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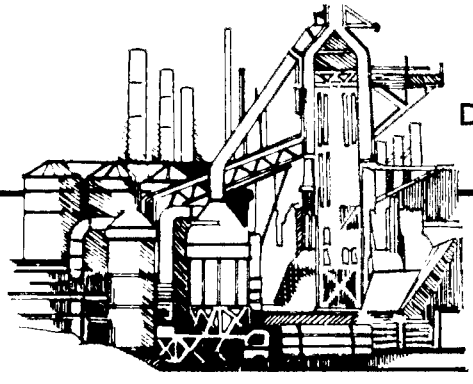

University of Pittsburgh
Department of Chemical and Petroleum Engineering

Seventh Annual International Conference on

Coal Gasification Liquefaction & Conversion to Electricity

August 5 thru August 7, 1980

PROCEEDINGS

Seventh Annual International Conference on Coal Gasification, Liquefaction and Conversion to Electricity

Edited by

Dr. Alan J. Brainard

August 5 - 7, 1980

Department of Chemical & Petroleum Engineering

University of Pittsburgh

Pittsburgh, Pennsylvania

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THE UNITED STATES SYNTHETIC FUEL CORPORATION - A BANKER'S PERSPECTIVE

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The United States Synthetic Fuel Corporation

Good morning. I appreciate this opportunity to contribute to your 7th Annual Conference. But with one political convention behind us and another just around the corner, I suspect there are more speeches floating around than anyone truly wishes to hear. Bearing this in mind, I promise you that, over the next 20 minutes or so, I shall at least refrain from nominating anyone to lead anything.

That the United States is finally attempting to meet the dual challenge posed by declining domestic energy resources and increasing reliance on foreign supply is obvious to all of us. I will not belabor the point; nor will I recite the litany of alternatives we face and actions we have or have not taken. And I can also assure you that I have no intention of analyzing fully the recently enacted Energy Security Act. Instead I propose to share with you my views on only the first part of the Act and discuss the significance of the U. S. Synthetic Fuels Corporation from a financial perspective.

I'll begin by quoting from the first section of the Act, which defines its purpose as, and I quote: "to improve the Nation's balance of payments, reduce the threat of economic disruption from oil supply interruptions and increase the Nation's security by reducing its dependence upon imported oil."

The creation in the Energy Security Act of the United States Synthetic Fuels Corporation is one of the seven specific programs in the Act designed to serve that purpose. While synfuel development is not considered to be the total solution to our energy problems, it certainly is, or has the potential to be, a significant part of that solution and deserves our earnest consideration.

The commercial development of synfuel in ths country will be a massive undertaking. Bankers Trust's current energy study concludes that the synthetic fuel industry alone will spend some $90.8 billion in current dollars by 1990, a figure that is remarkably close to the $88 billion covered by the Energy Security Act. Now $90 billion dollars, even when spread over ten or twelve years, seems like a lot of money to raise. However, this is not why the SFC is so important. The private sector has the capacity to raise capital of this magnitude for such special application, providing -- and this is an important caveat -- the risks associated with the investment are viewed by the private sector as manageable. The fact is, however, that some of the risks are just too high and uncertain at this time for the private sector to undertake widespread commercialization of new technologies and processes without government support.

That's what the Synthetic Fuels Corporation is all about. Basically, it has been given a mandate to carry out a program of finite length designed to give the synfuel industry initial developmental assistance by assuming those risks currently viewed as unmanageable by the private sector alone. And while we feel that its production goals -- 500,000 barrels of crude equivalent a day by 1987 and two million barrels by 1992 --- may be over-optimistic, we applaud the government's foresight and wisdom in establishing the program in the first place. Whether the production goals are met on time or not, the machinery is now in place to develop, as rapidly as possible, an industry necessary for both our national security and our economic well-being.

To put it simply: The Synthetic Fuels Corporation is intended to shorten the lead time for the development of a viable synfuels industry. In setting up the Corporation the Government has recognized the need to offer initial aid by assuming unquantifiable risks. Under this umbrella the private sector can then evaluate and eventually accept these risks, and with them the full ownership and control of the industry.

This government action will result in the promotion and development of a new industry on an accelerated basis, at a time when its development is most critical.

The synfuels Corporation is nearly unique in the history of the U. S. Government support of industrial development. Perhaps the program that was closest to the SFC was Comsat Corporation. This program was set up by the government in conjunction with private industry in 1962 to promote the use of new space technologies in international communications. Then, when successful operation was achieved, the government sold its interest into the public market. It was an extremely successful program for an industry whose time had come. All that was needed was government assistance for it to get off the ground -- figuratively and literally. Like Comsat, the SFC is an entity separate from any government agency. It is designed to commercialize a new technology. It's building a future industry rather than supporting a current one. It has a life limited to twelve years. And it is intended to be flexible enough to adapt to the job it has to do within that time period. No other programs I know of have ever had all these particular characteristics.

And that's a very important point. It means that the synfuels Corporation is equipped to face challenges that could not be coped with through the capabilities granted to any other agency. The critical issue is how successfully it meets those challenges. To a very large extent this will depend upon the Corporation's inherent structural strengths and weaknesses and the skill with which the program is administered. It will also depend on its ability to attract investors and their financiers.

What about these strengths and weaknesses? To begin with, the synfuels Corporation is a quasi-independent corporation and this bodes well for its success. I believe Congress tried to eliminate the problem of political partisanship by limiting the Board to no more than four members of any one political party. But this requirement is a doubled-edged sword, and this very recognition of a potential problem may yet encourage undesirable political overtones and could vitiate the whole purpose of the Corporation.

Nothing will affect the Corporation more than the quality of the people chosen to carry out its mandate. A strong, highly independent Chairman and Board must be selected. They should have demonstrated experience in competent admini-

stration and negotiation. They must collect an intelligent motivated staff with an appropriate technical and financial background. And they must also be able to resist political pressures. I can assure you that the success of the Corporation will be seriously jeopardized if its management cannot meet these high standards.

The Corporation must develop its mandate as rapidly and efficiently as possible. It must not get bogged down in that favorite Washingtonian exercise: creating and appling red tape. Without an Energy Mobilization Board type of override there is a very real danger that every action proposed could become mired in regulatory delay.

I'm suggesting that Congressional action should be taken to insure the Corporation the degree of override power needed to meet the urgency of our times. I am not suggesting that the Corporation should ride roughshod over the regulatory agencies. Nor am I proposing that we ignore the very real environmental concerns that surround the synfuels industry. What I am saying is that the Corporation will probably need some additional means by which to speed up the approval process for its programs. Without that leverage, the chance to develop the synfuels industry now, when it is needed, may be lost to us.

The third area that concerns me is that of cost overruns. As an experienced lender to many projects I recognize two areas of concern which seem to be treated broadly in the Act as "overruns." First is any extra cost incurred in building a facility to its designed specifications. This cost may develop due to such things as strikes, process redesign, or delays in site preparation and equipment deliveries. There is no question in my mind that the SFC is set up to deal with this type of overrun problem through a rather inadequate formula that requires the equity owners to take increasing percentages of exposure as the overrun mounts.

But beyond this obvious overrun cost is the need to arrange funding for the circumstance where the facility has been built precisely to design but does not produce the intended products in the expected amounts and at the specified quality. The cost of necessary modification to make the plant run as intended must be accepted as a vibrant risk with the first signing of the contract. This is more than overrun cost, this is make-it-run cost. From the Act it is not clear to me if the SFC is to consider the make-it-run cost to be part of

the overrun cost or not. The Act refers to the need for considering completion guarantees in the comprehensive strategy study that the SFC must deliver to Congress within four years. This implies that completion guarantees are apparently different than overrun costs. Now as a banker with no small experience in this area, I recognize that we are working at the very cutting edge of technology and its commercialization. To me the ultimate risk is not that the plant may not be completed, but that, when completed it may not work. I urge Congress to recognize the depth of both risks and grant the SFC greater initial flexibility to negotiate both overrun coverage and completion guarantees. The extent of these coverages should be left to the wisdom of the SFC. Only they will be able to judge the significance of the project, the depth of its problems and the capacity of its investors. And only after the fact should they be accountable to Congress for their exercise of good judgement.

With such powers the Corporation would be free to negotiate particular overrun or make-it-run provisions for each project, suited to the nature of the project and its sponsors. In some situations, the sponsors will be able to pick up most or all of the exposure; in others, the Corporation will feel a need to do so. This freedom, when intelligently managed, will get the government more mileage for its investment dollars. It will also reduce the likelihood of a project left incomplete or inoperative because of unavailable financing.

The overrun problems also back into the funding problem. At present the Corporation has $20 billion appropriated out of $88 billion authorized. Any participant in the program will want to know how his overrun potential is to be funded. He will want to know whether it is automatically recognized as an SFC obligation under the initial terms of the contract without relevance to the size of the SFC allocation, or whether the SFC must include that overrun liability as a charge against the $20 billion. This would limit their kitty to only $20 billion of aid including overruns. I am doubtful that anyone will be prepared to accept overrun liability to be charged against unappropriated funding.

I've told you what I believe to be the chief weaknesses of the synfuels Corporation as it's set up. Make no mistake: They are serious weaknesses; and any one of them

could jeopardize the ultimate success of the entire program.

Let me now turn to the Corporation's strengths. Politically it has been structured in a favorable fashion. It is an independent corporation with a great deal of operating flexibility. This flexibility permits it to adapt to the necessary allocation of each perceived risk in each individual project. How does this flexibility manifest itself? Well, the Corporation is empowered to give consideration on a prioritized basis to proposals that ask for a commitment in the form of price guarantees, purchase agreements, or loan guarantees. After that there are direct loans, followed by joint ventures. Only as a last resort, and under specific conditions provided for in the Act, can the Corporation undertake its own synfuel projects. But as I mentioned, these are general guidelines. Flexibility is built into the system because the risk allocation is not standardized by government decree. Consequently, each project can have tailor-made coverage and hence build its own financing capability.

To appreciate this better, let's look at the areas of risk involved. At this point I'll repeat what my colleague, David Ormes, said when he spoke to this Conference last year. He identified three special areas of risk in developing a commercial synfuel facility: technological, market, and government. Technological risk involves process and equipment malfunctions. As engineers and managers you are all familiar with the problems these can create. I'm sure you also realize that they will be dominant in the development of the synfuel industry. We know that certain processes work because we've seen them function in other applications, and we know that compressors, pumps and heat exchangers work because they've all been tested elsewhere. But when you bring them all together in a new installation built on a larger scale than ever before attempted, Murphy's law takes over. The design, equipment and construction people start sweating blood as time runs on, costs keep climbing, and the unit refuses to function as designed.

The market risk goes to the economics of the plant. Here we have accepted the technological problems. But we are still faced with the economic problems associated with raw material and labor costs not to mention the ability to deliver a product acceptable to the market. This product must be delivered at a price which not only covers the necessary expenses but also the investor's requirement for a reasonable

rate of return. I might add that this market could have some bizarre price changes because of foreign political moves.

Lastly, is the government or regulatory risk. Despite the best intentions of all parties, rules and regulations must be met and differences in their interpretations must be resolved. Hearings, injunctions, suits and bureaucratic indecision will not only delay a project, they can also result in expensive design and construction modification or even a change in the siting. These events are beyond the ability of the investor to anticipate or control and they require attention and alleviation by the same body politic that creates them. The seriousness of any delay is of course much exacerbated by an inflationary economy.

These special risks are added to the more manageable ones expected in any project. I'm referring to the normal delays in construction or the operational inefficiencies that will affect the initial cost of the plant. These are factors that impair a project's ability to generate the cash flow needed for debt service and corporate health, but are covered by normal contingency allowances.

Given the intent of the Act -- to establish a corporation creating a synfuels industry while shouldering as little risk as is necessary -- how should the risk and rewards be allocated?

Let's remember that not all rewards are just financial. Our government has created the SFC not because it thinks it can make a bundle of money; but because it recognizes the urgent need for a new industry. An industry capable of supplying a product vital to the well-being of the nation. It is willing to take risks beyond the point of manageability by the private sector to achieve this goal, or reward. On the other hand the SFC was not established to create a perpetually subsidized industry. Our government recognizes the country's desire to have the industry stand on its own merits and ultimately compete in our free enterprise system. This means that the private sector will be expected to invest some of its capital in the hope of achieving an attractive profit, but only as the risks involved are perceived as more manageable. Private investors will probably bring their financing institutions along with them in this effort. Banks, insurance companies, finance companies, pension funds and the investing public will all share in this endeavor, and each

will invest to the extent he feels the reward justifies the risk.

The enabling legislation that creates the Synthetic Fuels Corporation recognizes much of what I have mentioned. It permits each risk to be covered or allocated in a mutually acceptable manner to the equity owner, the government, and any third-party lender. The government can cover additional technological costs with a flat loan or loan guarantee. The market exposure can be resolved with purchase contracts or price guarantees. Potential Government problems, at least in part, are also addressed. For example, additional costs incurred by a project arising from changes in environmental regulations will be charged fully to the Corporation's account.

The more normal hazards associated with the construction and operation of a plant can be shared through the joint venture approach which the Act permits, albeit not as a preferred option. Cost overruns are specifically covered by a formula for sharing.

Coverage of each of these risks may be negotiated through the use of any or all of these protections. At all times the investor will have his equity on the line, but his exposure can be mitigated by the deal he cuts with the Corporation.

The lenders may accept certain financial risks if they so desire, or they may require the full Government guarantee on their money. This is a function of their interpretation of the problems and the gain available to them by increasing their exposure. No two institutions will necessarily approach such a financing in the same manner.

I expect that negotiating a deal with the Synthetic Fuels Corporation will therefore be a somewhat complex process, given the number of variables involved. And, while the Act calls for competitive bidding where possible, I believe that most of the proposals will be dealt with strictly on a negotiated project basis.

At this point I would like to speak for the banking industry. We support, and we are deeply interested in all phases of this effort. The money center banks have both technical and corporate finance expertise to work with you in developing your proposal. Banking institutions can act as

your financial advisor as you negotiate with the Corporation. This role is identical to those taken in Ex-Im, FmHA or Title II transactions. We can also arrange the necessary third-party funding through syndication of a bank loan, by arranging longer term senior and junior debt or by placing your U.S. Government guaranteed obligations in the public market. Beyond that we can assist you in finding interested partners if you need more equity coverage and prefer not to enter into a joint venture with the Corporation.

End of the commercial for my industry. Now -- back to the libretto.

I have been speaking of risk primarily from the investor's and lender's points of view; let me now shift my emphasis to the role of the Synthetic Fuels Corporation in all this. While each form of support the Corporation can provide has its own statutory ceilings, individual contracts can be written for any support of combination of support elements the Corporation deems appropriate. Only at the close of the contract, then, is the total level of government support firmly set. Before that, everything is open to negotiation between the interested parties.

But let us not think the SFC can be totally molded to our purpose. If proposals acceptable to the Corporation are not submitted in sufficient number to fulfill the production goals of the Corporation as set forth in the Act, then the Corporation is mandated to, and I quote: "undertake to negotiate contracts . . . as necessary to achieve the purposes of this title." If submittals fail, the SFC is instructed to go out, solicit the business and create the projects in order to make this industry a reality. That's quite a mandate, quite a responsibility. May I emphasize again that it means that the staff of the Corporation will have to have a sophisticated understanding of its assignment and of the level of risk the private sector is willing and able to manage at this early stage. Finally, don't forget that the SFC is permitted to go it alone if the private sector cannot find adequate justification to join it. One way or another we will have a synfuel industry. I just hope it will be an efficient one!

Well --- I've tried to give you an analysis of the Synfuels Corporation as seen through the eyes of a financial person. And the fact is that the more ways we look at this unique new "life form" called the SFC, the greater our chances

will be of dealing with it successfully.

For my part, and for Bankers Trust's part, the government's recognition of the need to nuture the growth of the synfuels industry is a most welcome development. We applaud the creation of the Synthetic Fuels Corporation. As I have said, there are some serious weaknesses in the program, weaknesses that could easily prove fatal if not treated properly. However, if these weaknesses are recognized and dealt with, I am optimistic that the prospective marriage between this government corporation and the private sector will result in a reasonable, even mutually satisfactory relationship.

As we all roll up our sleeves to tackle this challenging task, we must remind ourselves constantly that the Corporation has been established for the benefit of us <u>all</u>, and we must work with that mutual goal in mind if the general good is to be achieved.

SYNTHETIC FUELS: A VIEW OF THE ENERGY SECURITY ACT FROM THE INSIDE

Richard D. Grundy

SYNTHETIC FUELS: A VIEW OF THE ENERGY SECURITY ACT FROM THE INSIDE

by

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Faced with an unprecedented threat to the United States' national security and to its economic and political future, in a truly bipartisan effort the 96th Congress enacted and President Carter on June 30, 1980, signed into law the Energy Security Act (P.L. 96-294). The synthetic fuels cornerstone of the statute is Title I which establishes the United States Synthetic Fuels Corporation (Part B) and authorizes an interim synthetic fuel commercialization program pursuant to the Defense Production Act of 1950 (Part A).

I. Background

The history of Federal support of synthetic fuel development predates the 1973 OPEC oil embargo by 30 years with enactment of the Synthetic Liquid Fuels Act of 1944 (P.L. 78-290). The legislative and programmatic foundations were laid in the Congress and in the Executive Branch over a seven year period beginning in the early 1970's. The foundations lay in the deliberations on President Nixon's November 1974 proposed Project Independence[1], President Ford's 1975 State of the Union Message (including Energy and the Economy)[2], President Ford's and Vice President Rockefeller's proposed Energy Independence Authority [3], the November 1975 recommendations of the Synfuels Interagency Task Force [4], and President Carter's April 1977 National Energy Plan [5], as well as an extensive legislative record in the Congress.

What is new is the recent, widespread support by industry as well as government for legislative proposals for the commercialization of synthetic fuel in the United States. Spurred by the 1975 cut-off of Iranian oil, such support was eight years in coming.

Legislation introduced by Senator Henry M. Jackson in 1972 to establish a Coal Gasification Development Corporation (S. 1846, 92nd Congress) was opposed by the Nixon Administration and no final action was taken. However, legislation later introduced in 1973

(S. 1283, 93rd Congress) was enacted as the Federal Non-Nuclear Energy Research and Development Act of 1974 (P.L. 93-577), which is now administered by the Department of Energy. That Act authorizes a wide range of joint government-industry energy research and development incentives related to alternative fuel production, including Federal product price guarantees, purchase agreements, loans, cooperative agreements, direct grants, government-owned and contractor operated energy facilities, and Congressionally chartered corporations. When the 1974 Act was debated the Senate supported the establishment of joint Federal-industry corporations to foster commercial scale demonstration of coal gasification, coal liquefaction, and oil shale, as well as advanced combustion power cycle and geothermal energy. The goal was to establish within 10 years the option and the capability for the United States to become energy self-sufficient[6]. The final statute outlines such model corporations subject to specific Congressional approval; however, no such proposals have been made by the Executive Branch. (Subsequently, the Department of Energy (authorization) Act, 1978, added loan guarantees to the list of authorized Federal financial initiatives.)

As 1975 began, the United States was faced with the immediate crisis of a rapidly declining economy and the longer range problem of future energy shortages. In February 1975 the Senate Democratic leadership proposed four national objectives for a Congressional Program of Economic Recovery and Energy Sufficiency[7], namely:

> --to restore in the shortest period of time a healthy economy with full employment, reduced inflation, and increased economic output and productivity;
>
> --to prevent steep increases in the price of all energy and the pervasive economic adversities which such increases surely would entail;
>
> --to manage energy supply in the near term so as to reduce import dependence steadily and surely consistent with repid economic recovery, providing standby protections against sudden supply curtailments; and
>
> --to expedite and mandate programs to conserve energy and expand domestic supply in order to improve our balance of payments and achieve national energy sufficiency in a timely and reliable way.

As an extension of the 1974 legislative action on synthetic fuel, the Congressional Democratic leadership also advocated a comprehensive energy conservation and development program which contained two recommendations[7] critical to this discussion: first, that "commercial demonstration of new synthetic fuel from coal should be undertaken with

an ultimate production goal reaching the equivalent of 500,000 barrels of oil per day" by 1985; and, second, "the creation of a National Energy Production Board as an independent agency . . . (to) mobilize unutilized and under-utilized private and public resources to increase domestic energy production on an urgent basis . . ." The Board, subject to Congressional review, was to have "authority and funding to break energy bottlenecks, and to take all actions necessary to accelerate the production of and conversion to domestic energy sources"[7].

In his 1975 State of the Union Message, President Ford advocated expanding America's energy capabilities over the next 10 years, in part through a National Synthetic Fuels Commercialization Program with the goal of producing by 1985 the equivalent of 1 million barrels of oil per day[2]. This goal was estimated to require 20 major new synthetic fuel plants at a cost of over $20 billion.

Two virtually simultaneous reports were released by the Executive Branch. The first, the June 1975, Energy Research Plan of the Energy Research and Development Administration, envisioned 140 synthetic oil or natural gas plants by the year 2000, each capable of producing the equivalent of 50,000 barrels of oil per day from coal[8].

The second, a July 1975 report of the Interagency Task Force on Synfuels to the President's Energy Resources Council, discussed what types of Federal incentives would be required to support the goal of developing an equivalent of 1 million barrels per day of synthetic fuel by 1985 from coal and oil shale[4]. In contrast to the program of the Energy Research and Development Administration, which was aimed at developing new or improved technologies, President Ford's program envisioned, through Federal incentives, commercial demonstration of a limited amount of synthetic fuel production. Alternative size synthetic fuel programs were discussed with three different 1985 national synthetic fuel production goals of 350,000 barrels per day, 1 million barrels per day, or 1.7 million barrels per day. The financial incentives evaluated for specific technologies included loans and loan guarantees; purchase agreements and price supports; tax incentives including investment tax credits, construction expensing, and accelerated depreciation; construction grants or subsidies; Government financed and owned plants; and combinations thereof. The Task Force recommended that the 350,000 barrel per day program be installed immediately in a way which would not preclude achieving the 1 million barrel per day goal by 1985. It suggested that by deferring until later in the 10-year period the decision to commit firmly to that goal, additional information would be available for further expansion of the program, thus maximizing the benefits and reducing the economic and environmental costs.

