/COGAS process, which has been licensed to ICGG by the COGAS Development Company (CDC). CDC is owned by four parent companies:

- . Consolidated Natural Gas Supply Company of Cleveland
- . FMC Corporation (COED process developer)
- . Panhandle Eastern Pipeline Company
- . Tennessee Gas Pipeline Company.

Each of these companies has participated in the development of the COGAS process through its research and development phase but ongoing internal research is limited with the demonstration program seen as the next step.

3. Other Gas Company Activities

A limited number of gas companies are maintaining their own independent research in coal gasification. Such programs consist of research into various sectors of the total gasification system, such as:

- . Coal preparation
- . Acid gas removal
- . Gasifier catalysts
- . Methanation
- . Effluent cleanup.

For example, one firm is participating with DOE in a research program on gasifier catalysts. This is an \$800,000, 3-year program with the firm supplying 25 percent of the funds (averaging \$67,000 per year). This same firm is conducting other proprietary in-house coal gasification research projects. Its total projected level of gasification research funding is less than \$2 million per year.

Although other gas firms are keeping abreast of coal gasification research, and some are conducting feasibility and design studies, almost no direct independent research activities are currently being funded. The general opinion among gas companies is that the technology is available in various processes and the next logical step is to prove these in commercial sized operations. Estimates from the gas industry indicate that less than \$5 million per year is being spent by the gas industry on coal gasification research and this research is primarily concentrated in various associated processes, not basic conversion technologies.

Many of the gas companies interviewed during this effort expressed their support and participation in projects that are, in fact, GRI programs. Funds passed on to GRI by many gas companies are considered to be research funds and are considered as a part of the companies' research programs.

(2) Industry Expenditures Outside the Gas Industry
Are Less Than \$5 Million Annually on Internally
Funded SNG-From-Coal R&D

Interviews with several leading firms (see Appendix A) indicated that little coal gasification R&D is being supported by companies outside of the gas industry when compared to DOE's spending.

Because of the proprietary nature of the information, most companies were reluctant to specify the internal funding level or technical content of their ongoing coal gasification research. However, the firms did indicate that the pattern for most current R&D in coal gasification is to spend internal funds developing a concept to the point where it can be presented to a funding agency, such as DOE or GRI, for further funding. All companies agreed that coal gasification research is extremely expensive since it must proceed to pilot plant and demonstration stages very quickly in order to prove concept validity.

This study identified few companies with ongoing R&D in coal gasification. In general, the internal funding of most research has been completed and the companies are participating or proposing to participate with DOE or GRI in major pilot plant and demonstration programs. The tremendous cost prevents the companies from proceeding alone. Only Enrecon, Inc. and its parent company, Roldiva, Inc., which is planning to build a 600 ton-per-day commercial facility based on the Enrecon process, has solely financed its technology development through the pilot-plant stage.

The SNG-from-coal processes developed outside the gas industry and previously discussed include:

- . Exxon catalytic gasification
- . Rockwell International SRT hydrogasification
- . Bell Aerospace High-Mass-Flux gasification
- . The Westinghouse process.

Exxon, through Carter Oil Company, originally planned to construct a 500 ton-per-day facility in Baytown, Texas, during 1974-1976; however, this project has been deferred for lack of capital. The Rockwell International, Bell Aerospace, and Westinghouse processes have proceeded to the stage where the companies are receiving outside funds to support their research efforts. These companies are receiving funds from DOE/GRI to generate data needed to design and build a pilot plant. Current company funding is minimal in these projects.

Several construction engineering firms have designed systems to take advantage of unused capacity in medium-Btu gasifiers that are planned at several industrial facilities. Foster Wheeler Corporation is considering the addition of a small shift conversion-methanation facility to a planned medium-Btu plant. Excess gas capacity would be converted to high-Btu gas and fed to the natural gas pipeline as an energy credit to the system.

Fluor Engineers and Constructors, Inc. has developed a system using both the British Gas/Slagging Lurgi and Texaco processes in tandem to produce a system that is supposedly more efficient and commercially applicable than either system along, when the shift conversion and methanation equipment are considered.

