10--GOVERNMENT POLICIES TO ENCOURAGE THE PRODUCTION OF SYNTHETIC LIQUID FUELS

By Ernest C. Harvey

A. Introduction

In the past, various government policies have been adopted to encourage investment in specific industries, to protect industries from foreign competition or domestic overproduction, and to generate rapid increases in the output of particular products. Measures such as investment incentives provided through the tax structure, price support formulas, import quotas or tariffs, and investment grants or loans have been employed. At the time it was initiated, each of these policies was regarded as appropriate for the industry for which it was adopted. Whether any of these or other policies would be appropriate for a synthetic liquid fuels industry, or would be regarded by the Administration or Congress as politically feasible, depends on the specifics of national energy policy, on the contribution that might be made by this industry to the objectives of this policy, and on the cost to the public of achieving this contribution--not only in dollars but in environmental degradation, disruption of local economies, and other costs.

To assess alternative policies in this context, it is necessary first to examine the characteristics of this industry and to identify the principal features of a policy that could be expected to stimulate the commercialization of synthetic liquid fuels. Industry characteristics have been described in detail in other chapters, as well as the factors that would affect the decisions of private sector companies to commit resouces to the production of synthetic liquid fuels. These characteristics and factors are summarized and policy requirements are identified in the next section. The principal policy mechanisms that might be considered are examined in the following sections along with the assessment of their applicability to synthetic fuels.

B. Required Features of Federal Policy

There are two principal characteristics of a new synthetic liquid fuels industry that would influence both business decisions to commit resources to the industry and government decisions to provide incentives or other support:

- Large investment relative to output.
- High level of uncertainty regarding major factors that determine potential profitability.

Investment costs of producing synthetic liquid fuels have escalated rapidly in the last few years. For this analysis it is accurate enough to know that investment would be in the neighborhood of $1.0 billion (1973 dollars) for an output of 100,000 B/D.* As has been pointed out in other chapters, this is a very large investment even for large companies, an investment with none of the exit points that exist for exploration and development activities and involving techniques with which oil companies are not familiar.

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*Colony Development Operation is currently estimating more than $800 million for a 50,000-B/D (8,000 m^3/D) oil shale facility; other companies are hesitant to make any firm estimate. The exception seems to be Occidental's in situ oil shale process, which is expected to require about $100 million investment for a 50,000-B/D output. Industry experts are skeptical at this point about Occidental's estimates.

The uncertainty is not limited to investment requirements. There are sharp differences between the Administration and the Congress on the specifics of a federal energy policy, and the future world price of oil is highly uncertain in view of the apparent instability of OPEC and the large discoveries that have been made around the world.

It is clear that the commercial production of syncrude is a high-risk venture* and that the short-term contribution to domestic self-sufficiency in crude production would be negligible. Without some form of federal incentive, it is unlikely that investments of the size required to achieve significant output will be made by the private sector, particularly if relatively high rates of inflation persist. It is also unlikely that the federal government will consider costly incentive programs unless they can be relied on to significantly reduce the nation's dependence on foreign sources of oil.

Under these circumstances the most appropriate federal policy would appear to be one that limited itself to determining, and, to the extent possible, reducing, the costs of commercialization of synthetic liquid fuel production. The time required to accomplish this would permit more careful analysis of energy demand/supply prospects and development of energy policy guidelines within which a longer-term incentive program for synthetic fuels could be established.

C. Incentive Policy Options

For purposes of analysis, incentive policies can be grouped into several categories that reflect increasing levels of government involvement:

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*With the possible exception of Occidental's _in situ_ oil shale process and a proposed venture by Superior Oil Company that includes recovering nahcolite and dawsonite along with kerogen from the oil shale.

- Removal of constraints
- Tax incentives
- General price supports
- Specific price supports
- Government participation in investment.

These incentives are discussed briefly below, with comments regarding their applicability to synthetic liquid fuels.

1. Removal of Constraints

In a study of incentives recently completed by the National Science Foundation (NSF) and the Federal Energy Administration (FEA) 23 companies were asked if the removal of a number of constraints would constitute an incentive.[1] The constraints related primarily to the lack of a firm government policy with respect to independence from foreign sources of oil and to the current "excessive" government involvement in the energy market.