Given this bipartisan support by two Republican Administrations and a Democratic Congress, the Energy Research and Development Administration Authorization for Fiscal Year 1976 (P.L. 94-187) authorized major fossil energy research and development initiatives, including four synthetic fuel from coal demonstration projects.

However, another promising Senate initiative to bring about commercial demonstration of synthetic fuel production proved unsuccessful at conference. In addition to the mentioned four coal synthetic projects under cooperative agreement, the Senate passed measure (S. 598) contained provision authorizing $6 billion in Federal loan guarantees for coal gasification and liquefaction, oil shale, and other non-conventional energy technologies pursuant to P.L. 93-577. The report of the Senate Committee on Interior and Insular Affairs advocated that:

> "Greater Federal incentives are needed to cut the Gordian Knot of economics for the first generation of pioneer synthetic fuel plants in this country. The marketplace does not now provide sufficient incentives or an adequate mechanism for encouragement of the establishment of this industry"[9].

Unfortunately, the House of Representatives opposed this synthetic fuel commercialization initiative employing loan guarantees. The related provision was rejected by a vote of 263 to 140 on December 11, 1975, on a separate vote.

Nevertheless, the Senate continued to support synthetic fuel legislation. On June 25, 1976, similar generic loan guarantee authority was added to the ERDA Authorization bill for Fiscal Year 1977 (S. 3105) to be subject to future authorization and appropriation on a project-by-project basis. The House rejected this type of iniative also when it disapproved the rule on the bill by a one-vote margin. However, similar loan guarantee authority eventually was enacted as part of the Department of Energy Act of 1978-Civilian Applications (P.L. 95-238).

During this period in October 1975 under the leadership of Vice President Rockefeller, as Chairman of the Domestic Council, the Ford Administration proposed a $100 billion Energy Independence Authority (EIA), a government corporation with authority to provide financial assistance to encourage energy conservation and to hasten the commercial operation of new energy technologies[3]. Financial assistance was to be principally in the form of loans and loan guarantees to the private sector; but also through price guarantees or by direct investment in energy-related enterprises. Also supported by the Ford Administration, industry, and labor, no final action was taken on the proposal by the 94th Congress. Each time the Congress was faced with the decision to commercialize synthetic fuel production, the proposal was defeated by a coalition of the "right" which portrayed it as socialism and the "left" which portrayed it as a sellout to big business[9].

II. Legislative History - 96th Congress

If the United States needed to be reminded of its insecure dependence on foreign sources of petroleum, the termination of Iranian oil exports in December 1978 did so. Indeed, the events following the cutoff seemed to be a replay of the events that followed the 1973-74 OPEC oil embargo, for the United States was the second largest consumer of Iranian oil, behind Japan. Such imports represented 9 percent of the United States' imports and 4 percent of our oil consumption.

The Congress, having just completed action on the National Energy Act, turned its attention from an emphasis on the immediate benefits to be derived from energy conservation, greater coal utilization, and natural gas deregulation to answers to longer-term energy supply problems facing the United States.

On June 9, 1979, following extensive hearings on the Iranian situation, Senator Henry M. Jackson (D.-Wash.), with 19 cosponsors, introduced S. 1308, the Energy Supply Act. This measure set forth a national program for the expedited development of domestic energy supplies, including synthetic fuel, and establishment of an Energy Mobilization Board. The Board was modeled after Senator Jackson's earlier proposed National Energy Production Board. Concurrently, Senator Pete Domenici (R.-N.M.), with 9 cosponsors, introduced related legislation, the Synthetic Fuels Production Act of 1979 (S. 1377), to establish a Synthetic Fuels and Alternative Fuels Production Authority. The Authority was modeled after the Energy Independence Authority proposed by the Ford Administration. These measures served as the basis for the Energy Security Act (P.L. 96-294), the Energy Mobilization Board (S. 1308), and the Powerplant Fuels Conservation Act of 1980 (S. 2470).

Concurrently, on June 26, 1979, the House of Representatives shed its longstanding opposition to commercial demonstration of synthetic fuel and passed S. 932, the Defense Production Act Amendments of 1979, authored by Representative Bill Moorhead (D.-Pa.). The House passed measure declared as national policy that because of national defense and national security considerations, it is necessary and appropriate to achieve greater domestic energy supply independence through the production of synthetic fuel. To implement this stated policy, a new section 305 of the Defense Production Act directed the President to attempt to achieve a national synthetic fuel production goal of at least 500,000 barrels per day of crude oil equivalent by 1985 and at least 2,000,000 barrels per day by 1990 to meet national defense needs of the United States. The "Moorhead" provisions authorized a wide-range of financial assistance for the commercialization of synthetic fuel, including purchase agreements, loans and loan guarantees, the construction of government-owned facilities at both government and private installations, and the establishment of Federal corporations. The most important feature of the measure was its emphasis on national defense and national security, which served to catalyze House support for synthetic fuel legislation.

Subsequent to House passage of S. 932, President Carter, in an address to the Nation on July 20, 1979, set forth the elements of his Program for Energy Security[10]. The President called for the creation of an energy security corporation to assist the development by the private sector of a synthetic fuel industry and the production of unconventional gas and creation of an Energy Mobilization Board (EMB) to cut through the red tape and bureaucratic obstacles blocking nationally significant energy projects. The EMB would identify priority energy projects and set deadlines for the Federal, State and local government actions needed to bring them on-line through a single, coordinated and expedited decision-making process.

Driven by the gasoline lines resulting from the Iranian situation in early 1979, the legislative environment was ripe for the Senate to achieve its long sought for goal of enactment of a national synthetic fuel commercialization policy. The Senate leadership threw its support behind enactment of the Energy Security Act (P.L. 96-294) and the Priority Energy Project Act (S. 1308).

While there was agreement in the Senate on the need for synthetic fuel commercialization, there was disagreement on how to get there. What ensued in the Senate was a major disagreement between the Senate Committees on Energy and Natural Resources and on Banking, Housing and Urban Affairs on three issues which were to dominate the Senate's debate and the later Senate-House conference on the measure. These were: (1) the administrative agency; (2) the level of funding; and (3) whether or not to authorize government-owned synthetic fuel projects. Each of these issues reflected an underlying concern that the program might eventually lead to establishment of a Federal corporation which could eventually be expanded into other energy activities.

These concerns lead to the Senate's adoption of a two-phased Federal program. During Phase I the emphasis was to be on commercial demonstration of one-of-a-kind technologies for which $20 billion was authorized. Before undertaking Phase II, a comprehensive strategy for achievement of the 1995 synthetic fuel production goal of 1.5 million barrels per day would require Congressional approval and be limited to an authorization of not more than $68 billion. Also, during Phase I up to three government-owned but contractor operated synthetic fuel projects were authorized as a last resort after the solicitation of proposals for financial assistance and the negotiation of contracts when, in the judgment of the Board of Directors, there still are, or will be, insufficient acceptable proposals as necessary to achieve the purposes of the Act. To assure an adequate political base to assure Senate passage, additional titles were added on biomass and alcohol fuel, energy conservation, renewable resources, and others. And as a consequence, the conference continued for almost four months after completing action on Title I - Synthetic Fuels.

What might have been an extended conference on synthetic fuel was expedited by the early adoption on December 14, 1979, of a resolution proposed by House Majority Leader Jim Wright (D.-Texas). The

resolution in principal adopted the House synthetic fuel production goal based on national defense needs; endorsed establishment of the Senate passed Synthetic Fuels Corporation with an authorization of $20 billion; established a $3 billion interim program under the Defense Production Act, which will convert to a standby mode when the Corporation is fully operational; and required affirmative Congressional approval of a comprehensive production strategy. An essential ingredient of this resolution was the House's recognition of the special needs of the Department of Defense and defense contractors. There then ensued three months of extensive negotiations which led on March 4, 1980, to resolution of the details of the combined synthetic fuel package. This blending of the two measures produced a final legislative product that was more significant than either the Senate or House passed measures.

The "fast-start" features of the Defense Production Act facilitated an immediate start on the synthetic fuel program during the period before the Corporation is fully operational at which time those authorities convert to standby. For the longer-term, the greater flexibility of the United States Synthetic Fuels Corporation will be available to foster commercial synthetic fuel production. In addition to the "demand pull" provided by sytnehtic fuel needs of the Department of Defense serve to be action forcing.

The final legislative product, the Energy Security Act (P.L. 96-294), was signed by the President on June 30, 1980. Title I, Synthetic Fuels, is comprised of two parts: Part A, Development of Synthetic Fuels under the Defense Production Act of 1950, and Part B, the United States Synthetic Fuels Corporation Act of 1980. Besides the synthetic fuel provisions the Energy Security Act contains titles dealing with biomass energy and alcohol fuel (Title II), energy targets (Title III), renewable energy initiatives (Title IV), solar energy and energy conservation (Title V), geothermal energy (Title VI), acid precipitation and carbon dioxide studies (Title VII), and the strategic petroleum reserve (Title VIII).

III. United States Synthetic Fuels Corporation

The purpose of Title I of the Energy Security Act is to utilize to the fullest extent the Constitutional powers of the Congress to ". . . reduce the threat of economic disruption from oil supply interruptions and increase the Nation's security . . ." by "fostering . . commercial synthetic fuel production /of/ the equivalent of at least 500,000 barrels of crude oil equivalent per day by 1987", increasing to 2 million barrels per day by 1992.

A synthetic fuel is defined as any solid, liquid, or gas (or combination thereof) which can be used as a substitute for petroleum or natural gas and which is obtained from coal (including lignite and peat), shale and tar sands (including heavy oil), and which can be used as substitutes for natural gas and petroleum (including crude oil, petroleum products and chemical feedstocks). Also eligible for financial assistance are facilities (a) used solely to produce mixtures of coal and

and petroleum for direct fuel use; (b) used solely for commercial production of hydrogen from water; and (c) any MHD (magnetohydrodynamic) topping cycle used solely for the commercial production of electricity. Specifically excluded are synthetic fuel derived from biomass, which is dealt with in Title II.

To achieve these purposes, the Energy Security Act (P.L. 96-294) establishes both an interim program under the Defense Production Act (Part A of Title I), as discussed in Section V, Interim Programs), and the United States Synthetic Fuels Corporation (Part B of Title I).

Perhaps the most significant feature of the Energy Security Act is the Congress' judgment that such a major Federal commitment to the development of a domestic synthetic fuels industry required creation of a special purpose Federal entity -- the United States Synthetic Fuels Corporation. "An independent Federal entity" was authorized to provide "financial assistance to encourage and assure the flow of capital funds to those sectors . . . important to the domestic production of synthetic fuel"[11]. This action is comparable to establishment of the National Aeronautics and Space Administration (NASA) to carry out our national commitment to place a man on the moon.

National Synthetic Fuel Production Goal

The national synthetic fuel production goal is to achieve the capability for commercial production by 1987 of the equivalent of at least 500,000 barrels per day of crude oil, increasing to at least 2 million barrels per day by 1992. The shorter-term objective is based upon the needs of the Department of Defense; however, the statute also requires that a broad enough diversity of technologies be pursued in order to assure establishment of the necessary infrastructure to support achievement of the longer-term national production goal.

Comments on the short-term goal, which is based on defense needs, is needed. While the Department of Defense's pro-rata share of the Nation's total energy usage is comparatively small, the Department is the single largest energy user in the United States, accounting for 81 percent of all the energy used by the Federal government. In 1979, the Department of Defense consumed approximately 465,000 barrels per day of petroleum. Some 87 percent of this, or 405,000 barrels per day, was for fuels for use by aircraft, ships, and land-based mobile systems. Unlike the civilian sector, in which approximately 70 percent of the petroleum consumption is as gasoline and heating oil products, in the case of the Department of Defense nearly 80 percent of its petroleum needs are middle distillates.

But more importantly, this need can be met by synthetic fuel. The Department of Defense's capability to use synthetic fuel is greater than its expectation of the rate of growth of synthetic fuel production capability in the United States. For example, the Department of Defense's immediate synthetic fuel needs are for testing with a 1981 requirement for more than 90,000 barrels of synthetic fuel[12]. When its

fleetwide demonstration program is undertaken in 1983, synthetic fuel requirements will jump to 3.5 million barrels (or approximately 9,600 barrels per day), increasing to 7.0 million barrels in 1984 (or approximately 19,200 barrels per day) and approximately 220,000 barrels per day in 1985. At that point approximately one-half of the Department's fuel consumption could be synthetic fuel, if available.

In other words, accomplishment of the short-term national synthetic fuel production objective would satisfy at least one-half -- if not all -- of the synthetic fuel needs of the Department of Defense, with the displaced conventional energy supplies being made available for civilian purposes.

General Corporate Powers

The general powers of the United States Synthetic Fuels Corporation as set forth in the Energy Security Act[11] are similar to those provided other Federal government corporations. For example, the Corporation is empowered to adopt bylaws, make agreements and contracts; to sue and be sued in Federal district court; to represent itself or contract for representation (except for actions cognizable under the Federal Tort Claims Act); to determine and prescribe the manner in which obligations of the Corporation shall be incurred; and to adopt a corporate seal. The Corporation is created as an "independent Federal entity" free from most laws applicable to Federal agencies as such. Under the Act, the Corporation is only deemed an agency or an instrumentality of the United States where expressly provided in the Act. The Federal laws generally applicable to agencies or instrumentalities of the United States apply to the Corporation only as expressly provided in the statute. Consequently, for example, the Corporation is not subject to the Administrative Procedures Act.

The powers of the Synthetic Fuels Corporation are vested in the seven member Board of Directors to be appointed by the President, with the advice and consent of the Senate, for seven year staggered terms. The Chairman must be designated for an initial seven year appointment and must serve full-time. The other six Directors may be either full-time or part-time. Directors serving full-time may not hold any other salaried position; and Directors serving part-time may not hold any other full-time salaried position in Federal, State or local government.

Compensation of the Directors, which is to be fixed by the President, is not subject to Federal pay limitations. And the Directors may be removed by the President only "for neglect of duty or malfeasance in office".

The Corporation will have its principal office in the District of Columbia. The Board of Directors is responsible for establishing the offices, such as General Counsel and Treasurer, and appointing the officers of the Corporation, except for the Inspector General and Deputy Inspector who are appointed by the President with the advice and consent of the Senate.

A six member Advisory Committee also is established consisting of the Secretaries of Energy, the Interior, Defense and the Treasury; the Chairman of the Energy Mobilization Board (when enacted); and the Administrator of the Environmental Protection Agency.

The Chairman is responsible for appointing and discharging Corporation employees (other than officers), who may not exceed 300 full-time professionals at any time. The Directors, officers, and employees of the Corporation are not subject to laws relating to Federal government employment. Thus employment with the Corporation is not subject to civil service laws such as Federal salary limitations and likewise employment does not qualify for Federal fringe benefits such as retirement and medical benefits. When establishing compensation for officers and employees the Board of Directors is to consider Federal schedules for comparable positions; however, higher compensation rates may be established unless disapproved by the President.

Under the Act the annual administrative expenses of the Corporation may exceed $35 million, adjusted upward for inflation. The annual administrative expenses of the Office of Inspector General may not exceed $2 million. In addition, up to $10 million may be expended annually for generic studies and specific reviews of individual proposals for financial assistance.

Applicability of Other Federal Laws

The principal objective in creating the United States Synthetic Fuels Corporation outside the regular Federal government structure was to free the Corporation from the complex of administrative and procedural controls applicable to Federal departments and agencies, funds, officers, and employees, except those made specifically applicable by the Energy Security Act. This action was intended to avoid the administrative and procedural burdens otherwise applicable to an "agency or instrumentality of the United States", which might prove cumbersome or seriously impede the efforts of the Corporation to carry out its charter. The Congress thus sought to strike a balance between providing the Corporation with sufficient flexibility to fulfill its mandate yet enough accountability to assure that the intent of Congress is carried out.

With regard to accountability to the public for its actions, the financial disclosure provisions of the Ethics in Government Act apply to Directors, officers, and certain employees of the Corporation as if Federal employees. A Directors is required to disqualify himself from any decision involving his financial interests, unless the Board determines that the interest of the Director is too remote or inconsequential and vote to permit the affected Director to participate in the decision. The Board of Directors is expected to establish directives prohibiting officers and employees of the Corporation from taking any personal substantial action on any matter affecting their actual or prospective financial interest. Nevertheless, the validity of any otherwise lawful action, such as the award of financial assistance, would not be affected

even though a Director subsequently is found to have a conflict of interest that was not disclosed and even should such conflict of interest be cause of removal of such Directors.

The Act requires that all meetings of the Board of Directors be open in accordance with standards comparable to those that apply to a Federal agency under the Government in Sunshine Act (5 U.S.C. 552b). The Board of Directors may vote to close its meetings only for reasons in the Act, which are generally the same as those that permit the closing of agency meetings under the Sunshine Act. For example, a meeting may be closed if a public meeting is likely to result in the premature disclosure of information which would likely impede the ability of the Corporation to (a) "establish procurement or synthetic fuel project selection criteria" or (b) "negotiate a contract for financial assistance"[11].

Similarly the Corporation is required to inform the public of its activities, subject to the same limitations and prohibitions on the disclosure of information that are applicable to Federal agencies (or officers and employees) under the Freedom of Information Act (5 U.S.C. 552).

The Federal statute prohibiting post-employment conflicts of interest (18 U.S.C. 207(a)) is made applicable to employees of the Corporation as if they were former employees of an agency or instrumentality of the United States.

In these and some other respects the Corporation is treated as if it were a regular Executive Branch agnecy. However, in the conduct of its business generally the Corporation is expected to function largely as if if were a private corporation. When it comes to the award of financial assistance such decisions are essentially left to the Board of Directors, subject to broad criteria and standards set out in the Energy Security Act. For example, the Corporation will decide the extent to which a particular resource will be emphasized; the size and number of synthetic fuel projects that will be supported; and what types of assistance will be provided.

In order to similarly free the Corporation from the complex of certain State laws, the Corporation is to be deemed a Federal agency, and its employees Federal employees, for the purpose of (a) antitrust laws, (b) the Longshoremen's and Harbor Workers' Compensation Act, and (c) securities laws of the United States. Therefore, the Corporation can function as an investment bank without the requirement for registration. For the same reason certain Federal laws were made specifically inapplicable to the Corporation, such as (a) the Government Corporation Act, and (b) the National Environmental Policy Act, except in the case of Corporation construction projects.

Financial Assistance

The Board of Directors is empowered to provide financial assistance to the private sector for the commercial production of

synthetic fuel (for detailed discussion see next section). The Congress expects the Corporation to function much like a private business entity, such as a bank or other financial institution, not like a Federal agency such as the Department of Energy.

The initial emphasis of the Corporation's activities will be to develop experience within a broad spectrum of financial and industrial firms. This experience is to encompass a technological diversity of processes, methods, and techniques for commercially producing synthetic fuel from domestic resources, while, at the same time, developing the industrial base to undertake achievement of the national synthetic fuel production goal.

When awarding financial assistance, the Corporation is required to give preference to certain forms of financial assistance in the following order of decreasing priority:

(1) purchase agreements, price guarantees, and loan guarantees;

(2) loans; and

(3) joint ventures for commercial modules.

Multiple forms of financial assistance are authorized only if required for the viability of a project and necessary to satisfy the goal and purposes of the Energy Security Act.

Corporation construction projects (or Corporation owned but contractor constructed and operated projects) would be authorized under three principal conditions: first, only prior to Congressional approval of the comprehensive strategy; second, only for one-of-a-kind facilities which employ technologies utilizing significant domestic resources; and, third, only after no participant could be found who would be willing to proceed under one or more of the above forms of financial assistance.

During Phase I of the program -- the period prior to approval of the comprehensive strategy -- up to three such projects are authorized on a last resort basis. They can be undertaken after 30 days notice of the Corporation's intent to establish such a Corporation construction project and only if no acceptable notice of intent to submit a proposal is received from the private sector.

Such Corporation construction projects would be subject to (a) the EIS requirements of the National Environmental Policy Act and (b) Federal, State and local environmental, land use and siting laws to the same extent as a privately sponsored project.

Also the Corporation, under certain limited circumstances, would be authorized to acquire control or to purchase and leaseback a synthetic fuel project, subject to Congressional review and veto. Such control must be disposed of within five years after acquisition.

Authorization of Appropriations

The Corporation's initial obligational authority is $20 billion, subject to appropriations. (Initial appropriations to the Energy Security Reserve of up to $17,522,000,000 are provided by P.L. 96-126 and P.L. 96-304, as discussed under Section V, Interim Federal Programs.) The second and subsequent installments would be authorized (up to a maximum of $68 billion) four years later, upon Congressional approval of the comprehensive production strategy, subject to appropriations to the Energy Security Reserve.

Comprehensive Production Strategy

Within four years after enactment (or by June 30, 1984) the Corporation is required to develop and submit to the Congress a comprehensive strategy for achievement of the national synthetic fuel production goal, which must be approved as a condition precedent to subsequent authorizations of appropriations. The comprehensive strategy, which must be accompanied by a funding request and a financial or investment prospectus, would emphasize private sector responsibilities and describe how specific limitations will be placed on Federal involvement.

In addition, the comprehensive strategy must be accompanied by a review of the solicitation and award experience obtained by the Corporation during Phase I. Such review will encompass for each facility receiving financial assistance: (a) the economic feasibility (including product quality, quantity and unit production cost); and (b) the environmental effect and water requirement, as well as recommendations concerning the specific mix of resource types and technologies to be supported.

In formulating the comprehensive strategy, the Corporation must specifically consider the feasibility of meeting the national defense fuel requirement utilizing synthetic fuel produced by synthetic fuel projects assisted by the Corporation.

Congressional approval of the comprehensive strategy would be by joint resolution under expedited procedures. Besides approval of the comprehensive strategy, the initial joint resolution would authorize additional budget authority up to $68 billion (or a total or $88 billion) for the Corporation's synthetic fuel activities. Upon Congressional approval, subject to the availability of the necessary appropriations, implementation of the strategy would proceed.