These designs have been formulated to hasten the entry of coal gasification into industry by reducing the capital investment levels required for high-Btu gasification plants. However, there is currently no research and development work being funded by companies in this area.

Private companies are funding a limited amount of research at universities. Individual support grants or contracts typically are on the order of \$100,000 per year. Several universities are active in these programs, including:

- . Alfred University, conducting research in high temperature refractories and refractory slagging.
- . Pennsylvania State University, continuing its efforts into environmental effects of coal gasification.
- . Carnegie Mellon, University of North Dakota, and University of Pittsburgh, conducting research in effluent cleanup.
- . The Massachusetts Institute of Technology, researching the coal gasification process using funds provided by industry.

Although the industrial sector outside the gas industry is funding SNG-from-coal research at less than \$5 million per year, most firms feel that more research should be done. Opportunities for research as perceived by industry include:

- . Effluent treatment
- . Cleanup of slag and gasifier liquors
- . Effect of ash disposal on soil
- . Waste containment during emergencies
- . Coal lock valves for the injection process
- . Slurry pumps
- . Flow measuring devices for solids.

Large scale commercial demonstration projects are considered by industry to be necessary to the further development of coal gasification as a viable gas supply alternative.

4. GRI RESEARCH EFFORTS IN COAL GASIFICATION

The Gas Research Institute operates on funds contributed by the natural gas consumer, via the gas industry, and is currently supporting research in third generation high-Btu coal gasification. GRI's Synthetic Natural Gas (SNG) from Coal Subprogram has three current objectives:

- . To develop new coal gasification processes with improved resource utilization, high throughput, and improved economics
- . To develop coal gasification associated technology, including reactor design fundamentals, downstream gas processing unit operations, studies of materials of construction, and engineering evaluation of alternative processes
- . To develop new underground coal gasification processes for the purpose of producing SNG without mining coal.

Coal gasification research, funded at the \$14 million level, was supported by GRI on a co-funding basis with DOE during 1979 to achieve these objectives.

GRI and DOE (and their predecessor agencies) have funded a pilot plant research program since 1971 to develop coal gasification concepts based on modern engineering techniques. This research program included several gasification processes that were ready at that time for pilot scale testing, including the Bi-gas, HYGAS, CO₂ Acceptor, Steam Iron, and the Self-Agglomerating Ash processes. The status of these projects were discussed earlier.

In keeping with the current objectives of GRI, five coal gasification processes were funded at \$10.9 million level in 1979 as part of the joint DOE/GRI program. At the end of 1979 those processes showing the greatest promise will be selected for continued development. The processes include:

- . HYGAS. GRI terminated its funding of this project on June 30, 1979 because the technical feasibility of the process was considered proven.

- . Peatgas. This project will assess the resource base; peat mining, drying and environmental problems; and the best technologies available for gasification. In addition, peat will be tested in the HYGAS pilot plant to gather design data.

- . Catalytic Gasification. Continued operation of the Exxon process development unit to produce data for the design of a pilot plant.

- . Westinghouse Two-Stage Fluidized Bed Gasification. Operation of the process development unit in the oxygen-blown mode to produce data for the design of a pilot plant.

. Bell Aerospace High-Mass-Flux Gasification.

Operation of the high-mass-flux reactor in the air-and-oxygen-blown mode to produce data for the design of a pilot plant.

GRI will conduct research projects into various associated SNG technologies including:

- . Reactor design fundamentals
- . Downstream gas processing unit operations
- . Studies of materials of construction
- . Engineering evaluation of alternative processes.

During 1979 GRI funded research at the \$3 million level in several projects including:

- . Rapid Rate Bituminous Coal Gasification
- . Evaluation of Coal Conversion Catalysts
- . Sulfur Insensitive Methanation Catalysts
- . Basic Studies of New Coal Conversion Catalysts
- . Acid Gas and Trace Impurity Removal
- . Ferromagnetic Separation of Oil-Water-Char Mixtures
- . Regenerative Heat Exchange
- . Materials Evaluation
- . Engineering Evaluation.