There was a consensus that a comprehensive national energy policy should encompass policy decisions in a variety of areas, provide for improved coordination among the many government agencies involved in regulation or approval of synthetic fuels development, and incorporate a commitment that these policies will remain in effect at least through 1990. The areas most in need of firm policy determination were listed as availability of federal land (on which most of the best oil shale is located) and clarification of environmental regulations.

In view of the controversial nature of these and other identified policy areas, it is unlikely that such a comprehensive energy policy will be developed in the near future. It is also unlikely, given the short-term perspective of most members of Congress, that the type of commitment felt to be necessary will, in fact, be made.

With respect to government involvement in the market, the major constraints are price controls on crude oil and regulation of the price of natural gas. Although the Administration favors removal of these constraints, Congress is reluctant to do so; proposals have, in fact, been made to roll back the price of old oil and place a ceiling on the price of new and released oil. However, respondents to the NSF/FEA survey were not consistent: although they called for a free market, they gave high priority to guaranteed procurement of synthetic liquid fuels and to loan guarantees and direct grants.

It was the conclusion of the NSF/FEA study that removal of constraints, although important, would not be sufficient to ensure commercialization of synthetic liquid fuels production. The key to such development is the assurance of profitability. Current statements by the industry, as reported in trade journals, recognize the importance of uncertainties surrounding government policy but also place major emphasis on cost and the uncertain future course of crude oil prices as major deterrents to commercialization.

2. Tax Incentives

Historically, a variety of tax incentives has been used to stimulate investment generally or in specific industries. Investment tax credits and rapid write-off provisions have been offered; minerals industries are allowed depletion allowances and the timber industry is accorded capital gains treatment. These policies are effective only where profitability can be assumed, even if it is marginal. The objective in such cases is to raise potential profitability of the activity receiving special treatment to a level that would make it competitive with alternative uses of funds, without recourse to a direct, overt subsidy.

An investment tax credit was given relatively high priority by respondents to the NSF/FEA survey, ranking 9th out of 45. However, most of the companies surveyed indicated that a credit significantly greater than that suggested (7-10 percent) would be required--perhaps as large as 50 percent--although it was recognized by many that credits in excess of 10 percent probably would not be politically acceptable. A tax credit of 7 percent was available for new investment at the time of the survey. This had been increased to 10 percent under the new tax law. Therefore, the 7-10 percent range for synthetic fuels investment does not constitute a special incentive.

In practice, the effectiveness of a tax credit of a given size will vary with the characteristics of the companies considering synthetic liquid fuels production and the specific application of the credit. If the credit is applicable only to synthetic fuels production it will not constitute an incentive unless there is reasonable assurance of profitability. If it is not restricted in application, considerations include the cash flow and profitability implications of initiating synthetic fuels production and taking advantage of the credit relative to other investment alternatives.

It should be pointed out that current congressional sentiment is to eliminate special tax "privileges." The oil depletion allowance has already been eliminated and elimination of other special tax provisions has been discussed. It seems clear that if production of synthetic liquid fuels were determined to be required in the national interest Congress would prefer to direct subsidy rather than the indirect and somewhat uncertain route of tax incentives. Congress has already expressed concern about the profits of oil companies, which are prime candidates for development of synthetic liquid fuels production, has taken action to constrain these profits by removing the depletion allowance and retaining controls on crude oil prices, and has considered an excess profits tax. A new tax incentive is unlikely.

3. General Price Support

Price support programs of various types have been used in agriculture for years. The general approach was to set floor prices for the various farm crops. At harvest time farmers could store their crops and receive payment, on a loan basis, at the support price. If the market price rose above that level he could sell the crop and repay the loan; if it declined title passed to the Commodity Credit Corporation. The Sugar Act provided for maintenance of the domestic sugar price by limiting imports of foreign sugar by means of a quota system. Crude oil and petroleum products received similar support before March 1973. Imports were restricted through quotas and duties,* which made possible the continued existence of a relatively high-cost domestic oil industry.