In the event that full funding for implementation of the comprehensive strategy is not initially approved by the Congress, under this procedure the Corporation may submit additional funding request to the Congress, accompanied by a financial or investment prospectus. Similar expedited procedures would apply to any such subsequent authorization request until the full $88 billion appropriation is approved.

However, the Corporation cannot enter into any obligations for financial assistance which could expose the Federal government to a

greater liability than $20 billion prior to the Congressional approval of the comprehensive strategy and appropriation of the necessary funds to the Energy Security Reserve.

Appropriations Process

Very importantly, the Corporation is an off-budget Federal entity. The desire of the Congress was to protect it from the vagaries of the annual Federal budget process. Funds thus could not be appropriated directly to the Corporation without subjecting it to the scrutiny of the President's Office of Management and Budget. The approach, therefore, was to authorize appropriations to the Energy Security Reserve in the Department of the Treasury and then authorize the Corporation to borrow the funds for specified purposes set forth in the Energy Security Act. Once borrowing authority is appropriated to the Secretary of the Treasury, the Corporation determines the pace of obligations and outlays. Thus the Board of Directors is able to make reasonable and credible commitments to private industry for large projects with long lead-times without the uncertainty of year-to-year budgetary second guessing.

For example, when the Corporation needs actual funds for administrative expenses or to support financial assistance, such as loans or joint ventures, the Secretary of the Treasury would be authorized to purchase notes of the Corporation to the extent of its appropriated borrowing authority from the Energy Security Reserve. (These notes eventually would be retired from revenues or upon dissolution of the Corporation.)

In turn, when the Corporation proposes to award financial assistance as conditional obligations, for example, a price guarantee, purchase agreement, or loan guarantee, it must notify the Secretary of the Treasury of its maximum liability under the proposed contract or other oblibation agreement. Upon the receipt of notification from the Corporation that amount of borrowing authority would be set aside in the Energy Security Reserve and would otherwise be unavailable to the Corporation until needed under the terms of the contract. The Treasury, within 15 days, must certify back to the Corporation that such amounts had been set aside at which time the proposed contract or other obligation agreement could be finalized.

All financial transactions between the Secretary of the Treasury and the Synthetic Fuels Corporation, such as the issuance or retirement of notes of indebtedness, will be reflected in the budget of the United States. Thus the extent of actual borrowing by the Corporation from the Department of the Treasury (from the Energy Security Reserve) will be reflected as outlays of the United States Government. However, conditional obligations would not be reflected as outlays until the obligation is actually incurred.

The internal financial operations of the Corporation are not reflected in the Federal budget since it is to be an independent (off-budget) entity. For example, any receipts and disbursements in

transactions between the Corporation and other persons are not considered receipts or outlays for the purpose of the Federal budget. Nevertheless, the salaries and expenses of the Corporation, its contractual obligations, and its accounting system will be available for scrutiny through statutorily required annual and quarterly reports by the Corporation, outside audits, as well as General Accounting Office reviews and audits.

As noted earlier, an initial appropriation of $20 billion to the Secretary of the Treasury for deposit in the Energy Security Reserve is authorized with a corresponding borrowing authority by the Corporation. Additional amounts would be authorized upon approval of the comprehensive strategy up to an aggregate total of $88 billion. Such monies would be available to the Corporation only so far as necessary to meet obligations.

Termination

The authority of the Corporation to obligate funds would cease after September 30, 1992. And the Corporation must terminate its affairs by September 30, 1997. Upon termination, the outstanding contracts for financial assistance would be transferred to the Secretary of the Treasury for administration.

IV. Forms of Financial Assistance

Before awarding financial assistance the Corporation must undertake a solicitation on a competitive basis. An initial set of solicitations must be made by July 1, 1981. The initial solicitation must encompass a diversity of synthetic fuel technologies as well as all the available forms of financial assistance. The Congress intended that all solicitations be formulated to encourage innovative synthetic fuel proposals encompassing the broadest range of concepts. Thus the Congress intended that solicitations not unnecessarily contain sufficient detail so as to constrain bidders.

The final judgment on awards rests with the Board of Directors which is provided flexibility within broad statutory guidelines to decide what proposals will be awarded financial assistance. For example, in the event that the responses to solicitations produce insufficient acceptable proposals, the Board of Directors may negotiate on a sole-source basis sufficient contracts to achieve the purposes of the Energy Security Act. However, all financial assistance must be by written contract. Moreover, the contract must specify within its terms and conditions all obligations (including conditional obligations) of the Corporation and the maximum dollar obligation.

The Congress intended that one contract award be made with regard to any specific synthetic fuel project. To the extent that there are two or more participants in a project, the Congress intended that their respective positions be reflected within the terms and conditions of a single contract for financial assistance. The explicit exception to

this rule is in the case of loan guarantees: an award of financial assistance may be made to a person with a partial interest in a synthetic fuel project, which otherwise is not the subject of financial assistance.

No single synthetic fuel project, or one person (including that person's affiliates and subsidiaries), may be awarded more than 15 percent of the Corporation's total obligation authority. Initially this would amount to approximately $3.0 billion adjusted for obligations under the "interim, fast-start program". Should the full $88 billion be eventually authorized the corresponding limit would be $13.4 billion.

General Selection Criteria

The Corporation may only award financial to "qualified concerns" who, in the judgment of the Board of Directors, can demonstrate their capability to undertake directly or by contract the design, construction and operation of the proposed synthetic fuel project.

In awarding financial assistance, the Corporation must consider certain general selection criteria such as promoting competition. In addition, within a given technologic process area, the Corporation must give preference to the proposal which represents the least commitment of financial assistance by the Corporation and the lowest unit production cost.

The Corporation also is to give priority to applications for assistance for projects "in those States which, in the judgment of the Board, indicate an intention to expedite all regulatory, licensing and related government agency activities"[11].

Project Specific Selection Criteria

In awarding financial assistance, the Board of Directors must consider the following project specific selection criteria, among others: first, any specific tax credit directly associated with a project also must be taken in to consideration in determining the need for financial assistance; and, second, any recipient of financial assistance, who bears an ownership or profit interest in the synthetic fuel project, must bear a substantial risk of after tax loss in the event of any default or other cancellation of such project. The nature and extent of such risk will be determined as part of the contract negotiations; however, any financial institution which issues a loan which is guaranteed by the Corporation is not expected to participate in such risk-sharing if it does not bear such an ownership or profit interest.

When awarding financial assistance the Board of Directors also must determine that such assistance will not compete with nor supplant available private sector investment. In addition, the Board must determine that adequate financing otherwise would not be available

on reasonable terms and conditions which would permit the proposed synthetic fuel project to be undertaken.

Purchase Agreements

The Corporation is authorized to award a purchase agreement (or a "take-or-pay" contract) for all or part of the production from a synthetic fuel project. The sales price specified in the purchase agreement cannot exceed the estimated prevailing market price on the date of delivery, as estimated by the Secretary of Energy, unless the Corporation determines that a higher price is necessary in order to insure the production of synthetic fuel to achieve the purposes of the Energy Security Act. However, each such agreement must provide that the Corporation retains the right to refuse delivery upon such terms and conditions as specified in the agreement.

When entering into a purchase agreement, the Corporation is directed to obtain assurance that the quality of the synthetic fuel meets standards and that the ordered quantities are delivered on a timely basis. The Congress intended that the Corporation, to the maximum extent feasible, utilize purchase agreements to obtain synthetic fuel from synthetic fuel projects in a form which can be directly substituted for conventional supplies. The Department of Defense is afforded a right of first refusal. If the Department of Defense, or another Federal agency, elects to purchase the synthetic fuel, it pays the prevailing market price for the conventional fuel and the Corporation pays any difference.

In addition, the Board of Directors may impose as a condition of a purchase agreement (or a price guarantee or joint venture) a requirement that the Corporation share in any profits from the operation of the synthetic fuel project. The actual terms of the profit sharing agreement would be negotiated as part of the contract.

Price Guarantees

The Corporation is authorized to award a price guarantee for all or part of the production from a synthetic fuel project at a specific sales price. In awarding a price guarantee, the Corporation shall set the sales price at the level which will provide the minimum subsidy necessary to provide an adequate incentive, in light of projected price of the competing fuel and the requirement for economic and financial viability of the synthetic fuel project.

The Corporation may award a price guarantee on the basis of a "cost-of-service" pricing arrangement, such as those used by the Federal Energy Regulatory Commission (or other regulatory bodies or those used by a concern pursuant to law). However, such awards may only assure the regulated company (or such other concerns) recovery of depreciation, actual operating expenses, taxes, interest on debt, and a reasonable return on equity invested.

Conversely, the Corporation may not enter into any "cost plus" arrangement (or variation thereon) in order to guarantee a profit to the concern. A "cost plus" arrangement is prohibited because in the normal context it would guarantee an entity a negotiated fee based upon a percentage of the expenses of the synthetic fuel project or a specified fee regardless of cost without independent restrictions. Thus, if "cost plus" contracts were permitted, there would be little if any financial discipline on the part of the recipient of financial assistance.

As in the case of purchase agreements, the Corporation may impose as a condition of a price guarantee that the Corporation share in any profits.

Loan Guarantees

The Corporation is empowered to provide financial assistance in the form of a loan guarantee, up to 75 percent of a synthetic fuel project costs. Such loan guarantees are backed by the full faith and credit of the United States.

In awarding a loan guarantee, the Board of Directors must give preference to proposals which represent "the least Corporation financial commitment". The Corporation also must insure that the rate on a guaranteed loan is not excessive, taking into account the range of rates for similar loans in the private market and the risks assumed by the Corporation.

Any recipient of a loan guarantee is required to pay an annual fee of up to 0.5 percent of the amount of financial assistance. Any loan guarantee may not have a maturity date of more than 30 years or the useful life of a synthetic fuel project, whichever is less. Because a loan guarantee involves a three party contract, it is anticipated that the Board of Directors will participate in negotiations for the financing of loans sought to be guaranteed by the Corporation.

After awarding a loan guarantee the Corporation is authorized to extend financial assistance, subject to appropriations, to cover (a) 50 percent of cost overruns up to 100 percent of the initially estimated synthetic fuel project cost and (b) 40 percent of additional cost overruns, subject to Congressional notification in the event that the project cost exceeds 250 percent of the estimate upon which the initial award of financial assistance was based.

In the case of loan guarantees (or loans), in order to reduce the risk of cost overruns, the Corporation is authorized to award financial assistance to a qualified concern to refine the design of the proposed synthetic fuel project to improve the accuracy of the initial estimated cost on which the loan guarantee is to be awarded. However, these monies eventually must be included in the total project cost; they are not to be treated as a grant.

In awarding a loan guarantee, the Corporation must consider whether the concern making such application otherwise would be unable, exercising prudent business judgment, as determined by the Board of Directors, to finance the synthetic fuel project, taking into account among other factors, the availability of debt financing under normal lending criteria based on the assets associated with the project.

The Davis-Bacon Act applies to loan guarantees. Purchase obligations issued, sold or guaranteed by the Synthetic Fuels Corporation are not eligible for purchase by the Federal Financing Bank. This is intended to assure that the Corporation cannot exceed the ceiling on total financial assistance by "rolling over" loan guarantees.

Loans

The Corporation is empowered to provide financial assistance in the form of a loan, up to 49 percent of initially estimated project costs unless such limits would prevent the financial viability of the proposed project in which case up to 75 percent would be authorized.

Before awarding a loan or joint venture agreement, the Board of Directors must determine that a purchase agreement, price guarantee, or loan guarantee (a) will not adequately support the construction and operation of a synthetic fuel project or (b) will restrict the available participants for such project.

The Corporation may enter into a loan either directly or in cooperation with, or participation by, banks or other lenders. Such loans can be made either directly upon promissory notes or other evidence of indebtedness or by way of discount or rediscount of obligations tendered for that purpose.

Any loan must carry a maturity date of no longer than 30 years or the useful life of the project, whichever is less. Any loan also must bear a rate of interest taking into account the needs and capacities of the recipient and the prevailing rates of interest. However, such interest shall not be less than the rate determined by the Secretary of the Treasury taking into consideration current yields of outstanding obligations of the United States.

As in the case of a loan guarantee, the Davis-Bacon Act applies to loans.

After awarding a loan and in the event that the total cost of a synthetic fuel project exceeds that initially estimated, the Corporation is authorized to extend additional loan assistance, subject to appropriations, to cover (a) 50 percent of cost overruns up to 100 percent of the initially estimated project cost and (b) 40 percent of additional cost overruns, subject to Congressional notification in the event that the project cost exceeds 250 percent of the estimate upon which the initial award of financial assistance was based.

As in the case of a loan guarantee, in order to reduce the risk of cost overruns, the Corporation is authorized to award financial assistance to a qualified concern to refine the design of the proposed synthetic fuel project to improve the accuracy of the initial estimated cost on which the loan is to be awarded. However, these monies eventually must be included in the total project cost; they are not to be treated as a grant.

The Board of Directors is authorized to forebear from exercising its rights under a loan agreement if (a) the borrower is not in default; (b) the public interest is better served by continuation of the project; and (c) the probable net benefit to the Corporation is greater from forebearing than from a default. However, the borrower must agree to reimburse the Corporation for such payment on terms and conditions including interest which are satisfactory to the Corporation.

Joint Ventures

During Phase I (or prior to approval of a comprehensive strategy), the Corporation is empowered to provide financial assistance in the form of a minority equity interest in a joint venture (where the government could provide up to 60 percent of project cost) for a commercial synthetic fuel module. A synthetic fuel project module is defined as a demonstration project of a size smaller than a synthetic fuel project which can eventually be expanded at the same site into a full scale commercial synthetic fuel project.

More significantly, however, the Congress intended that joint ventures be undertaken only in those situations where the Board of Directors determines that a joint venture is the only feasible means of attracting private sector participation on a scale necessary to "prove" a specific technology, utilizing a given feedstock. Conversely, the Congress intended that the Corporation attempt to limit the form of its financial participation in a synthetic fuel project to price guarantee, purchase agreement, loan guarantee, or loan. However, it was recognized that such incentives might be insufficient to induce the private sector to demonstrate all of the synthetic fuel technologies which must be demonstrated if the production goals are eventually to be realized.

In addition to the general restrictions on financial assistance, the Corporation's role in joint ventures is restricted to a limited partnership status and cannot include any direct role in the construction or operation of the module. In circumstances where the partner cannot, or will not, continue participation, the Board of Directors is authorized to take control of the synthetic fuel project module in order to protect its investment. But in no case would the Corporation retain control of the management of a facility for more than five years from the date of commercial production.

The Corporation is required to consult with the affected Governors with respect to the development of joint venture projects and and with related regulatory and other government activities.

Western Hemisphere Projects

Up to two synthetic fuel projects located in the Western Hemisphere may receive financial assistance if (1) a class of resources will be utilized that is located in the United States but will not be subject to timely commercial production; (2) financial assistance also will be provided by the host country; (3) the synthetic fuel will be available on equitable terms to users in the United States; and (4) all technology, patents, and trade secrets developed are available to citizens of the United States. This authority is available only during Phase I (or prior to approval of the comprehensive strategy) subject to one-House Congressional disapproval. Such projects, in the aggregate, may not receive more than 10 percent of the available obligation authority of the Corporation.

Terms and Conditions

Any recipient of financial assistance is required to pay a one-time administrative fee, not to exceed 1 percent of the amount of financial assistance. Any recipient of financial assistance also must keep records relating to the synthetic fuel project in a manner prescribed by the Corporation. In addition, the recipient must permit agents of the Corporation to have access to such records at all reasonable times.

As a condition for receipt of financial assistance, the recipient must develop a plan, acceptable to the Board, for the monitoring of environmental and health emissions from the construction and operation of the synthetic fuel project. Such plan must be developed after consultation with the Environmental Protection Agency, the Secretary of Energy and appropriate State agencies.

The recipients of financial assistance, and the Corporation in the case of Corporation construction projects, are required to provide for reasonable participation by small and disadvantaged businesses.

V. Interim Federal Programs

During the interim period until the United States Synthetic Fuels Corporation becomes operational, there are two "fast-start" programs: the Department of Energy alternative fuels program under the Federal Non-Nuclear Energy Research and Development Act of 1974 (P.L. 93-577) and the joint Department of Defense-Department of Energy program under the Defense Production Act, as amended by the Energy Security Act.

In order to coordinate these interim programs, on July 8, 1980, the Secretary of Energy established a Synthetic Fuels Transition Office. The responsibility for these transitional programs rests with the Assistant Secretary for Resource Applications. In carrying out this responsibility, Resource Applications will continue to involve Procurement,

General Counsel, the Office of Environment, and other Department of Energy offices, in the evaluation and review activities, and final selection for awards. In addition, participants from the Department of Defense will be involved throughout the solicitation review and selection process.

The objective is to assure a smooth, productive and expeditious transfer of projects and activities to the Synthetic Fuels Corporation as provided for in both the Energy Security Act (P.L. 96-294) and in the Fiscal Year 1980 Supplemental Appropriation Act (P.L. 96-304).

In summary, these two statutes provide that the $19 billion appropriated to the Energy Security Reserve in P.L. 96-126 are to be allocated as follows:

--up to $5.518 billion for the interim programs under the alternative fuels program and the Defense Production Act;

--$12.212 billion for the Synthetic Fuels Corporation, plus balances from the interim program unobligated by June 30, 1981; and

--$1.27 billion for the purposes of Title II, Biomass and Alcohol Fuels, of the Energy Security Act.

When the United States Synthetic Fuels Corporation is fully operational those synthetic fuel actions initiated by the Department of Energy shall transfer to the Corporation to be administered in accordance with the terms and conditions established by the Department of Energy. In turn, non-synthetic fuel actions, such as biomass, solid wastes, or unconventional gas, initiated by the Department of Energy shall remain with it. The intention here is to establish a domestic capability to produce significant quantities of alternative (of synthetic) fuels in the least amount of time. Consequently, the total obligational authority available to the Synthetic Fuels Corporation will range from $14.482 billion up to $20 billion depending on the amount of funds committed to non-synthetic fuels (including biomass) under the interim programs.

Alternative Fuels Production

Following the signing on November 27, 1979, of Public Law 96-126 (making appropriations for certain programs of the Department of Energy for fiscal year 1980), the Department of Energy initiated the Alternative Fuels Production program. That statute established the Energy Security Reserve, to which was appropriated $19 billion to stimulate domestic commercial production of alternative fuel. That statute also immediately made available to the Department of Energy $2.208 billion for alternative fuels production, including up to $100 million for project development feasibility studies (up to $4 million each); $100 million for similar cooperative agreements (up to $25 million

each); $1.5 billion for purchase commitments or price guarantees; $500 million for a reserve to cover any default of loan guarantees up to an aggregate amount of $1.5 billion; and $8 million for program management.

In response to its February 25, 1980, solicitation, on July 9, 1980, nine days after the signing of the Energy Security Act, the Department of Energy announced award of 110 alternative fuels feasibility studies and cooperative agreements totaling approximately $200 million, out of 971 submitted proposals. Included in the 99 feasibility studies were 42 alcohol fuel projects. And included in the 11 cooperative agreements were two alcohol fuel projects. These awards included the use of coal, lignite, peat, shale, tar sands, biomass, solid wastes, and unconventional gas, to produce gaseous, liquid, and solid fuels as well as chemical feedstocks.

The Department of Energy then followed with its announcement of support for the first domestic commercial scale plant to produce high-Btu gas from coal, through a conditional commitment to a $250 million loan guarantee to the Great Plains Gasification Project (headed by the American National Resources Corporation) in addition to the $22 million cooperative agreement.

In order to take advantage of the momentum of this interim program, the Fiscal Year 1980 Supplemental Appropriations Act (P.L. 96-304) appropriated an additional $100 million for feasibility studies (up to $25 million each) and $200 million for cooperative agreements (up to $10 million each) to continue the (alternative fuels) program. Subsequently, on August 1, 1980, the Department of Energy announced the second round of solicitations. The closing date for submission of proposals is September 30, 1980.

Draft solicitations for loan guarantees, price guarantees, and purchase commitments under the Federal Non-Nuclear Energy Research and Development Act were issued for public comment on August 26, 1980. Solicitations are expected in mid-September, with responses required by early December to facilitate awards by June 1981.

Section 305 of the Defense Production Act

The interim synthetic fuel authority in section 305 of the Defense Production Act is vested in the President acting through the Department of Energy and other Federal agencies. The President is authorized to contract for the purchase of synthetic fuel for Federal government use to meet defense needs. In addition, loan guarantees and loans are authorized to finance the construction of synthetic fuels for Federal government use to meet defense needs. However, a loan guarantee in excess of $38 million or a loan in excess of $48 million is subject to one-House Congressional veto.

The Fiscal Year 1980 Supplemental Appropriation Act (P.L. 96-304) appropriated $3 billion to the Department of Energy for purchase agreements and loan guarantees pursuant to the Defense Production Act.

Because these monies were appropriated to the Department of Energy rather than the President, an Executive Order will be required to clarify the respective responsibilities of the Departments of Defense and Energy.

Draft solicitations for purchase agreements and loan guarantees under the Defense Production Act were issued by the Department of Energy for public comment on August 26, 1980. Solicitations are expected in mid-September, with responses required by early December to facilitate awards by June 1981.

As anticipated, the interim Defense Production Act programs will emphasize liquid fuels for national defense applications, with the quantities, specifications and delivery dates to be provided by the Department of Defense. In the case of price guarantees under section 305, it is expected that the Defense Fuel Supply Center will arrange for receipt, use or disposition of synthetic fuel acquired through the financial assistance programs initiated by the Department of Energy under the Section 305 authority.

The Section 305 authority converts to standby when the President determines that the Synthetic Fuels Corporation is fully operational. At that time, the synthetic fuel projects receiving financial assistance under the DPA will be eligible for transfer to the Corporation under the terms of P.L. 96-304. The remainder of the interim program's unobligated funds also will be transferred for use by the Corporation on June 30, 1981.