GRI support for the development of techniques by which SNG may be processed from coal without first mining it (in-situ) began in 1979. This program is co-funded with DOE and is operated in conjunction with the Lawrence Livermore Laboratory. In 1979, GRI, at a \$200,000 level of effort, continued research into oxygen-blown underground coal gasification using directionally-controlled drilling to establish a predetermined channel between vertical input and producer wells.

This section has discussed GRI's 1979 programs with total funding of \$14 million. The next chapter summarizes the ongoing research into coal gasification and its implications for GRI.

III. FINDINGS AND IMPLICATIONS

This chapter discusses the findings and implications which can be drawn from the information and data presented in the previous chapter. It is divided into two parts:

- . Summary of Findings
- . Implications for GRI's Programs.

I. SUMMARY OF FINDINGS

GRI and DOE continue to share the funding efforts in many related coal gasification projects because of the high costs associated with coal gasification research and a cooperative association since the early 1970's. Each of the groups involved in SNG from coal are funding at the following annual levels for FY 1979:

. DOE	\$105 million
. GRI	14 million
. Gas industry	5 million
. Other industry	5 million.

A summary of funding related to GRI's subprogram area is presented in Exhibit III-1. Programs for each of these are summarized in the following sections.




(1) The Department of Energy Is the Dominant Funder of Coal Gasification R&D

Coal gasification holds great promise for reasserting our nation's energy independence because of our large

EXHIBIT III-1
 Summary of Funding Related to GRI's
 SNG From Coal Program
 FY 1979

ORGANIZATION	RESEARCH AREA		
	GASIFICATION PROCESSES	ASSOCIATED TECHNOLOGIES	IN-SITU RESEARCH
DEPARTMENT OF ENERGY			
GAS INDUSTRY			
OTHER INDUSTRY			
GRI			

KEY:

- MINIMAL
-  LESS THAN \$5 MILLION
-  \$5 TO 15 MILLION
-  GREATER THAN \$15 MILLION

reserves in coal. Therefore, DOE is pursuing a research, development and demonstration program that is much greater than that of any private funding group. About half (\$52 million) is devoted to demonstration programs such as the:

- . British Gas/Slagging Lurgi process under development by Conoco Coal Development Company
- . COGAS process under development by the Illinois Coal Gasification Group, a confederation of natural gas companies.

Studies of the HYGAS process, developed by the Institute of Gas Technology, is also being pursued by DOE to determine the feasibility of building a commercial sized plant to demonstrate the technology. One or more of these demonstration programs will be co-funded by DOE and industry over the next few years.

The DOE is providing about \$25 million in research funds for third-generation coal gasification processes. Efforts funded include the:

- . Hydrogasification process, with Rockwell International, that includes the operation of a 0.25 ton-per-hour pilot plant.
- . Westinghouse fluidized bed gasification process, research that is being conducted to determine the feasibility of building a pilot plant.
- . Peat gasification, studies into the viability of peat as a resource base for gasification.

- . Exxon Catalytic gasification process, research that is being conducted to determine the viability of building a pilot plant.
- . Bell Aerospace High-Mass-Flux gasification process, research into the feasibility of building a pilot plant.

GRI is planning to participate with DOE in many of these programs during FY 1980.

DOE is also supporting research efforts into second-generation high-Btu coal gasification with FY 1979 funding of \$11 million. This program includes a technical and economic re-evaluation of the Bi-gas process to determine if the program should be continued. Funds from this program were also used to shut down the Synthane pilot plant.

There are also several other projects supported by DOE that can impact the GRI research program. These include:

- . The gasification test facility which DOE is planning to build to allow component testing of generic coal gasification equipment.
- . The In-Situ coal gasification project which is continued research into oxygen-blown underground coal gasification using directionally-controlled drilling to establish a predetermined channel between input and producer wells.

. Engineering evaluation and technical analysis programs that support DOE's on-going research programs.

Many of the above listed programs by DOE are being coordinated and co-funded with GRI, therefore, the efforts required by GRI to keep abreast of DOE programs are the same as those being currently exercised.