In the event of a national energy supply shortage threatening the adequacy of fuel supplies to meet direct defense and defense industrial base needs, standby synthetic fuel authorities under section 306 of the Defense Production Act could be activated on a specified Presidential determination to meet such needs. In addition to purchase agreement, loan and loan guarantee, authorities identical to those in section 305, the Presidential standby authorities, subject to appropriations in advance, include authority to install government owned equipment in private facilities and to install private equipment in government-owned facilities; to construct government-owned but contractor operated synthetic fuel projects; and to mandate fuel suppliers to provide synthetic fuel.

VI. Conclusion

In summary, passage of the Energy Security Act, with its creation of the United States Synthetic Fuels Corporation, represents a significant, and long overdue, step forward. As Senator J. Bennett Johnston has stated:

> ". . . probably most important, there is another signal that the Congress is sending by this massive commitment to synthetic fuels. That signal is aimed at OPEC. Our efforts to adjust to higher and higher

> energy prices will ultimately fail unless we take the essential step to establish a program to set a ceiling on the price that can be demanded of us for oil. And there is only one really effective way to place such a cap on the rising price of oil; that is, to ensure that the United States has a comprehensive and credible effort of synthetic fuels commercialization, energy conservation, and renewable resource development. And that is precisely what is embodied in the Energy Security Act"[13].

The establishment of the United States Synthetic Fuels Corporation dedicated to this single goal of commercial synthetic fuel production is an unprecedented commitment to the United States energy future.

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GOVERNMENTAL AND INDUSTRIAL MEASURES IN THE FIELDS OF COAL GASIFICATION AND COAL LIQUEFACTION IN THE FEDERAL REPUBLIC OF GERMANY

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GOVERNMENTAL AND INDUSTRIAL MEASURES IN THE FIELDS OF COAL GASIFICATION AND COAL LIQUEFACTION IN THE FEDERAL REPUBLIC OF GERMANY

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Introduction

Germany has a comparatively long experience in the fields of coal gasification and liquefaction. At present, the Federal Government of West German Republic, the State of Northrhine-Westphalia and the Saarland State are supporting various projects for coal conversion carried out by the German coal industry.

The Federal Government of West Germany has issued on J anuary 31, 1980, a very important coal conversion program for large-scale coal gasification and -liquefaction projects.

This program is based on the following fundamental goals of West German energy policy:

1. To reduce the import dependency on mineral oil

2. To avoid losses of energy

3. To offer alternative energies in the long term.

The German energy consumption is depends about 50% on crude oil; about 95% of this demand has to be imported, and 90% of these imports derived from the Middle East and Africa. Thus, the German primary energy market is dependent to a decisive extent on the

supply capacity and supply ability of the OPEC- countries.

In the short term, the structure and the resources of the German primary energy market cannot be fundamentally modified so that consequently the dependency on crude oil will continue in spite of all efforts to substitute oil and to save energy in general.

Facing this situation, the German Federal Government decided to take all necessary measures to diminish the dependency on oil imports in the medium and long term. The Government, therefore, announced in an official statement in July 1979 the coal conversion program for large-scale production of gas, oil and motor fuel on the basis of coal.

With the demonstration and market introduction of new technologies of coal gasification and liquefaction the following targets are envisioned:

- to emphasize the application of coal to ensure the German energy supply also in those fields where crude oil and natural gas are dominating up to now,

- to establish and to increase the know how in new coal conversion technologies for the German industrial companies to strengthen their position on the international market.

Going back into history, the production of coal derived distillate oil was developed in Germany at the beginning of this century by Bergius and Pier on a catalytic process basis and by Pott and Broche on a non-catalytic process basis. The utilization of coal hydrogenation on a large technical scale started in Germany in 1927. In the following years distillates were produced in twelve commercial plants and then further processed to fuels. In 1943 the major part of the German motor fuel consumption - approx. 4 m t/a - was produced by coal liquefaction. After 1945, mainly due to economic reasons, coal hydrogenation was not taken up again in the Federal Republic of Germany.

Early in 1974, after the first oil crisis, the Federal Ministry for Research and Technology in Bonn (BMFT) initiated the development of new technologies of coal conversion. The Federal Government Energy Research Program of 1974 - 1977 finally resulted in the presentation of the program "Energy Research and Energy Technology 1977 - 1980" and created and widened the basis to continue the development of promoting a major number of projects in the coal conversion area.

Within these two programs, the Federal Government alone has provided more than 400m US$ until 1979 only for coal gasification and

6. The Shell-Koppers pilot plant in Hamburg-Harburg using the entrained-bed gasification according to Shell/Koppers, producing synthesis gas or reduction gas; construction without public funds.

7. The PNP-project (Prototype plant nuclear process heat), a plant to use nuclear energy in the future for the production of the necessary process steam and process heat in a high-temperature gas-cooled reactor (allothermic process)

8. and others, e.g. combined cycle-technologies.

At first glance, it seems that too many projects have been developed. However, the different properties of lignite and bituminous coal, the objective to generate low BTU gas, synthesis gas or SNG, necessitated this broad approach. The temporal parallelism in the operation of pilot plants allows an intensive comparison of the different processes as basis for technical decisions to be made forthe realization of the intended large-scale plants.

Coal Liquefaction

Liquid products from coal can substitute all the products derived from crude oil. There are two basic process routes:

1. The anthracite is gasified and the gas produced undergoes a synthesis by which the liquid products are formed (Fischer-Tropsch-Synthesis).

2. The coal molecules are decomposed and by simultaneous combination with hydrogen converted directly into liquid products (hydrogenation).

Both methods have variations in their efficiency. The Fischer-Tropsch-Synthesis which is operated in commercial scale by SASOL in South-Africa, requires high capital investment and a higher energy supply per ton of liquid product. Direct catalytic hydrogenation based on the Bergius-Pier process has advantages of higher efficiency and lower cost.

The traditional technological know how of the Bergius-Pier catalytic hydrogenation process became the basis of the new German technology in the early seventies. Bench-scale experiments were started by Ruhrkohle AG at the Bergbau-Forschung GmbH laboratories in Essen supported by the Land Northrhine-Westphalia, and at Saarbergwerke AG and Rheinische Braunkohlenwerke AG, supported by

liquefaction aside from the general development of coal extraction and deep undersurface mining.

Test plants to be erected within the frame of these governmental energy programs were to investigate and to establish reliable parameters for construction and operation for future commercial size plants of coal gasification and liquefaction.

Coal Gasification

Gasification of coal in general means the conversion of organic substances in the coal into gaseous products by using auxiliary gases. In Germany, the conventional technologies of the so-called "first generation", e.g. Lurgi and Koppers-Totzek gasification, have been developed. The optimization of conventional technologies to the "second generation" have been concentrated on improvements of the autothermal gasification processes. The supported methods should produce under promotion of a specific gasification output only few by-products ensuring a high degree of coal utilization independently of the specific properties of the coal. In the area of coal gasification, various projects were supported by the two governmental programs with funds of about 150 mUS $ between 1974 and 1980:

1. The Ruhrkohle AG/Ruhrchemie AG pilot plant in Oberhausen-Holten, using the Texaco coal gasification process and the RAG/RCH-systems of wet coal grinding and waste heat recovery;
   coal throughput 150 t/d, products 290,000 cbm/d synthesis gas, operation period 1978 - 1981.

2. The Ruhr 100 pilot plant in Dorsten of Ruhgas AG/Ruhrkohle AG/ Steag AG using a modified fixed-bed pressure gasification according to Lurgi;
   coal throughput 70 - 170 t/d, products 40 - 95 cbm/d SNG, operation period 1979 - 1984.

3. The Saarberg-Otto pilot plant in Fürstenhausen/Saar using the slag bath gasification;
   coal throughput 250 t/d, products: systhesis gas or reduction gas.

4. The high-temperature Winkler process of Rheinische Braunkohlenwerke AG using the fluidized bed gasification:
   coal throughput 25 t/d, products: synthesis gas or reduction gas.

5. KGN plant Hückelhoven of PCV (Flick-group) using a fixed-bed gasification:
   coal throughput 35 t/d producing low BTU or synthesis gas.

the BMFT to establish with various process developments new reliable data as basis for the extrapolation and construction of demonstration plants.

The improvements in the catalytic coal liquefaction process are:

- Reduction of the process pressure and hydrogen consumption,
- increased process efficiency to reduce coal consumption,
- improved solid/liquid separation by distillation.

Decisions for coal liquefaction projects were taken in the two BMFT-programs for which the Federal Government contributed about 70 mUS $ in the years 1974 - 1980.

As an important prerequisite for the design and construction of large-scale liquefaction plants, Ruhrkohle AG together with Veba Oel AG started in 1977 the design of a demonstration plant based on the modified Bergius-Pier process. This plant which is now under construction in Bottrop/Ruhr area, is designed for a coal throughput of 200 t (waf)/d. Operation start is scheduled for February 1981, and test operation until the end of 1983. The engineering, construction and operation of this Bottrop pilot plant is substantially supported by the Land Northrhine-Westphalia.

Saarbergwerke AG are also constructing a small pilot plant based on a modified Bergius-Pier process for a coal throughput of 6 t/d. Construction and operation of this plant has been supported by the Federal Ministry for Research and Technology (BMFT).

In addition, Rheinische Braunkohlenwerke AG, Cologne, are developing in their laboratories the hydrogenation of lignite with funds of the BMFT.

International Cooperation in Coal Conversion

Within the international cooperation in the field of coal conversion, the Federal Government is mainly involved in US-projects, especially in the SRC-II process which has been developed mainly by the Gulf Oil Company. The SRC-I and SRC-II processes operate without catalyst; they require a coal having a high sulphur content so that the inorganic sulphur component can act as a catalyst. The primary aim of the development was an ash and sulphyr clean solid fuel (SRC-I). The further development of this technology has been directed towards a liquid product in distillate form (SRC-II) which can be adapted as transport fuel and as a substitute for mineral oil. The Federal Government of Germany has participated in the SRC-II development since 1974 and enabled Ruhrkohle AG to participate in the pre-design phases. In October, 1979, a Cooperative Agreement in

coal liquefaction using the SRC-II process has been signed between the U.S. Department of Energy and the Federal Ministry for Research and Technology. This governmental Cooperative Agreement covers the cooperation in the detailed engineering and the procurement, construction, operation and evaluation of a nominal 6,000 t/d demonstration module of the SRC-II process planned to be erected in Morgantown, West Virginia. The West German Government shall provide financial contributions of 25% of the cost of this SRC-II project which also covers the contribution of the German industry in the Cost Sharing Agreement between the US-DOE and the US Prime Contractor Pittsburg and Midway Coal Mining Company. The Japanese Government will also contribute a share of 25% of the total estimated investment and operation cost of about 1.44 b US $ of this SRC-II project. German industrial partners in this project are Ruhrkohle AG and Veba Oel AG. The Shareholders' Agreement between the Pittsburg and Midway Coal Mining Company, a wholly owned subsidiary of the Gulf Oil Corporation, Ruhrkohle AG and the Japanese Mitsui SRC Development Company has been signed on July 31, 1980 in the Rosegarden of the White House in Washington, D. C. with US-President Carter being present.

In January 1979, Ruhrkohle AG became a participant in the R & D- program relating to the EXXON Donor Solvent coal liquefaction process which is performed under a Cooperative Agreement by the EXXON Research and Engineering Company and the US-Department of Energy, Carter Oil and other private sector participants. The pilot plant at Baytown, Texas, using the EXXON Donor Solvent process, has a coal throughput of 200 t (waf)/d. Ruhrkohle AG's participation in this project has also been substantially funded by the Federal Ministry for Research and Technology.

Ruhrkohle AG together with Veba Oel AG are also involved in another coal liquefaction process in the US using the catalytic H-Coal process of Hydrocarbon Research Inc. (HRI). This participation in the H-Coal pilot project in Catlettsburg, Kentucky which started operation in July 1980, has been supported by Land Northrhine-Westphalia. Furthermore, these German companies have acquired exculusively an option to grant licenses of the H-Coal technology in Europe.

In addition to this governmental supporting and funding of private industry participation in US-projects, coal conversion is also subject to multinational cooperation within the European Community, Bruxelles, and within the International Energy Agency (IEA), Paris. The Commission of the European Community has issued different programs offering industrial companies a support for research and development projects within the field of coal conversion and alternative energy technologies in general. Another committee,

the International Energy Technology Group (IETG), which was established at the World Economy Summits in Tokyo and Venice, is also involved in the future evaluation of coal conversion.

Concepts for Large-scale Coal Gasification Plants

As the Federal Government and industrial companies ascertained, essential energy policy objectives can be only fulfilled by large-scale application of coal conversion. Therefore, the Federal Government announced in July 1979 its intention to establish a program for the demonstration and market introduction of large-scale coal conversion plants. With this declaration, the Federal Government invited the industry to propose large-scale projects offering financial support for the investigation of technical practicability, the environmental impact and the estimation of construction and operation costs.

In October 1979, different German coal-,oil-,gas-,electricity-, chemical-,steel- and engineering companies presented 15 project proposals (11 for coal gasification, 4 for coal liquefaction).

The state of introducing the industrial gas and oil production from coal required significant financial resources. A first estimate of the investment costs for completion of these 15 proposed coal conversion plants amount to about 8 b US$.

The proposals of the companies include various processes. It is worth noting that of the 11 proposals for commercial gasification processes, 6 projects are dealing with the production of synthesis gas.

The capacities of the proposed synthesis gas plants with a coal throughput of between 0.3 and 0.5 m t/a are in the scale of large chemical plants.

1. Ruhrkohle AG/Ruhrgas AG proposal
   Coal throughput 3 m t/a German hard coal, using the fixed-bed pressure gasification according to Lurgi; product 1.5 b cmb SNG/a location: Ruhr area.

2. Ruhrkohle AG/Ruhrchemie AG proposal
   Coal throughput 0.4 m t/a German hard coal, using the entrained-bed pressure gasification according to Texaco modified by RAG/RCH; products 0.7 b cbm synthesis gas/a, Location: Oberhausen.

3. German Shell AG proposal
   Coal throughput 0.3 mt/a hard coal using the entrained-bed

pressure gasification according to Shell-Koppers; products 0.6 b cbm synthesis gas/a, location not yet decided.

4. German Texaco AG proposal
Coal throughput 0.36 m t/a hard coal, using the entrained-bed pressure gasification according to Texaco modified by RAG/RCH; products 0.65 b cbm synthesis gas/a, location: Meerbeck, lower Rhine area.

5. PCV (Flick-group) proposal
Coal throughput 0.5 m t/a hard coal, using the fixed-bed gasification; products 1.1 m cbm synthesis gas/a for conversion to SNG, location: Hückelhoven.

6. Saabergwerke AG proposal
Coal throughput 0.4 m t/a German hard coal, using the combined process with Saarberg-Otto gasification; products 0.8 b cbm synthesis gas/a for a combined power plant, location: Saar area.

7. Rheinische Braunkohlenwerke AG proposal
Coal throughput 2.25 m t/a raw lignite, using the high temperature fluidized bed gasification according to Winkler; products 1 b cbm synthesis gas/a, location: Berrenrath.

8. Rheinische Braunkohlenwerke AG proprosal
Coal throughput 5 m t/a raw lignite, using hydrogasification; products 0.7 b cbm SNG/a.

9. Korf AG proposal
Coal throughput 1 m t/a hard coal, using the Saarberg-Otto-gasifier, producing reducing gas for direct reduction of iron ore.

10. VEW AG proposal
Coal throughput 1.8 m t/a hard coal, using the partial atmospheric gasification with air, producing coke and gas for a 800 MW combined power plant.

11. Thyssen Gas AG in connection with the Ruhrkohle AG/Ruhrchemie AG Synthesis Gas Plant, using the methanation in a fluidized bed, products 0.1 b cbm SNG/a, location: Oberhausen-Holten.

Concepts for Large-scale Hydrogenation Plants

In the field of coal hydrogenation 4 projects have been proposed to the Federal Minister of Economics:

1. Ruhrkohle AG is investigating a concept for the production of 2 m t/a of liquid products from bituminous coal at a site in the Ruhr area. The by-products are estimated to be max. 0.6 m t/a LPG and max. 1.8 b cbm SNG. The plant will have a coal throughput of about 6 m t/a. The investment cost will be about 2.6 b US$.

2. Veba Oel AG is preparing a concept by which coal/oil residues or a mixture of coal and oil residues can be converted into liquid products on a scale of 2 m t/a. The site of this plant should be either in the Ruhr area or on the North Sea coast. The investment for this plant would be similarly about 2.6 b US$.

   Ruhrkohle AG and Veba Oel AG are negotiating a cooperation in these two projects.

3. Saarbergwerke AG are considering the production of 800,000 t/a of transport fuel from bituminous coal. The throughput of coal in this plant should be about 2 m t/a. The siting is envisioned in the Saar area, and the investment would be between 1 and 2 b US$.

4. Rheinische Braunkohlenwerke AG has recently proposed a plant producing 400,000 t/a motor fuel or chemical raw materials with a coal throughput of 3.5 m t/a.

Mainly in the field of coal liquefaction, the aspects of international cooperation are promising. In about 5 to 10 years, commercial coal liquefaction plants could be erected in coal producing countries close to those mines where bitiminous coal is produced at much lower cost than in Germany itself. The import of coal-oil produced in such plants will have certain advantages compared to the liquefaction of coal imported into Germany, e.g. cost saving shipping and a lower environmental impact than in a densely populated country like Germany.

Realization of The Coal Conversion Program of January 1980

According to the political objectives of the Federal Government, the energy programs of 1974 through 1980 are consequently pursued by the 15 proposals of the industrial companies. These projects, however, differ in their technical conception and feasibility as well as in their market introduction. The experiences from the R&D work made until now do not allow final decisions which processes will have best chances for realization from the technical and economical standpoint.

The evaluation of each proposed project will only be possible when the basic assessment and planning work are carried out by the involved companies in pre-projects which are as well the basis for their own investment decisions. These pre-projects include the finding of plant sites, the technical design, prospective time schedule and cost estimation taking into account the use of German or imported coal, as well as the requirements of environmental impacts. The cost of such pre-projects amount to about 1% of the total estimated investment.

If the evaluation of these pre-projects prove to be positive, the detailed engineering has to be prepared. Those costs amount to about 10 or 20% of the total investment. Generally the decision for carrying out the detailed engineering means the final decision for construction and operation of the proposed project itself has been made.

The Federal Ministry for Economics and the Federal Ministry for Research and Technology have discussed each proposed project with the industrial partners involved. It has been decided that pre-projects will be carried out for all of the proposed projects. Thus, the Federal Government makes sure that the further general development of coal conversion will be continued on a broad basis without prejudices. First results of these pre-projects for the proposed gasification plants can be expected by the end of this year, the results for the coal liquefaction projects by mid-1981.

Three projects are already funded by the State of Northrhine-Westphalia. Due to the high technological and economic risks involved in some of the proposed gasification projects and in all of the liquefaction projects, the industrial partners are not ready to start the pre-projects without guaranteed governmental funding. The companies have applied for funds in the range of 50 to 90% of the estimated pre-project cost. The Federal budget established for 1980/81 includes already up to 40 m US$ for these purposes.

The Federal Government and the State of Northrhine-Westphalia require that the projects will rely heavily on the responsibility and competence of the industrial companies themselves. The companies, however, already see from today's viewpoint the necessity for governmental support not only for the pre-projects but also for the construction and operation phases of the large-scale production plants. The total investment cost of about 8b US $ up to 1993 - calculated on the price index of 1979 - for constructing the 15 proposed projects gives an idea of the upcoming additional charges to the Federal budget within the next 13 years regarding a prospective government support of about 50% of these costs.

Another reduction of the companies' own investment cost can be reached by Federal Tax exemptions and reduced Federal credit interest dues.

If the proposed gasification projects will start operation only in 1984, and the liquefaction plants not before 1986, the economy of coal conversion will substantially depend on the further increase of prices for crude oil, natural gas and coal. The Federal Government will have to decide about supporting the operation phase and the decision to maintain a substantial investment support. Therefore, the Government will have to face the possibility that such operation support can result in permanent grants for keeping these new technologies economic.

Outlook

This brief survey of the German Coal Conversion Program issued by the Federal Government in January 1980, indicates to what extent the further improvement of new coal gasification and liquefaction technologies has to be supported. In the course of the past two energy programs 1974 - 1980, the Federal Government has already contributed funds up to about 800 m US$ for the general development of coal extraction and conversion technologies. More than 90% of these funds were from industry which in return contributes with remarkable funds of its own, the average of the industrial contribution in the field of coal research amounting to about 40% of the total cost so that the overall sum for these projects amount to approx. 2 b US$. Adding the contribution of the State governments of Northrhine-Westphalia and Saarland, the sum for the general coal research program amounts to more than 2.3 b US$ for 1974 until today. These are enormous efforts for an area of production in which only 1% of all West German employees are engaged; contributing about 1% of the German gross national product.

In view of today's worldwide energy situation and recent political developments in some of the OPEC countries, these governmental efforts have already now proven to be justified and necessary in order to ensure a long term flexible supply of energy in the Federal Republic of Germany.

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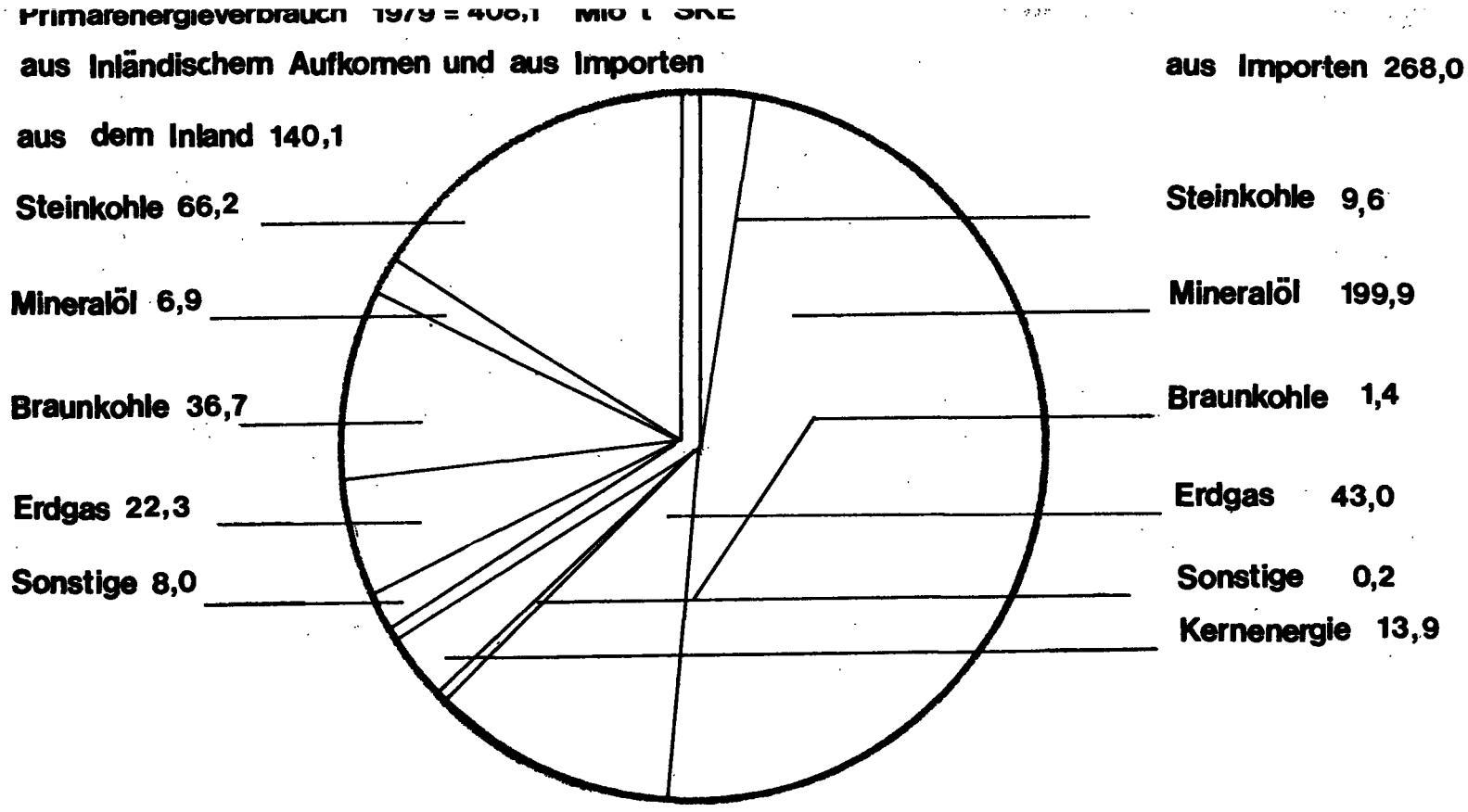
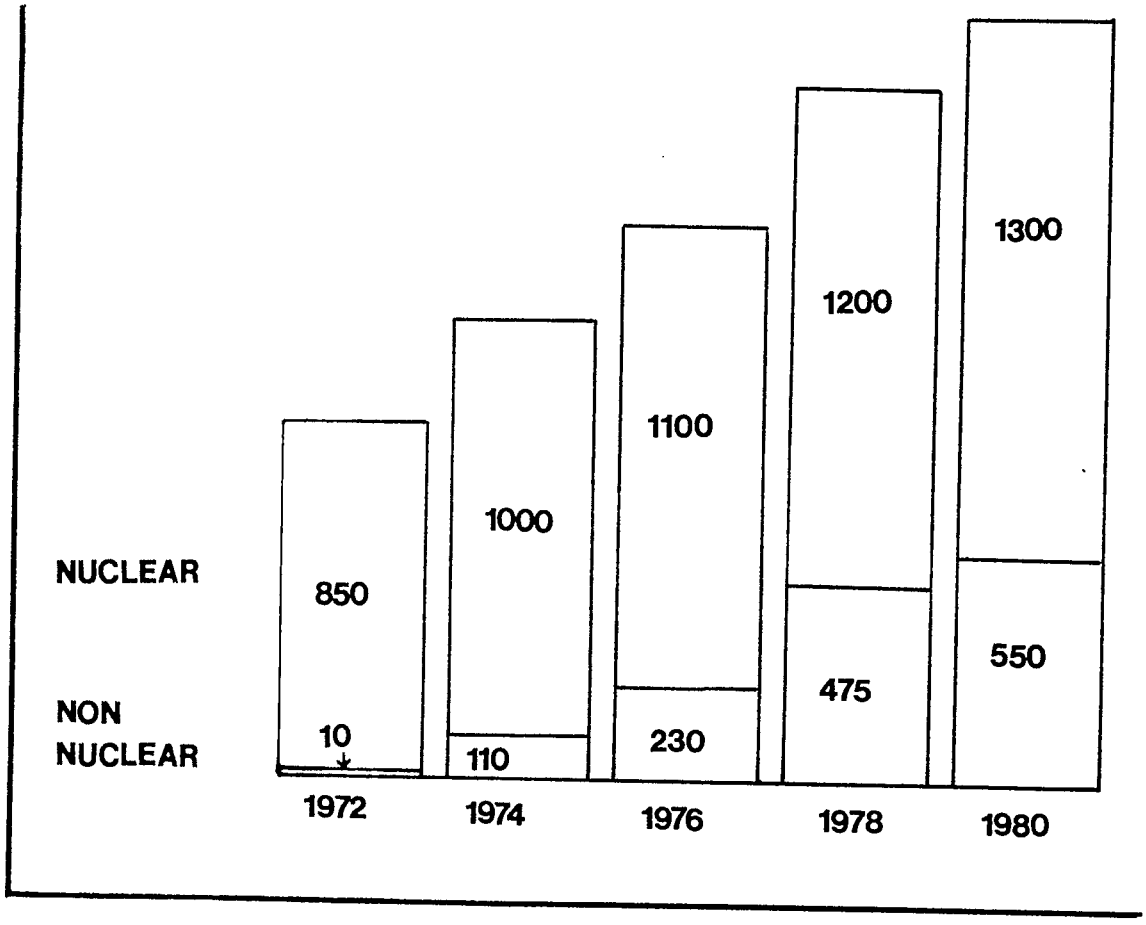


Primärenergieverbrauch in der Bundesrepublik 1979

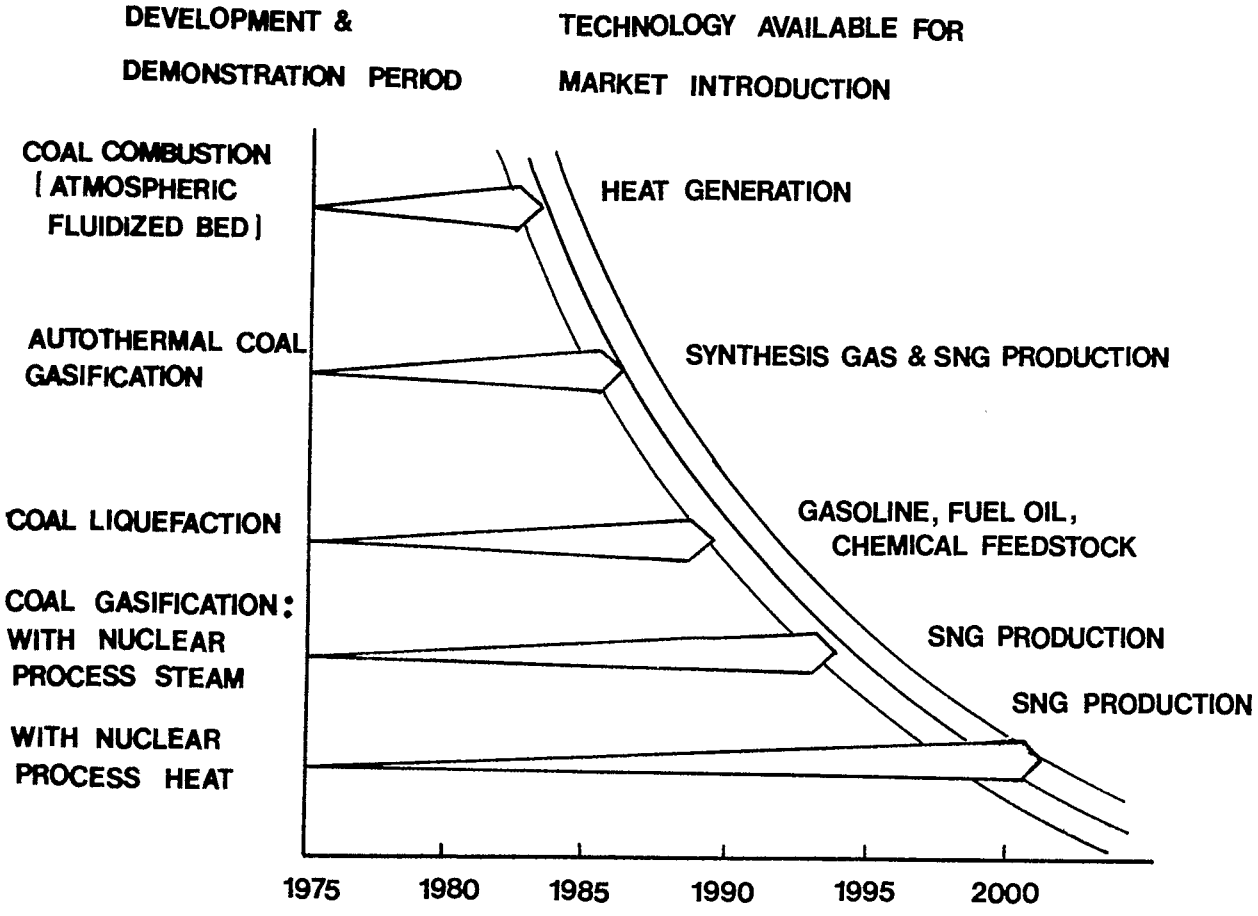
HYDRIERANLAGEN IN DEUTSCHLAND

	HYDRIERWERK	BEZIRK	HAUPTROHSTOFFE	HYDRIERVERFAHREN	INBETRIEB-NAHMEJAHR	DRUCK IN ATM SUMPF PHASE	DRUCK IN ATM GAS PHASE	KAPAZITÄT IN N 1000 JATO CA.
1	LEUNA	MITTELDEUTSCHLAND	BRAUNKOHLE (BRAUNKOHLENTEER)	SUMPF + GASPHASE	1927	200	200	600
2	BÖHLEN	MITTELDEUTSCHLAND	BRAUNKOHLENTEER	SUMPF + GASPHASE	1936	300	300	240
3	MAGDEBURG	MITTELDEUTSCHLAND	BRAUNKOHLENTEER	SUMPF + GASPHASE	1936	300	300	230
4	ZEITZ	MITTELDEUTSCHLAND	BRAUNKOHLENTEER	TTH + MTH	1939	300	300	300
5	WESSELING	NIEDERRHEIN	BRAUNKOHLE	SUMPF + GASPHASE	1941	700	300	200
6	BRÜX	SUDETENLAND	BRAUNKOHLENTEER	SUMPF + GASPHASE	1942	300	300	400
7	SCHOLVEN	RUHR	STEINKOHLE	SUMPF + GASPHASE	1936	300	300	200
8	GELSENBERG	RUHR	STEINKOHLE	SUMPF + GASPHASE	1939	700	300	350
9	BLECHHAMMER	OBERSCHLESIEN	STEINKOHLE	SUMPF + GASPHASE	1943	700	300	500
10	WELHEIM	RUHR	STEINKOHLENTEER	SUMPF + GASPHASE	1937	700	700	180
11	LÜTZKENDORF	MITTELDEUTSCHLAND	ERDÖLRÜCKSTÄNDE KOKEREITEER	SUMPF + GASPHASE	1940	700	700	50
12	PÖLITZ	STETTIN	STEINKOHLE KOKEREITEER ERDÖLRÜCKSTÄNDE	SUMPF + GASPHASE	1940	700	300	600



ENERGY R + D PROGRAM

[MIO DM] IN WEST GERMANY



DEVELOPMENT OF COAL CONVERSION TECHNOLOGIES

Projects	Partners	Total Costs Period	Process Data	Products
PILOT PLANT Bottrop	Ruhrkohle AG Veba Oel AG	300 Mio DM 1978 1983	Catalytic Hydrogenation ["German Technology"] 200 t/d 300 bar 475 C	Synthetic fuels 30 t/d gasoline 70 t/d middle Oil Gas 40 t/d
DEMON - STRATION PLANT Morgantown, W.Virginia	Gulf Mineral Resources Co. Ruhrkohle AG/ Steag AG	700 Mio $ 1975-1985	Solvent Extraction [SRC] 6000 t/d 140 bar 450 - 460 C	Synthetic I fuels [SRC II] 1945 t/d Naphtha 440 t/d Gas 420 t/d
PILOT PLANT Baytown, Texas	DOE The Carter Oil Co. [EXXON] EPRI Japan CLDC Phillips Petroleum Atl. Richfield Co. Ruhrkohle AG	300 Mio $ 1974-1982	Solvent Extraction [EDS] 250 t/d 100 - 150 bar 450 C	Synthetic fuels 32 t/d gasoline 17 t/d middle Oil 18 t/d heavy Oil Gas 17 t/d
PILOT PLANT Feldhausen/ Saar	Saabergwerke AG	30 Mio DM 1977-1980	Catalytic Hydrogenation ["German Technology"] 6 t/d 300 bar 475 C	Synthetic fuels Chemical Feedstock

COAL LIQUEFACTION PROJECTS 1979

	BUNDESREPUBLIK DEUTSCHLAND			USA		
Partner	Ruhrkohle AG	Veba Oel AG	Saaberg - werke AG	Gulf Mitsui Ruhrkohle AG	EXXON	Ashland
Standort	Ruhrgebiet	Ruhrgebiet oder Küste	Saargebiet	Morgantown	offen	offen
Anlagen - größe	6 Mio t/a Steinkohle	6 Mio t/a Steinkohle oder Schweröl	2 Mio t/a Saar - ländische Flammkohle	1,8 Mio t/a Steinkohle	7,5 Mio t/a Steinkohle	6 Mio t/a Steinkohle
Verfahren	Katalytische Hydrierung	Katalytische Hydrierung	Katalytische Hydrierung	Hydrierende Extraktion SRC II	Hydrierende Extraktion EDS	H - Coal
Produkte	1,8 Mrd m^3/a SNG 0,6 Mio t/a LPG 2 Mio t/a Rohnaptha u. Mitteldest	2 Mio t/a Flüssig - produkte	0,8 Mio t/a Hydrier - benzin	0, Mio t/a Gas 0, Mio t/a Rohnaptha 0,6 Mio t/a SRC II	0,7 Mio t/a Gas 0,8 Mio t/a Rohnaptha 1,5 Mio t/a Mittel - Schwerdest	0,1/0,4 Mrd m^3/a Gas 0,6/1,0 Mio t/a Rohnaptha 1 Mio t/a Mittel - Schwerdest
Planung Bau Betrieb	1980/83 1983/93 ab 1986	1980/83 1984/87 ab 1987	1980/82 1983/86 ab 1987	1979/82 1981/84 ab 1985	ab 1988	ab 1988

Industrieprojekte Kohleverflüssigung 1980

Projects	Partners	Total Costs Period	Process Data	Products
TEXACO Oberhausen Holten	Ruhrkohle AG Ruhrchemie AG	35 Mio DM 1975 - 1979	Entrained bed pressure gasification according to Texaco 150 t/d, 40 bar 1450 C	290 000 m^3/d Synthesis gas
RUHR 100 Dorsten	Ruhrgas AG Ruhrkohle AG/ Steag AG	145 Mio DM 1975 1984	Fixed bed pressure gasification according to Lurgi 70 - 170 t/d 100 bar 700 - 1000 C	100 - 236 000 m^3/d Synthesis gas 40 - 95000 m^3/d SNG
PNP 500 MW_{th} Prototype Plant Nuclear Process Heat	Bergbau-Forschung GmbH Gesellschaft für Hochtemperatur-reaktor-Technik GmbH Hochtemperatur-Reaktorbau GmbH Kernforschungsanlage Jülich GmbH Rheinische Braunkohlenwerke AG	1300 Mio DM 1975 - 1984	Fluidized bed gasification 1500 t hard coal/d 4000 t lignite/d Hydrogasification: 80 bar, 820 - 930 C Steam gasification: 40 bar, 630 - 800 C	1000 000 m^3/d SNG from hard coal 64×10^4 m^3/d SNG from lignite Synthesis gas Reduction gas
KDV Plant Lünen	Steag AG Lurgi Mineralöltechnik GmbH	205 Mio DM 1974 - 1982	Lurgi pressure gasification 1700 t/d 25 bar 700 - 1000 C	Electric Power by gas and steam turbine: 170 MW

SHELL - KOPPERS Hamburg - Harburg	Shell International Deutsche Shell AG Krupp- Koppers GmbH	60 Mio DM	Entrained bed gasification according to Shell: 150 t/d 30 bar 1150 – 1600 C	Synthesis gas Reduction gas
SAARBERG / OTTO Fürstenhausen/ Saar	Saabergwerke AG Dr. C. Otto & Co., GmbH	43 Mio DM	Slag bath gasification 250 t/d 30 bar 1450 - 1650 C	Synthesis gas Reduction gas
High Temperature WINKLER PROCESS Frechen	Rhein Braunkohlenwerke AG	32 Mio DM	Fluidized bed gasification 25 t/d 10 bar 870 - 1070 C	Synthesis gas Reduction gas
KGN PLANT Hückelhoven	PCV Gewerkschaft Sophia Jacoba	19 Mio DM	Fixed bed gasification 35 t/d 6 bar 920-1120 C	Low BTU gas Synthesis gas
VEW PROCESS Dortmond	Vereinigte Elektrizitätswerke Westfalen AG	18 Mio DM 72 Mio DM	Pilot Plant 24 t/d 1 bar Demonstration Plant 360 t/d 1 bar	Electric power

COAL GASIFICATION PROJECTS 1979

EXXON DONOR SOLVENT COAL LIQUEFACTION PROCESS: DEVELOPMENT PROGRAM STATUS

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D. T. Wade

EXXON DONOR SOLVENT COAL LIQUEFACTION PROCESS: DEVELOPMENT PROGRAM STATUS

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Abstract

The status of the Exxon Donor Solvent Coal Liquefaction Process Development Program will be reviewed. Included in the overview of this government-industry cost-shared development is a description of Exxon's integrated approach to the project. The status of the laboratory and engineering research and development studies along with an up-to-date status of the 250 T/D large pilot plant demonstration will be presented. The process description will include discussions of coal feed flexibility and product flexibility. Potential product utilization schemes, including direct utilization and various conventional upgrading routes, will be surveyed. The project environmental program philosophy and studies will be described. The economic outlook for the EDS process and the effects of various bases will be presented, concluding with consideration of the prospects for commercialization.

Introduction

This paper describes the status of the Exxon Donor Solvent (EDS) Coal Liquefaction Project. Included is an overview of this government-industry cost shared development, along with a description of Exxon's integrated approach to the development. The status of the laboratory and engineering research and development studies and the status of the 250 T/D large pilot plant and 70 T/D FLEXICOKING* prototype programs will be presented. The process description will include discussions of coal feed flexibility and product flexibility. Potential product utilization schemes will be surveyed. The literature contains past status reports of the development program, [1-8] and discussions of the potential for commercialization,[9] as well as the organizational structure of the EDS Project.[10]

*Service Mark

Figure 1 lists the project participants. The U.S. Department of Energy is providing 50% of the funding through a unique government/industry cost sharing arrangement, the Cooperative Agreement. The remaining funding for the liquefaction program is provided by Exxon Company, U.S.A., Electric Power Research Institute, Japan Coal Liquefaction Development Company, Phillips Coal Company, ARCO Coal Company and Ruhrkohle AG. Private sector support of the FLEXICOKING prototype construction and operation is provided by Exxon Company U.S.A., Japan Coal Liquefaction Development Company, ARCO Coal Company and Ruhrkohle AG. Additional participants are possible in the future.

The overall objective of the project is to bring the technology to a stage of commercial readiness so that commercial plants can be designed with an acceptable level of risk. The EDS project includes the process blocks of liquefaction, solvent hydrogenation, and bottoms processing; the program includes work on hydrogen generation, fuel gas generation, and environmental controls as well.

Integrated Development

To achieve the objective of commercial readiness, the EDS program integrates all phases of process development. Bench scale research, small pilot unit operation, and engineering design and technology studies support operation of a 250 T/D coal liquefaction pilot plant and a 70 T/D FLEXICOKING prototype program. Work is also in progress to evaluate the use of a bottoms partial oxidation process for generation of hydrogen or fuel gas.

As shown in Figure 2, the integrated approach involves optimum use of the laboratory and engineering R&D programs, the 250 T/D pilot plant, and the 70 T/D FLEXICOKING prototype to obtain the data for a commercial design. The design data for the key development areas, e.g. slurry drying, liquefaction, distillation, solvent hydrogenation, FLEXICOKING, product quality, and environmental control, will be obtained in the most appropriate project area at the minimum development cost. For example, the role of the ECLP (250 T/D) pilot plant and FLEXICOKING prototype in the EDS Project are to provide operability and design data in the slurry drying, liquefaction, distillation and bottoms processing areas. ECLP was sized so that the limiting pieces of equipment (e.g. coal slurry preheat furnaces and liquefaction reactors) are the minimum size that will allow confident scale-up to a commercial size plant. Other critical areas include environmental control, feed slurry drying, slurry pumping, high pressure letdown valves and vacuum bottoms pumping. The FLEXICOKING prototype unit was sized to provide scale-up data on the fluid bed operation, product quality data, and environmental control data.

EDS Process Block Diagram

One configuration of the EDS process is shown in Figure 3. Feed coal is crushed and dried by mixing with hot recycle donor solvent. The coal-solvent slurry is fed along with gaseous hydrogen to the liquefaction process block. The liquefaction reactor design is relatively simple, consisting of an upward plug flow reactor with design conditions of 800-900°F and about

2000-2500 psi total pressure. The reactor product is separated via conventional separation and fractionation steps into chemical and light hydrocarbon gases, C_3-1000°F distillate, and vacuum bottoms containing 1000°F+ liquids, unconverted coal, and coal mineral matter.