(2) Little Independent Coal Gasification R&D Funding Is Being Provided by Industry

Interviews with the major industrial firms involved in coal gasification indicate that little independently funded research is being conducted. Current funding levels are estimated to be less than \$5 million for the gas industry and less than \$5 million for other industry. This relatively low level appears to be caused by the fact that many companies invested in coal gasification research in the 1960's and early 1970's. During these efforts, they either withdrew from the technology or developed a process that is ready for demonstration. Processes such as the:

- . COGAS process developed by FMC
- . Consolidation Coal Company's CO₂ Acceptor Process,

are considered ready for demonstration; however, no companies have chosen to build a commercial-scale plant because of cost and the risk of a new technology.

The primary research currently in private industry is devoted to subsystems such as:

- . Coal preparation
- . Acid gas removal
- . Gasifier catalysts
- . Downstream shift conversion and methanation
- . Effluent cleanup.

Research in these areas is occurring as many companies await the possibility of participating in DOE/GRI demonstration programs that are currently being considered.

(3) GRI Is Focusing Its Coal Gasification Efforts on Third Generation Technologies

GRI has as its purpose in coal gasification to investigate and develop more efficient processes to produce SNG from coal. To accomplish this, it is conducting a \$14 million effort in 1979 consisting of the following programs:

- . Research into the Westinghouse fluidized bed gasification process to determine the feasibility of building a pilot plant
- . Research into the Bell Aerospace high-mass-flux gasification process to determine the feasibility of building a pilot plant
- . Peat gas testing in the HYGAS pilot plant and assessment of the peat resource base

- . Continued operation of the Exxon Catalytic gasification process development unit
- . Operation of the Rockwell International 0.25-ton-per-hour pilot plant utilizing the Hydrogasification process
- . Research into various associated SNG technologies
- . Continued operation of an oxygen-blown, in-situ coal gasification pilot program.

Most of these programs will be conducted and jointly funded in conjunction with DOE.

2. IMPLICATION'S FOR GRI'S PROGRAM

In order to ensure that GRI's program is well coordinated with work being performed by others, GRI must continue to stay abreast of projects being sponsored by other organizations such as the Department of Energy, industry, and private research organizations.

This will be extremely easy to do because GRI and Dr. Flowers were constantly referenced as the source of knowledge in the industry during interviews with DOE program managers, industry and others. GRI should utilize this position of pre-eminence to take a leadership role in the development of coal gasification. Specific implications for each funding group are discussed as follows:

- . The Office of the Assistant Secretary for Energy Technology within DOE is the focal point for the Fossil Energy Program. GRI is currently co-funding most of its projects with DOE and plans to do so in the future, which makes coordination relatively simple. While this leverages GRI's funds, the arrangement must be constantly reevaluated to make sure that scientific and technical independence is maintained and the specific programs help serve the overall purposes of the natural gas industry and its customers.

- . Interviews with industry, particularly the gas industry, indicate that GRI is considered the leader of coal gasification research in this country. Many respondents have discussed with GRI the potential of co-funding of research projects in coal

gasification. For these reasons, industry is aware of GRI and its programs. GRI is also aware of industry's programs, therefore, coordination with industry activities will be relatively easy.

Most of the research being conducted in private industry is either conceptual process research or development of subsystems of the gasification process. GRI should make a concerted effort to maintain its coordination efforts in the associated SNG technology program area to reduce the potential for research duplication.

* * * * *

This report has provided an overview of activities related to the GRI SNG from Coal Subprogram area. This overview has provided an insight to GRI's efforts in coal gasification. It also identifies some issues about the role of GRI's programs and its cooperative and co-funding programs.

APPENDIX A

ORGANIZATIONS CONTACTED FOR COAL
GASIFICATION OVERVIEW

1. GOVERNMENT

- . Department of Energy
 - Energy Technology
 - Resource Applications
 - Morgantown Energy Research Center
 - Laramie Energy Research Center
 - Lawrence Livermore Laboratory

2. NATURAL GAS INDUSTRY

- . COGAS Development
 - Consolidated Natural Gas Supply Company of Cleveland
 - FMC
 - Panhandle Eastern Pipeline
 - Tennessee Gas Pipeline
- . Columbia Gas
- . Consolidated Natural Gas
- . El Paso Natural Gas
- . Illinois Coal Gasification Group
 - Central Illinois Light Company
 - Central Illinois Public Service Company
 - Northern Illinois Gas Company
 - North Shore Gas Company
 - Peoples Gas Light and Coke Company