Part of the 400-800°F fraction of the C_3-1000°F distillate is taken as the recycle hydrogen donor solvent. This spent (dehydrogenated) solvent stream is hydrogenated in a conventional fixed bed catalytic hydrotreater using commercially-available hydrotreating catalysts.

The light hydrocarbon gases can be fed to a steam reformer to produce process hydrogen. The vacuum bottoms stream can be fed to a FLEXICOKING unit to produce additional liquid products and low BTU fuel gas while concentrating the coal mineral matter for disposal. FLEXICOKING is a commercial petroleum[11] process that employs integrated coking and gasification reactions in circulating fluidized beds. The process is a low pressure (<50 psi, and intermediate temperature operation (900-1200°F in the coker, 1500-1800°F in the gasifier). FLEXICOKING recovers essentially all of the feed carbon as product liquid or fuel gas. A small amount of carbon is purged from the unit with the coal mineral matter.

Partial oxidation of the vacuum bottoms (not shown) can produce either process hydrogen or intermediate BTU fuel gas[12] and this frees the light gas stream for sales or furnace fuel.[13] In high conversion coal liquefaction operating modes, process hydrogen can be generated by partial oxidation of coal.[14] Partial oxidation units typically operate in the 2500-2800°F range and at 400-1000 psi. Partial oxidation is a commercial process employing oxygen to gasify petroleum fractions. The process does not recover additional liquid product but has the potential to consume effectively all of the feed carbon in the production of hydrogen or fuel gas.

Coal Feed Flexibility

Coal is located in many places in the U.S. as well as other countries. Differences in deposits can be very important in coal liquefaction. As shown in Figure 4, bituminous coals are found in Appalachia, the mid-west, and the Southern Rocky Mountain regions. Subbituminous coals are found primarily in the west. Lignites are found in the west and the Gulf Coast. One of the technical challenges is to be able to convert this wide variety of different quality coals into liquids. To do this, we need to learn more about the chemical structure of coal and how it reacts to form liquids.[15]

The EDS process is suitable for a wide range of coals. Figure 5 shows that bituminous, subbituminous and lignite rank coals can be liquefied using the EDS process. The liquid yields resulting from once-through liquefaction and FLEXICOKING are shown on this slide. Bituminous coals studied produce 43-46% liquids, subbituminous coals 40-42% liquids, and the lignite about 37% liquids. The liquefaction yield can be increased substantially by recycling vacuum bottoms back to liquefaction.

Product Flexibility, Utilization

Figure 6 shows the range of product flexibility which can be obtained from EDS liquefaction of Illinois No. 6 coal. The ranges shown represent the variation in yield expressed as a percentage of the total liquid product between a plant operating without vacuum bottoms recycle (once-through) using steam reforming of the C_1 and C_2 hydrocarbon gases to produce process hydrogen with bottoms FLEXICOKING for plant fuel, and a plant operating with vacuum bottoms recycle using partial oxidation of coal to produce process hydrogen and bottoms FLEXICOKING for plant fuel. In addition, the end uses of the hydrotreated streams are shown. The C_1/C_2 stream can be used as synthetic natural gas, C_3/C_4 as a premium fuel or refinery feed, naphtha as a gasoline blending component, middle distillate as a stationary turbine fuel, and heavy distillate as low sulfur fuel oil. C_3 and C_4 liquefied petroleum gas, naphtha and mid-distillate yields are all maximized when operating with bottoms recycle while heavy distillate yield is minimized. Conversely, heavy distillate production is maximized with once-through operation.

All of the raw (unhydrotreated) EDS liquids contain significant levels of sulfur and nitrogen. They also contain compounds, e.g. nitrogen compounds, which cause degradation during storage. The heteroatom concentration increases with increasing boiling range.

The EDS project includes an effort to define suitable product uses, but does not include a major upgrading laboratory program. Limited hydrotreating studies are included in the project, to define the treatment required to stabilize the products for storage and shipment and to make them suitable for limited direct utilization. Major upgrading studies to make all clean products and/or transportation fuels are specifically excluded from the project.

Figure 7 shows several upgrading options and utilization routes for the EDS product streams. (16-21) Under each product the upgrading options shown represent increasingly severe processing. Our studies and the work of others(19) indicate that these are technically viable upgrading options although their economic viability remains to be determined. The naphtha stream can easily be hydrotreated to reduce sulfur and nitrogen contaminants and reformed to increase the octane number and recover net hydrogen. The reformate is then ready for end use such as motor gasoline blending or aromatics extraction.

The mid-distillate stream can be hydrotreated mildly to reduce sulfur and nitrogen and sent directly to end-use as either a No. 2 fuel oil or stationary turbine fuel. Other options would involve more severe hydrotreating to produce jet or diesel fuel or hydrocracking to produce a motor gasoline blend stock.

The vacuum gas oil stream also can be hydrogenated mildly to reduce sulfur and nitrogen content to levels suitable for use as a specialty fuel. At this level of hydrotreating these heavy distillate fuels require special handling due to their higher than normal viscosities and their incompatibility with comparable petroleum fuels. Alternatively, hydrocracking of the vacuum gas oil to produce all clean products or transportation fuels appears possible based on stream inspections, extrapolation of petroleum-based correlations, and the work of others.(20)

Figure 8 shows some of the results that UOP[21] has obtained on reforming the hydrotreated naphtha to a gasoline-blending component. It also shows results from an ER&E funded program evaluating reforming of EDS naphtha. What is plotted for catalytic reforming is the yield, as percent of C_5+ liquid reformate produced per barrel of feed versus the research octane--clear or unleaded--of the product. By comparison, the yield on naphtha from a Saudi Arabian feed is much lower for any given octane. Hence, the EDS-derived naphtha would be an excellent reformer feed when compared with a major current source of crude in the world market.

Environmental Program

The first step in formulating an environmental program was defining those areas expected to be different from petroleum experience.[22] As shown on Figure 9, three general areas were identified. The coal feed is expected to impact the following environmental areas: Air as fugitive dust emissions generated during coal handling and crushing, and coal fines disposal; noise generated during coal crushing; and worker health in light of potential dust emissions and noise levels. The products are anticipated to pose a potential health hazard to workers due to their high aromatics content.[23] Plant discharges are expected to impact due to fugitive dust and hydrocarbon emissions to the air, aromatic hydrocarbons and phenols in process and runoff water, and solid waste leaching in landfills.

Figure 10 shows the planned development strategy for addressing these concerns. The general approach is to define the problem using large pilot plant data and engineer solutions based on existing control technology. For example, air quality control measures based on existing petroleum refining and electric power industry control technology are being used in ELCP and the FLEXICOKING prototype unit. Also, all wastewater streams analyzed thus far appear to be treatable using existing refinery technology. (This will be verified in bench scale tests). Programs to protect workers from both coal and product-based emissions are based on Exxon's experience in more than 10 years of coal liquefaction of research and the experience of others.[24]

EDS Project Status

The schedule of the EDS Project is shown on Figure 11. In addition to the continuing laboratory and engineering programs, the schedules for detailed engineering, procurement, construction and operation of the 250 T/D Exxon Coal Liquefaction Pilot Plant (ECLP) and the 70 T/D FLEXICOKING prototype unit are shown. Construction and operation of the two large pilot plants are under the direction of Exxon Company, U.S.A.

The detailed engineering, procurement, and construction phase of ECLP which was begun in mid-1977 was completed in March of this year. The schedule has slipped about three months from the original schedule due to job scope changes. The cost of the unit was 118M$ compared with the original estimate of 110M$. The plant started integrated operation on June 24, 1980. The first run continued 5 days when coal feed was halted to make modifications to alleviate several minor mechanical problems. The planned ECLP operating

schedule spans a 30-month period beginning with a 15-month run on Illinois No. 6 coal followed by a 9-month run on a Wyoming subbituminous rank coal and a 6-month run on a third coal.

The detailed engineering, procurement, and construction phase of the FLEXICOKING prototype revamp began in July. This phase is estimated to last 22 months leading to a 2Q 1982 mechanical completion target. Eighteen months of FLEXICOKING prototype unit operations are planned on bottoms produced in ECLP from operations on two different coals. The first, from Illinois No. 6 coal, will last 12 months while the second, will last 6 months. Current projections based on this schedule indicate that a basis for a commercial plant design could be available in the fourth quarter of 1982, about midway through the FLEXICOKING run on Illinois No. 6 coal bottoms, assuming successful continuation of the program.

Pictures of ECLP/Prototype FLEXICOKING Unit

Figure 12 shows an overview of the pilot plant. The relative positions of the administration building, the coal storage and preparation facilities, the process area and the product tankage areas are shown.

Figure 13 is a view of the Prototype FLEXICOKING Unit. The large cylinder is the coke storage silo. The coking reactor is behind the silo and the gasifier is in the structure to the left.

EDS Economic Outlook

Figure 14 is a summary of the product cost outlook based on an EDS study design. All financial figures shown here are expressed in 1985 dollars. A study design is an in-depth examination of the EDS process. It involves designing a conceptual, pioneer commercial plant and then estimating its investment and operating costs. This outlook is for a plant using FLEXICOKING to produce process fuel and bottoms partial oxidation to produce hydrogen. It would process 28,000 tons/calendar day of coal and produce about 62,000 fuel oil equivalent barrels/calendar day of product. The investment required is estimated to be 3.7 billion dollars including a contingency of 35%. The required initial selling price (RISP) for the C_3^+ product from this type of plant operating on Illinois No. 6 coal would be about 48 $/B. A definition of RISP and example calculation can be found in a report on the EDS Commercial Plant Study Design.[25]

To calculate the cost of the liquids produced in such a plant various economic parameters must be specified. In total, there are about 90 parameters which must be specified to calculate the cost of liquids from a synthetic fuels plant. Figure 14 shows the impact of seven of the more significant economic parameters which must be chosen. The values shown as base are those used to arrive at the 48 $/B figure above. The impact on RISP of these seven areas are shown in $/B along with the change from the base. For example, reducing the discounted cash flow return on a 100% equity-financed plant by 5%

would reduce the RISP from 48 $/B to 37 $/B. Increasing it by 5% would increase the RISP by 15 $/B to 63 $/B. Similarly, changing from 100% equity financing to 75%/25% debt/equity financing would reduce RISP by 12 $/B to 36 $/B.

Of the other basis items, one of the most important parameters is the rate at which the selling price of petroleum and coal liquids will escalate during the plant life, as compared with the escalation rate of coal and other plant operation costs. The greater the differential escalation between hydrocarbon liquids and plant operating costs, the greater is the future flow of revenues to the synthetic fuels producer; this results in a lower RISP for the product when the plant starts up to achieve a desired rate of return over the life of the plant. As a base case, it was assumed that product price escalates at 6% per year, the same as operating expenses.

As a sensitivity, it was assumed based on published information(26) that plant revenues will escalate at 9% per year for the first 15 years of plant life and at 7-1/2% per year thereafter (equivalent to 8.7% per year on average), while plant operating costs escalate at 6%. On this basis a RISP of 37 $/B was calculated.

The effect of the other economic parameters on the RISP is generally smaller. For example, an investment tax credit of 10%, rather than 20%, would increase RISP by 3 $/B. Writing off equipment more quickly, such as through 3-year straight line depreciation or by treating capital costs as expense costs, would further reduce the RISP by 9 $/B. Lastly, a tax credit for coal liquids would lower RISP by 5 $/B.

It is clear that the assumed values of these economic parameters can strongly affect the calculated cost of synthetic fuels. The depth of detail present in a study design and the assumptions made during the study can also affect the calculated plant investment. These variations make it very difficult to compare the costs of products reported by different organizations on a consistent basis.

Summary

The prospects for successfully developing coal liquids technology are good with the programs presently in place, but the prospects and timing for an economically attractive coal liquids industry are uncertain.

Project activities are directed toward achieving commercial readiness for EDS. Startup and operation of ECLP is a high priority activity this year, and a continuing effort on process improvements will be made in an effort to reduce the cost of synthetic liquids. The project will also continue to focus attention on bottoms processing, a critical step in the development.

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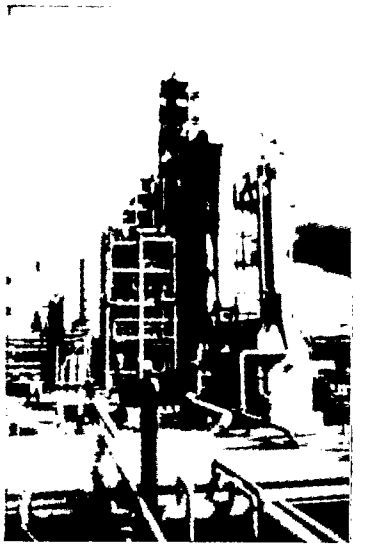
EXXON DONOR SOLVENT PROCESS
PROJECT
SPONSORED BY
U.S. Department of Energy
Exxon Company, U.S.A.
Electric Power Research Institute
Japan Coal
Liquefaction Development Co., Ltd.
Phillips Coal Company
ARCO Coal Company
Ruhrkohle AG
Exxon Research
and Engineering Company
Project Manager