- . Peoples Gas
- . Sun Gas
- . Texas Eastern Gas Pipeline
- . Trunkline Gas

3. OTHER INDUSTRY

- . Air Products & Chemicals
- . American Lurgi
- . Applied Technology
- . Babcock & Wilcox
- . Bell Aerospace
- . Chem Systems
- . Chevron Research
- . Combustion Engineering
- . Conoco
- . Davy Powergas
- . Enercon, Inc.
- . Exxon-Carter Oil
- . Fluor
- . Foster Wheeler
- . Garrett Research and Development
- . General Electric
- . Koppers Engineering & Construction
- . M. W. Kellogg
- . Rockwell International
- . Stearns-Rogers
- . Stone & Webster
- . Texaco
- . Total Energy
- . Union Carbide
- . Westinghouse Electric
- . Williputte

4. MISCELLANEOUS ORGANIZATIONS

- . American Gas Association
- . Bituminous Coal Research, Inc.
- . Electric Power Research Institute
- . Institute of Gas Technology
- . National Coal Association

CURRENT MEDIUM-BTU COAL GASIFICATION
TECHNOLOGY DEVELOPMENT

1. PRIVATE INDUSTRY

Private industry's activities in coal gasification are primarily concentrated in second generation technologies for the production of medium-Btu gas. Efforts in medium-Btu gas development is led by petroleum companies and some large construction engineering firms. These efforts are being expended to develop systems that will improve supply security for some industrial firms and provide feedstocks for chemical plants. Currently, R&D efforts into medium-Btu coal gasification are funded at less than \$10 million with most companies awaiting the results of DOE's various development and demonstration programs.

Only Texaco, which developed a medium-Btu gasification process, is proceeding with the independent development of its process. This is being done to protect its patent position. Further development work is being funded by licensing the process to those companies who wish to test it in their system. Texaco's current internal research level is minimal.

Other companies that have participated in medium-Btu coal gasification process development include:

- . Chevron Research Company (Chevron catalytic gasification process)

- . Consolidation Coal Company (CO₂ Acceptor process)
- . Garrett Research and Development Company (Garrett process)
- . Stone & Webster/Gulf Oil (Solution Gasification process)
- . Davy Powergas (Winkler process).

Interviews with the companies listed above indicate each of these processes are considered to be ready for full-scale (commercial) demonstration (such as the CO₂ Acceptor process of Consolidation Coal) or that the research and development has been terminated for various reasons. Each of these companies indicated minimal funds are currently being expended for coal gasification research.

2. ELECTRIC POWER RESEARCH INSTITUTE

The Electric Power Research Institute (EPRI) is funded by the electric power industry and is currently supporting research in medium-Btu coal gasification. The overall objective of EPRI's Clean Gaseous Fuels Program is to develop economically competitive and environmentally acceptable coal gasification-based electric power systems.

EPRI's research efforts consist primarily of support for medium-Btu coal gasification systems. The output of these systems can be utilized to drive gas turbines and other power systems for the generation of electricity.

The principal goal of EPRI's Clean Gaseous Fuels Program is to provide the necessary technological data for the design and operation of an integrated gasification/combined-cycle demonstration plant of 100-MW or greater size by 1985. The EPRI program is also focused on the development work required to achieve commercialization of lower-cost gasification technology. Two major objectives in this area are:

- . To provide a system test facility for integrated gasification/combined-cycle system controlled development, and for the evaluation of alternate component improvements.

- . To develop lower-cost systems through research on advanced gasification processes of greater flexibility, efficiencies, simplicity, and environmental acceptability than existing technology.

EPRI system control studies planned over the next 2 years are to be verified at a test facility for fixed-bed systems, and to some degree, for the Texaco entrained system at the Texaco pilot plant. It is planned that results from these projects, together with the parallel gasifier developments under the DOE demonstration program will provide the information for design of larger gasification/combined-cycle units. These efforts were funded at a level of \$9 million in 1979 and are projected to grow to \$16 million in 1983.