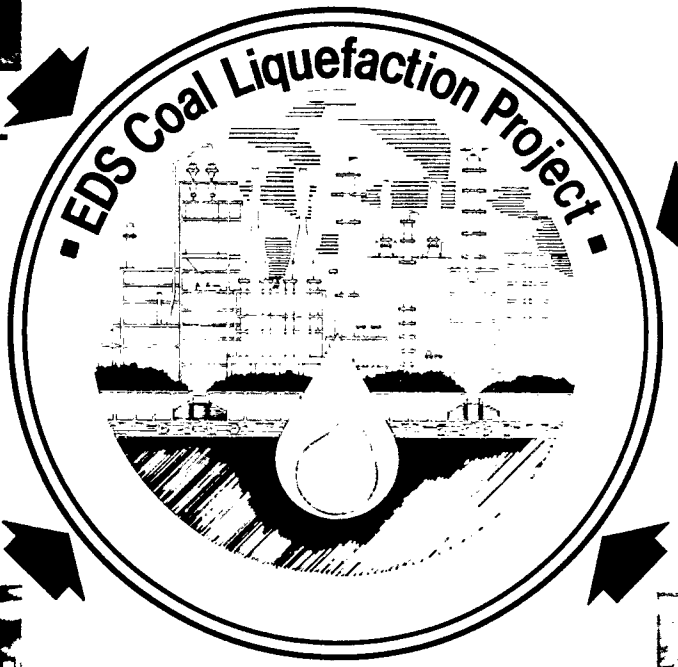
Figure 1

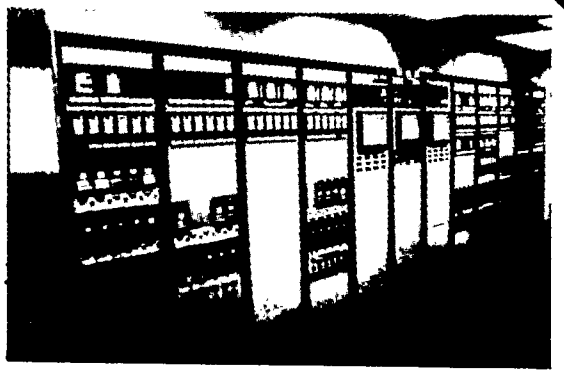
INTEGRATED EDS COAL LIQUEFACTION PROJECT

ECLP LIQUEFACTION
PROCESS DEVELOPMENT



BOTTOMS PROCESSING
DEVELOPMENT





LABORATORY R&D

ENGINEERING R&D

Figure 2

EXXON DONOR SOLVENT COAL LIQUEFACTION

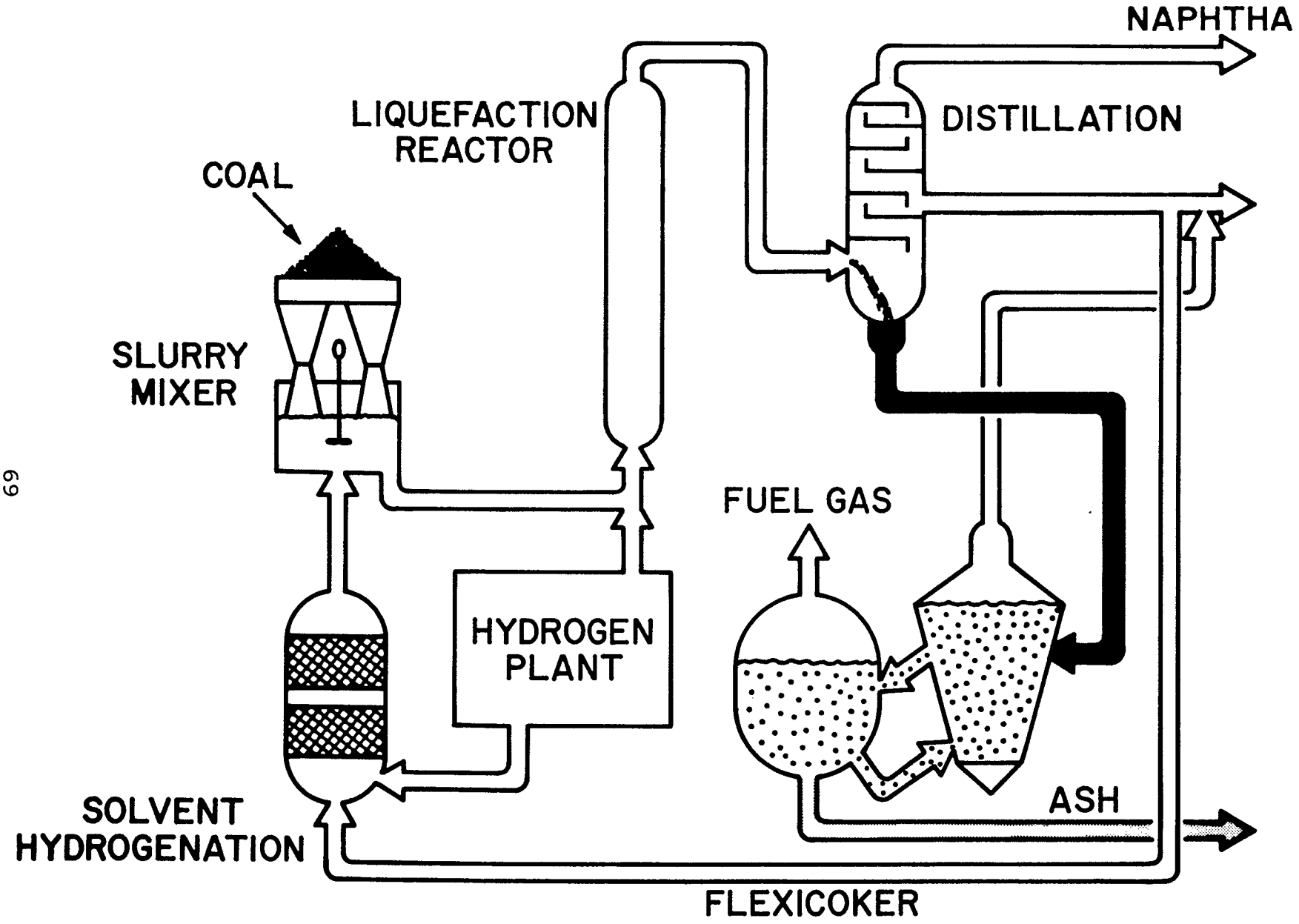


Figure 3

LOCATION OF U.S. COALS

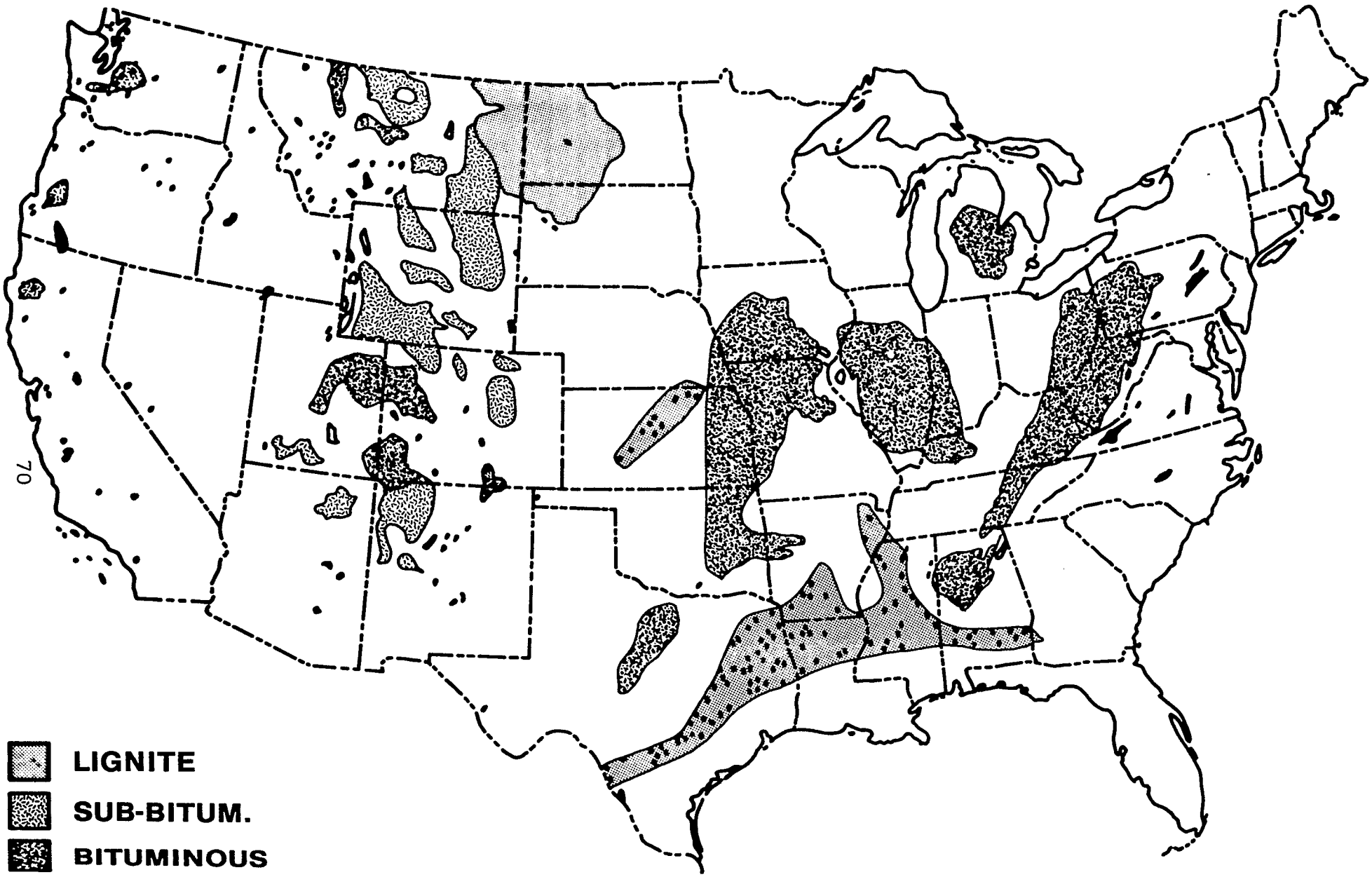


Figure 4

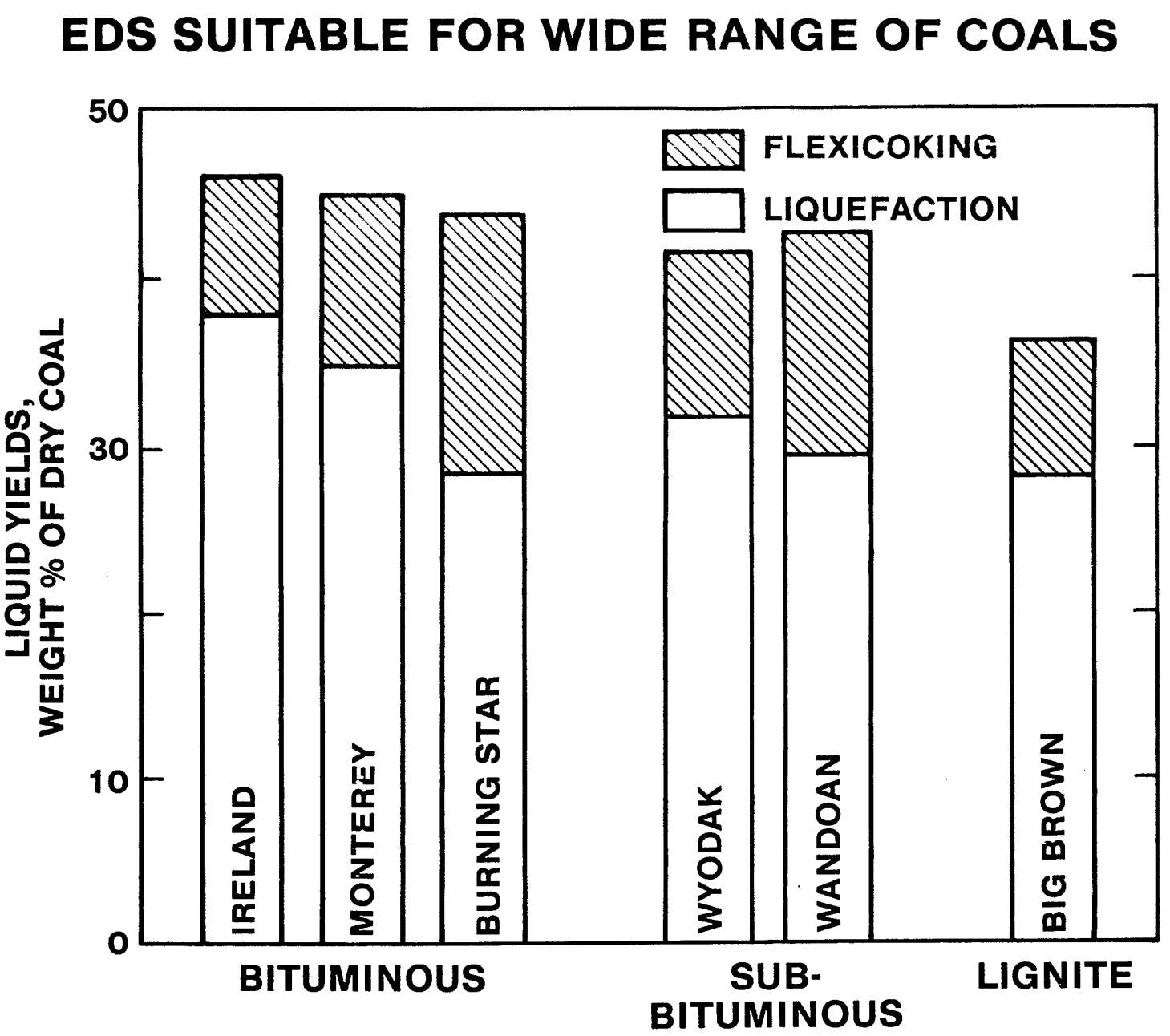

EDS SUITABLE FOR WIDE RANGE OF COALS
LIQUID YIELDS, WEIGHT % OF DRY COAL
50
30
10
0
FLEXICOKING
LIQUEFACTION
IRELAND
MONTEREY
BURNING STAR
WYODAK
WANDOAN
BIG BROWN
BITUMINOUS
SUB-BITUMINOUS
LIGNITE

Figure 5

RANGE OF PRODUCT FLEXIBILITY/PRODUCT INSPECTIONS

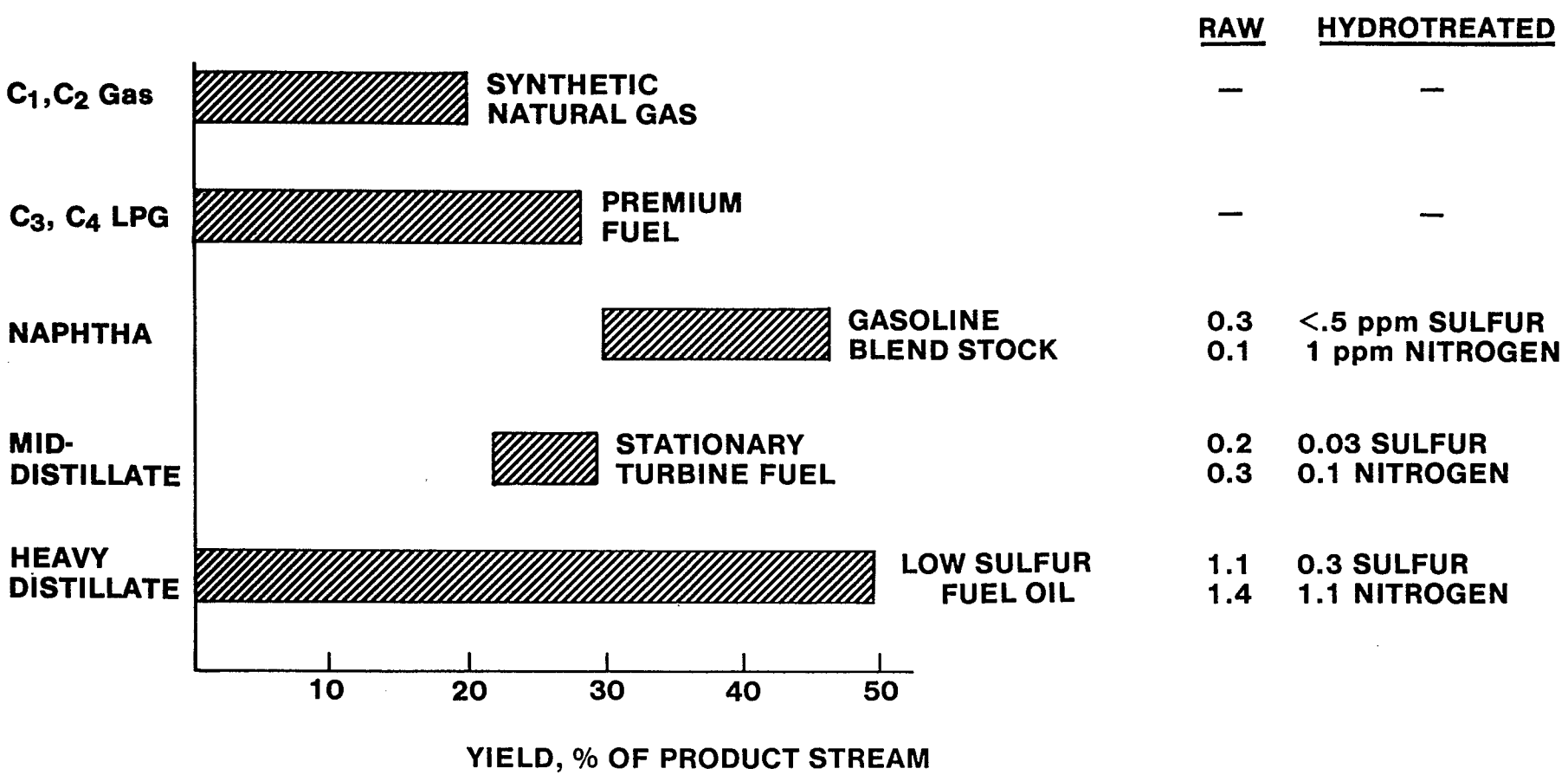


Figure 6

Figure 6

UPGRADING/UTILIZATION OF EDS PRODUCT STREAMS

STREAM	UPGRADING	UTILIZATION
NAPHTHA	HYDROTREATING REFORMING	MOGAS BLENDING
MID-DISTILLATE	HYDROTREATING	NO. 2 FUEL OIL STATIONARY TURBINE FUEL JET FUEL/DIESEL FUEL
	HYDROCRACKING	MOGAS BLENDING
VACUUM GAS OIL	HYDROTREATING	SPECIALTY FUEL OIL
	HYDROCRACKING OR HYDROTREATING/ CATALYTICCRACKING	STATIONARY TURBINE FUEL JET FUEL/DIESEL FUEL MOGAS BLENDING

Figure 7

EDS NAPHTHA
IS EXCELLENT REFORMER FEED

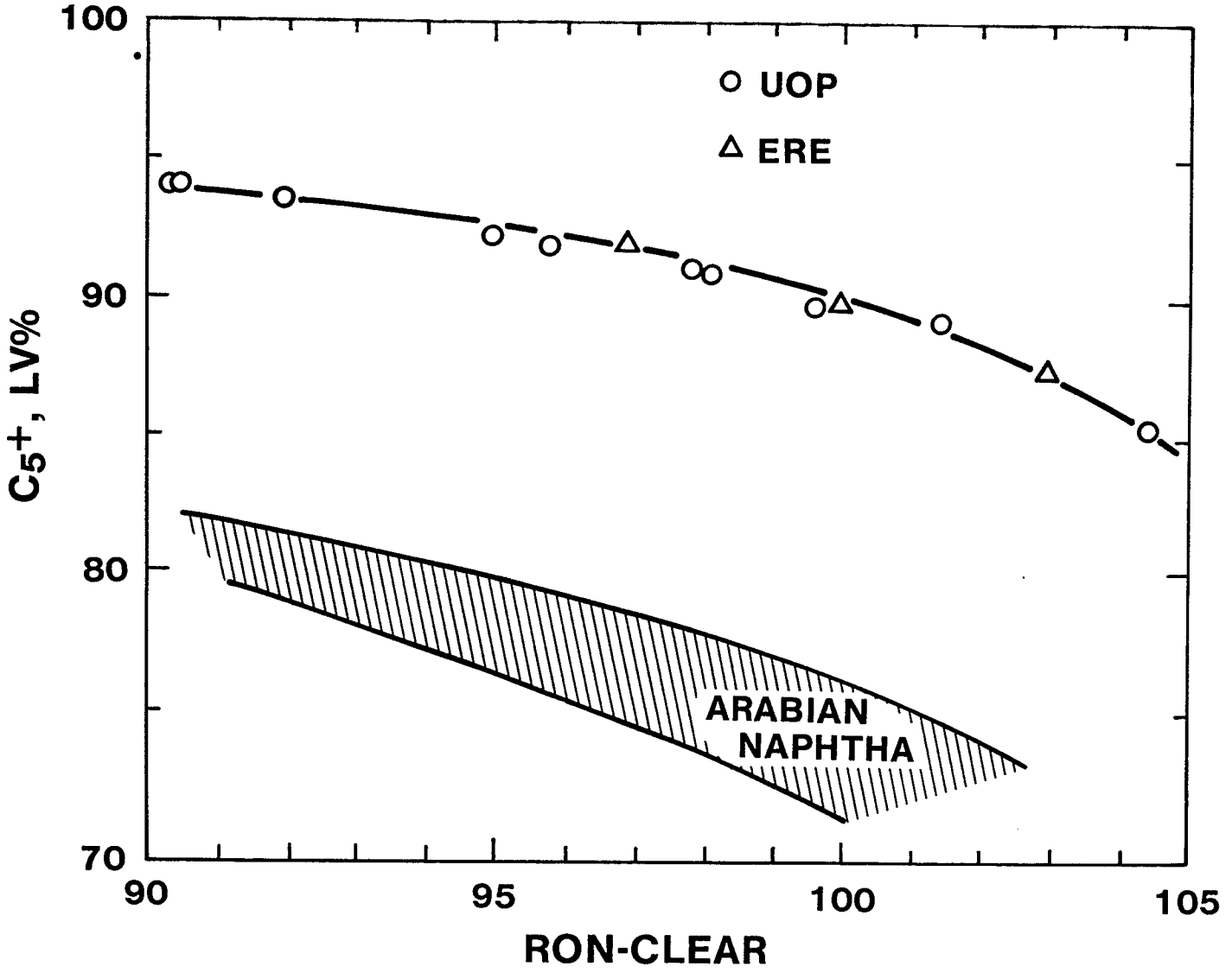


Figure 8

ANTICIPATED ENVIRONMENTAL IMPACT AREAS

SOURCE	AIR	WATER	SOLIDS DISPOSAL	NOISE	OCCUPATIONAL HEALTH
COAL FEED	X		X	X	X
PRODUCTS					X
PLANT DISCHARGES	X	X	X		

Figure 9

ENVIRONMENTAL CONTROLS DEVELOPMENT STRATEGY

- **AIR**
  - — QUANTIFY ECLP/FLEXICOKING PROTOTYPE EMISSIONS
  - — ADAPT CONTROL TECHNOLOGY FROM ELECTRIC POWER/ PETROLEUM REFINING INDUSTRY
- **WATER**
  - — CHARACTERIZE WATER FROM LARGE PILOT PLANTS
  - — SIMULATE TREATING SCHEME USING EXISTING TECHNIQUES
- **SOLIDS**
  - — PERFORM LEACHING/CHARACTERIZATION ON FLEXICOKING SOLIDS
- **NOISE**
  - — IDENTIFY/QUANTIFY SOURCES IN LARGE PILOT PLANTS
  - — ADAPT CONTROLS FROM ELECTRIC POWER/PETROLEUM REFINING
- **OCCUPATIONAL HEALTH**
  - — MONITOR WORKPLACE
  - — ASSESS ADEQUACY OF HEALTH PROGRAMS

Figure 10

EDS PROJECT SCHEDULE

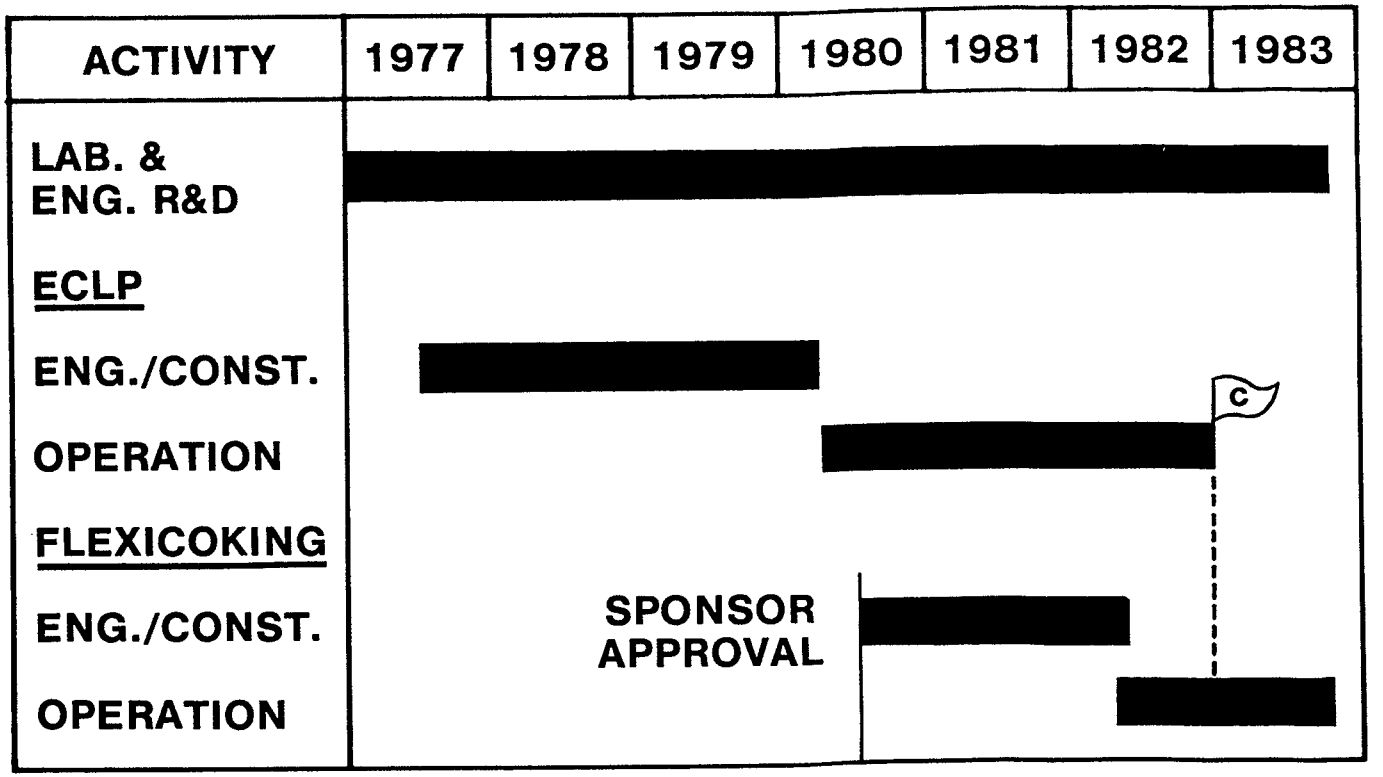


Figure 11

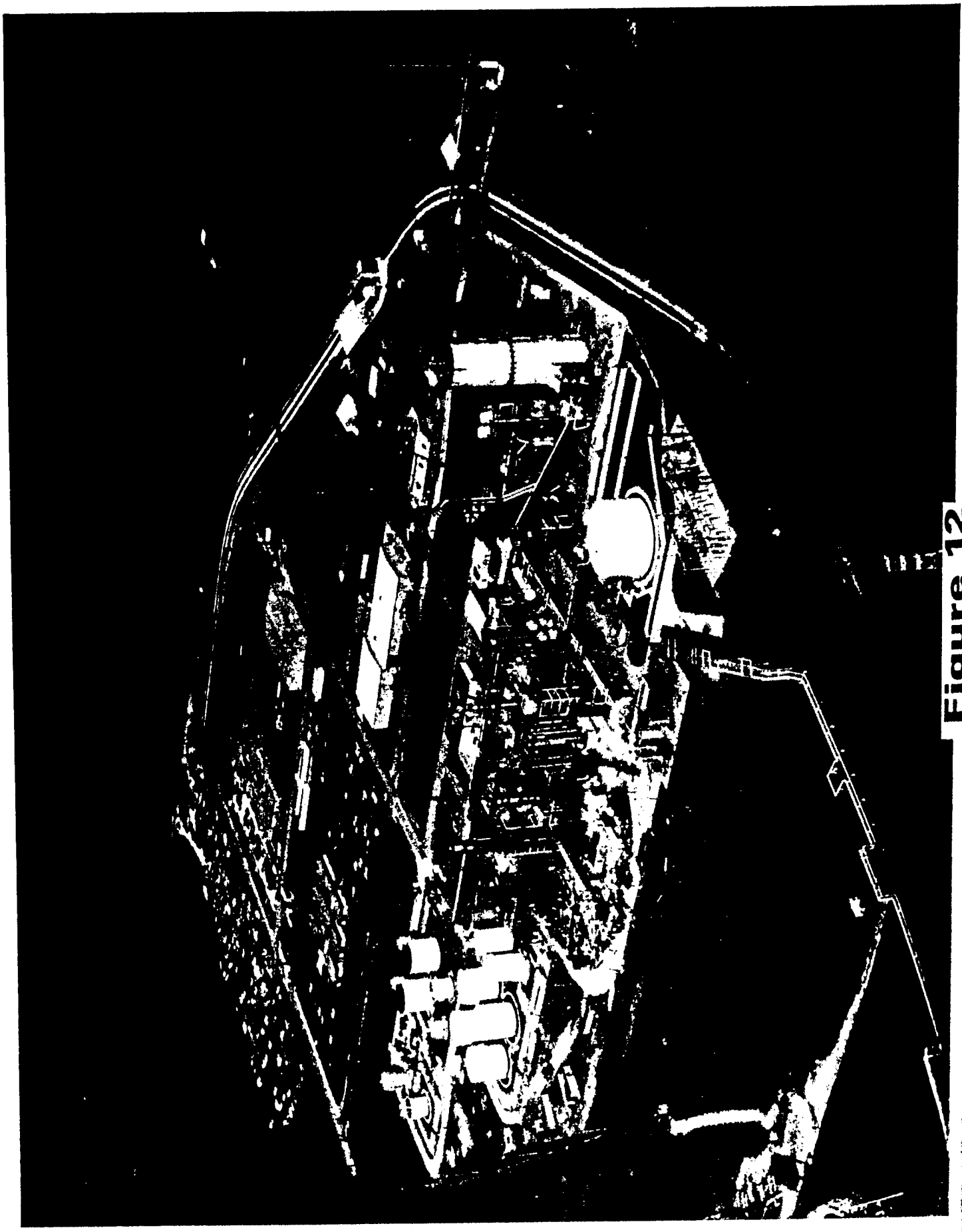


Figure 12

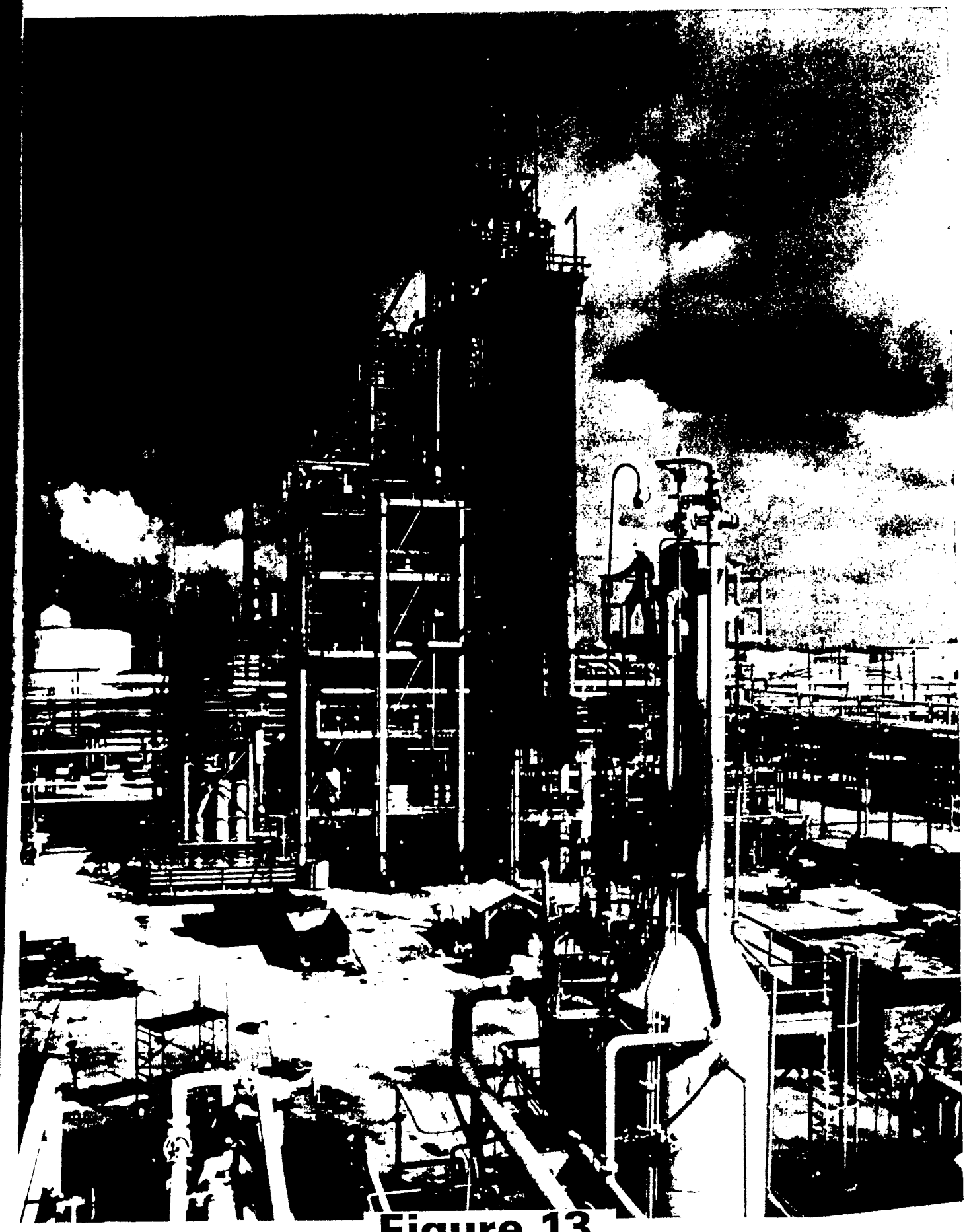


Figure 13

IMPACT OF SELECTED BASES ON REQUIRED INITIAL SELLLING PRICE (RISP)
(1985 $)

- ILLINOIS NO. 6 COAL
- 28,000 T/CD PLANT
- 3.7 BILLION $ INVESTMENT
- 48 $/B RISP ($C_3^+$ PRODUCT)

BASIS ITEM	BASE	SENSITIVITY	RISP IMPACT, $/B
• CURRENT $ DCF RETURN	15%	−5% TO +5%	−11 TO +15
• DEBT/EQUITY FINANCING	100% EQUITY	75%/25%	−12
• ITC	20%	10%	+3
• DEPRECIATION	13 YR. SYD	3 YR. STR. LINE	−2
• CAPITAL COSTS TREATED AS EXPENSE			−9
• COAL LIQUIDS TAX CREDIT	NONE	6 $/B	−5
• OPERATING COST/PRODUCTS ESCALATION	6%/6%	6%/8.7%	−11

Figure 14

CURRENT STATUS OF H-COAL® COMMERCIALIZATION

Harold H. Stotler
James B. MacArthur
Alfred G. Comolli

CURRENT STATUS OF H-COAL® COMMERCIALIZATION

Harold H. Stotler
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Alfred G. Comolli

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A B S T R A C T

H-Coal® is a direct catalytic hydroliquefaction process for converting coal into high quality, clean liquids. The process uses the commercially proven ebullating-bed reactor to achieve superior distillate yields in the range of 40 to 50 weight percent from a wide variety of coals. Having been thoroughly and successfully tested in laboratory equipment at coal capacities up to 3.5 tons per day, H-Coal is now being demonstrated in commercial-size equipment at the 600 ton-per-say pilot plant in Catlettsburg, Kentucky. Design of a commercial H-Coal plant has been initiated under sponsorship of the Department of Energy. A comparative economic study of several coal liquefaction processes prepared for the U. S. Department of Energy suggests that the H-Coal syncrude mode operation is a front-runner in terms of lowest product cost.

Continuing research and development on the H-Coal Process has led to the discovery of better catalysts, to improvements in modes of operation and has demonstrated versatility of the ebullated-bed reactor in processing various coals. The current H-Coal Development Program consists of Laboratory R&D Studies and PDU Operations; Engineering Process Development and Economic Studies; Product Testing, Upgrading, and End Use Studies; and the Large Pilot Plant Construction and Operation. It is scheduled to run through the end of 1982 and cost a total of 296 million dollars.

Initially, Dynalectron Corporation, HRI's parent company, supported the development program and, as the process advanced, funding became available through other companies. Currently, the sponsors are the U. S. Department of Energy, the Electric Power Research Institute, Ashland Oil, Inc., Standard Oil Company of Indiana, Conoco Coal Development Company, Mobil Oil Corporation, the Commonwealth of Kentucky, and Ruhrkohle, a West German coal company.

H-COAL® PROCESS DESCRIPTION

Slide 3 presents a schematic of the H-Coal® Process. Coal is crushed, dried and slurried with a process-derived oil, pumped to reactor pressure, mixed with hydrogen and fed to the reactor. There, the coal, recycle oil, and hydrogen react in the presence of a catalyst. The reactor typically operates at a temperature of about 850°F and 3000 psig pressure. Depending on the process severity selected, the net product yield can be all-distillate material, or at low severities, a distillate and a heavy fuel oil. The reactor effluent slurry is processed through hydroclones to reduce its solids content. Low solid content oil is recycled as a slurry oil for the feed coal. The balance of the liquid is fractionated to produce an all-distillate product. The vacuum residuum, containing non-distillate oils, unconverted coal, and ash, can be fed to a partial oxidation unit to produce the hydrogen for the process as shown or used for plant fuel.

Slide 4 lists some of the main features of the H-Coal Process. High yields of distilled low sulfur liquids have been demonstrated with bituminous and sub-bituminous coals and lignites. The presence of the catalyst in the coal liquefaction reactor significantly improves conversion of heavy coal liquids to distillate boiling range products. Typically 2.8 to 3.5 barrels of C_3/975°F oil is produced per ton of dry coal fed to liquefaction. The catalytic ebullating bed reactor combines coal liquefaction, solvent hydrogenation, and product upgrading in a single reactor. This reduces the number of process steps as compared to some of the other coal liquefaction technologies. This simplified flow scheme helps to reduce plant costs, increase process efficiency, and improve plant service factor.

Hydroclones are used to recover a high residuum content recycle oil (to maximize distillate liquid yields and improve unit operability) while minimizing solids recycled to the H-Coal reactor. Liquid products are recovered by conventional atmospheric and vacuum distillation.

Process hydrogen requirements can be met by Partial Oxidation of liquefaction bottoms and by Steam Reforming of light hydrocarbons produced in the H-Coal Process. Some further product upgrading is required to produce high quality transportation fuels such as gasoline, diesel, or jet fuel.

H-COAL® REACTOR DESCRIPTION

Slide 5 is a simplified sketch of the H-Coal® reactor. The reactor feed and controlling ebullating recycle stream enter the bottom of the reactor. The liquid flow causes the catalyst bed to expand and fluidize. The catalyst remains in the bed. The reactor products, including the unconverted coal and ash solids, leave the bed and are separated in a vapor-liquid separator for further processing. Because the catalyst is constantly in motion, a portion of the catalyst can be withdrawn and replaced with fresh catalyst to maintain high catalyst activity. On a daily basis, about one percent of the catalyst inventory is removed for this purpose. The ebullating-bed reactor system has over 27 unit years of commercial operations in our H-Oil® petroleum residuum hydroconversion process. The current H-Coal catalyst has also been demonstrated commercially in H-Oil operations.

The ebullated bed reactor allows intimate contact between catalyst particles, hydrogen, and the coal-oil slurry and thus achieves essentially isothermal reaction conditions and provides low and constant reactor differential pressure. Other major advantages of the H-Coal reactor system are:

- High liquid yields and qualities are achieved in the presence of a synthetic catalyst and are not dependent on the catalytic effect of coal ash.
- Continuous catalyst replacement controls deactivation, provides constant product quality, allows the possibility of continuous catalyst regeneration, and provides for high unit service factors.
- Operating conditions can be varied to meet flexible product slate requirements.
- Direct catalytic hydrogenation of coal offers the potential for use of different and improved catalysts in the future as product requirements.
- The ebullated bed assures good temperature control throughout the reactor, using the energy of the reaction to heat the feed slurry to reaction temperatures.

H-COAL PERFORMANCE

Hydrocarbon Research has experience with a large number of coal feeds over a wide range of operating conditions. Slide 6 presents a summary of some of the coals run in the H-Coal Process. The Eastern U. S. coals processed include Illinois No. 6, Indiana 5, Kentucky 9, 11, and 14, and Pittsburgh seam coal, all of which are bituminous coals.

The Western U. S. coals include both bituminous and sub-bituminous coals. Of these coals our experience is most extensive with Wyodak coal. This coal has presented difficulties to other direct coal liquefaction processes due to the formation of calcium carbonate deposits in the liquefaction reactor. This has not been a problem in our well-mixed catalytic H-Coal reactor system. High liquid yields and excellent operability have been demonstrated.

Lignites have been successfully processed as have the Australian Brown coal and German "Steinkohle".

Slide 7 summarizes some typical H-Coal yields on the basis of pounds per 100 pounds of dry coal. The first two columns compare yields from an Illinois No. 6 coal for two different modes of operation, the Syncrude and the Fuel Oil modes. In the Syncrude mode, high yields of distillate liquids are achieved, in this case 47.8 wt% C_4/975°F liquid products. The yield of bottoms material is adequate to meet hydrogen requirements if they are processed in partial oxidation to product hydrogen.

In the Fuel Oil mode, operating conditions are less severe to produce a heavier product slate. The heavy fuel oil is recovered using a solids-liquid separation technique such as the Lummus Anti-Solvent Deashing or Kerr-McGee Critical Silvent Deashing process. Hydrogen consumption is also much lower than in the Syncrude mode. Other product slates intermediate to those presented may be produced to meet the particular market needs.

The third column shows yields achieved from Wyoming subbituminous coal in the Syncrude mode. The hydrogen consumption for this case was higher than the Illinois coal due to the increased yield of water with this high oxygen content coal. Distillate liquid (C_4/975°F) yields of 44.4 weight percent are achieved. Less severe conditions again could be utilized to obtain a heavier product slate and lower hydrogen requirements.

Some typical H-Coal liquid product qualities are presented in Slide 8. The analyses are for coal liquids produced from Illinois coal and Wyoming coal in the Syncrude operating mode. These qualities were achieved at lined out operating conditions on HRI's 3.5 T/D Process Development Unit during the current H-Coal process development program. Note that these H-Coal liquids are very low in sulfur compared to typical petroleum fractions. The oxygen and nitrogen contents, however, are higher. Unlike petroleum crudes and products from some other direct coal liquefaction technologies, no residual oil products (975°F Plus Boiling Range)

are produced.

The coal liquids produced in the H-Coal process may require some further upgrading prior to their ultimate utilization. The naphtha cut requires hydrotreating to remove sulfur, nitrogen and oxygen contaminants. The hydrotreated naphtha then makes an excellent quality feedstock for catalytic reforming to produce a high octane gasoline blend stock. The reformate can also be used for production of chemicals such as benzene, toluene and xylenes.

The mid-distillate material can be used as home heating oil, diesel fuel, jet fuel, or turbine fuel after some mild to severe hydrotreating. The heavy fuel oil material can be used directly as boiler fuel or may be upgraded to meet specific customer requirements. Extensive upgrading and end-use testing has been carried out and more is planned as part of the current H-Coal Large Pilot Plant project.

H-COAL PROCESS DEVELOPMENT UNIT EXPERIENCE

The H-Coal Process Development Unit (PDU) has been operated intermittently over the last 14 years to demonstrate scaleup of yield data, to demonstrate equipment operability, and to obtain products for downstream testing. Nine PDU runs, typically of about 30 days duration, have been carried out under the current H-Coal development program and some of the major accomplishments are summarized below.

- Illinois No. 6, Kentucky No. 11 and Wyodak coals successfully processed.
- Equilibrium catalyst conditions simulated using continuous catalyst addition and withdrawal.
- Syncrude, Fuel Oil and Intermediate Modes of Operation Demonstrated.
- Emergency operating procedures for Pilot Plant were tested while providing operator training.
- Critical operating limits such as maximum gas velocity were evaluated.
- Two-stage slurry letdown system designed for Pilot Plant demonstrated.
- Irradiated catalyst used to test ebullated-bed mixing and catalyst deactivation.
- Demonstration run on Illinois No. 6 coal used as basis for Ashland Oil Commercial Plant.

The PDU is scheduled for further use to demonstrate process improvements coming out of the ongoing R&D program and for demonstration runs on projected commercial coals. It is currently in operation with Wyodak coal to demonstrate H-Coal Performance with an approved catalyst.

LARGE PILOT PLANT PROJECT

This plant is the largest Coal Liquefaction Pilot Plant ever built in the U. S. It is designed to feed up to 600 tons of coal per day to produce up to 1800 barrels per day of liquid product. Ashland Oil is responsible for Pilot Plant operations.

The H-Coal Process has been thoroughly tested on bench and PDU-size equipment and is now demonstrated in commercial-size equipment at the Catlettsburg Pilot Plant. The Pilot Plant has several major objectives which are not obtainable on laboratory-scale equipment. These objectives include:

- Demonstrate of the mechanical operability and reliability of commercial scale equipment.
- To provide products for commercial testing at rates of 100 to 300 tons per day.
- Verify yields in commercial size equipment.
- Collect scale-up and engineering data.
- Determine appropriate materials of construction.
- Establish maintenance requirements for key items of equipment.

Two operating configurations have been designed into the plant, and a two-year demonstration program is planned, encompassing syncrude and boiler-fuel mode operations and using three differenct coals. Plans for the first year include syncrude operations with Kentucky No. 11 and Illinois No. 6 coals. The schedule for the second year calls for boiler fuel operations with those two coals and a return to the syncrude mode using Wyodak coal.

Startup operations are currently underway. The H-Coal Section has been pressure tested, the catalyst loaded and processing of residual fuel oil completed. The coal has been crushed to size and was introduced into the H-Coal reaction section at the end of May, 1980. Break-in operations are with Kentucky #11 coal at a feed rate of 220 tons per day in the syncrude operating mode. Process-wise, the operation has been extremely stable with coal slurry mixing, pumping and preheating performing smoothly in the H-Coal reaction exhibiting excellent stability and achieving high coal conversion. The unit has also experienced some initial startup problems.

These have included wear problems with the reactor effluent slurry let-down valves as well as non-process related problems including power failures and leaks in the Dowtherm system.

The H-Coal Pilot Plant is currently operating at target conditions while the data collection and various test programs are underway.

DEVELOPMENT PLAN FOR COMMERCIALIZATION

The development path for commercialization of H-Coal is similar to that used by HRI for scale-up of the commercial H-Oil® residuum and heavy crude hydroconversion process. The H-Oil Reactor system was scaled-up from the bench, through the PDU, followed by a large Pilot Plant demonstration unit and finally to the commercial scale plant. The reactor diameters are shown below.

	H-Oil Reactor Diameter	H-Coal Reactor Diameter
Bench Unit	3/4"	3/4"
Process Development Unit	8-1/2"	6 & 8-1/2"
Large Pilot Plant	4'6"	5'
Commercial Plant	13'	10-13'

Likewise, the H-Coal commercialization steps follow the same reactor scaleup criteria. The 5 foot diameter H-Coal reactor is currently in operation at Catlettsburg while the commercial-scale reactors are being designed as part of the Phase Zero H-Coal Commercial Plant Project. An H-Coal commercial plant would have several reactors in parallel, depending on the economy of scale desired by the operator and the availability of capital. In terms of the individual reactor train, the commercial scale reactor would have about ten times the throughput as the Catlettsburg Pilot Plant with a diameter scaleup of 2 to 3 times.

The Department of Energy has authorized work to begin on the design of a commercial scale H-Coal liquefaction plant. This plant is to be located in Breckinridge County, Kentucky and will be designed to feed about 23,000 tons per day of run-of-mine Illinois #6 coal to produce a nominal 50,000 B/D of Hydrocarbon liquid products and about 30 MSCF/D of SNG. The Phase Zero program includes:

- Commercial Plant Design
- Cost Estimate & Economic Evaluation
- Detailed Plans for Construction & Operation

Phase Zero is a 9 million dollar cooperative effort between DOE, Ashland Oil, and AIRCO extending through April, 1981. The schedule calls for follow-on phases for detailed engineering, procurement, and Construction leading to startup of the commercial plant about mid 1986. HRI is currently involved in feasibility studies for other commercial H-Coal liquefaction facilities.

FUTURE PROSPECTS FOR H-COAL

The cost of coal liquids by direct hydroliquefaction is generally considered to fall in the range of 25 to 45 $/B (1979 $). The wide range of cost estimates derives from the great variations in basic assumptions made and level of detail incorporated in the calculations. These costs are presently about equal to the average cost of importing oil at OPEC prices. In addition, the balance-of-payments and security-of-supply issues have led the U. S. Government to act further to stimulate commercialization of a coal liquids industry.

In part because of the wide variation in product costs calculated for coal liquefaction, comparisons of the various processes are difficult to make, and infrequently reported. One such comparison, though, was made in July, 1979, by the Engineering Societies Commission on Energy (ESCOE), under Department of Energy Contract No. EF-77-C-01-2468. Product costs estimated by ESCOE are summarized for various coal liquefaction processes. These costs are calculated by two alternate methods. The first column lists costs of producing coal liquids for the various technologies on an energy basis in terms of dollars per million BTU's of energy produced. Since different products and product qualities are produced from each process, it is necessary to adjust the product costs to reflect the value of the products in the market place. In the second column, the individual products are assigned value factors, based on current market price relationships. These factors provide a basis for determining an effective cost for the multi-product slate, to simulate the cost incurred if all products were transformed to gasoline product.

The H-Coal syncrude mode appears to produce products at the lowest estimated cost for all processes reported by ESCOE. While these data are not conclusive, H-Coal would appear to be a front-runner in terms of lowest-cost product. Low costs for H-Coal reflect the superior liquid yields demonstrated in the development to date. Combined with the inherent flexibility of a direct-catalytic process, and the proven capability to handle a full range of coal types, this economic assessment suggests a bright future indeed for the H-Coal Process.

SLIDE 1

BACKGROUND OF THE H-COAL PROCESS

- H-COAL® IS A PATENTED CATALYTIC HYDROLIQUEFACTION PROCESS DEVELOPED BY HRI.
- THE PROCESS PRODUCES C4-975°F DISTILLATES IN THE RANGE OF 40-50 W % OF FEED COAL.
- MORE THAN 15 YEARS OF DEVELOPMENT
- OVER 54,000 HOURS OF OPERATION IN BENCH-SCALE AND PROCESS DEVELOPMENT UNITS
- BENCH SCALE OPERATIONS
  - PROCESS OPTIMIZATION
  - CATALYST EVALUATION
  - NEW COAL EVALUATION
- PDU OPERATIONS
  - CONFIRM DESIGN BASIS
- THE FEASIBILITY OF THIS PROCESS WILL BE DEMONSTRATED IN A 600 T/D PILOT PLANT IN CATLETTSBURG, KENTUCKY

SLIDE 2

H-COAL LARGE PILOT PLANT PROJECT

DEVELOPMENT PROGRAM

- LABORATORY R&D STUDIES AND PDU OPERATIONS
- ENGINEERING PROCESS DEVELOPMENT AND ECONOMICS STUDIES
- PRODUCT TESTING, UPGRADING AND END USE STUDIES
- LARGE PILOT PLANT CONSTRUCTION AND OPERATION

SCHEDULE AND COST

1974 THROUGH 1982

$ 296 MILLION

CURRENTLY SPONSORED BY

U. S. DEPARTMENT OF ENERGY

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RUHRKOHLE AG

H-COAL® PROCESS