Programs of this type are effective in large-output situations in which the problem is one of overproduction relative to market demand. In agricultural price supports, acreage limitations were also imposed to restrict output and reduce the downward pressure on prices. The objective is to maintain the market price at a level sufficient to ensure reasonable profitability. However, such a program would not be applicable to synthetic liquid fuels because, at least in the near and medium term, the output would not be large enough to affect the price of crude oil. Other measures, such as restrictions on imports, would be required to force up the price of conventional crude to the level required to

*Imports of No. 4 distillate and residual fuel oil into the East Coast were exempt from quota.

make synthetic fuels profitable. Largely because of consumer pressure, Congress has not accepted Administration proposals to free the price of old oil, and as stated earlier, it is considering a rollback of the old oil price and a ceiling on the price of new and released oil. Therefore, Congress is not likely to support a program that would induce significantly higher price increases, with its potential impact on the rate of inflation and on profits of the oil companies.

The general price-support approach could, of course, be used to provide a price guarantee to producers of synthetic liquid fuels, recognizing that, for the foreseeable future, the government would have to assume title to the output and sell it at a loss. This program would become a specific price support program; such programs are discussed in the next section.

4. Specific Price Supports

Several types of specific price support have been suggested and are under study by FEA. These include government procurement at cost plus a fixed fee, at a fixed price, or under a contractual arrangement with adjustments for inflation. Another mechanism, which is not technically a price support but which is similar in effect, is the payment of direct subsidies to producers of synthetic fuels.

Each of these proposals would require industry to provide the necessary capital funds unless capital expenditures were also subsidized. Rate of return on these funds would depend on the fee or fixed price negotiated or on the level of the subsidy provided. The cost plus fixed-fee arrangement would probably be the fastest way to achieve commercialization unless the rate of return implied by the negotiated fee were perceived to be less than could be obtained from other uses of funds. Furthermore, this approach would provide no incentive for efficiency unless provision were made for renegotiation of the fee upward to reflect substantial reductions in cost.

Although the fixed-price and contractual approaches would tend to encourage efficiency, many of the uncertainties--e.g., future world crude prices and government import and tariff policies--that have prevented commercialization to date would remain. The negotiated price would have to include a substantial allowance for these uncertainties to ensure even a reasonable prospect of profitability, even if provision were made for inflationary adjustments. If the negotiated price were high enough the impact on efficiency might be minimal, but, if it were significant, it would probably generate government pressure for renegotiation.

A direct subsidy would contain elements of several of the above approaches. It could be a fixed amount negotiated in advance or an amount sufficient to cover the excess of costs over revenues, with or without allowance for profits. Advantages and disadvantages similar to those indicated above apply, depending on specifics.

Any of these schemes could be handled on a levy/subsidy basis. An extra tax collected on gasoline could be distributed to synthetic crude producers to reduce the sales price of syncrude to the market level. The amount required would depend on government policy with respect to the pricing of domestic oil and the levying of tariffs on imported oil and on the future world price of oil. However, as long as the supplies of syncrude remained small, a relatively small tax would be sufficient. Presumably, a large increase in the proportion of syncrude produced would be accompanied by, and would indeed be conditional on reductions in its relative cost of production. In that event, the levy/subsidy arrangement could be adapted without undue hardship to the consumer to accommodate a proportion of the order of 10 percent of total supplies in the form of syncrude.

An alternative to a levy/subsidy mechanism would be to allocate a proportion of any extra costs entailed in the production of syncrude to each refiner in proportion to output. This type of approach is currently employed in the oil "entitlements" program to eliminate disparities in cost among companies with varying proportions of old oil, new and released oil, and imported oil in their refinery mixes. Its application to syncrude production, given its administrative complexity and the small quantities involved initially, does not seem appropriate in the short run.

There has been no discussion in recent articles in trade magazines of the mechanics and cost of marketing syncrude. Incentive programs entailing government purchase would presumably leave the marketing function to the government; either party could be responsible under a direct subsidy program. So long as the output remained small, marketing should not present serious problems. However, if relatively large quantities of syncrude were produced ultimately, substantial investment in new pipeline links would almost certainly be required. More generally, to the extent that syncrude replaces imports (which would be the logical limit on making it, unless and until it becomes cheaper than conventional crude) it will be necessary to contemplate adding to the pipeline network sufficient capacity to transport it where it is needed for refining. If syncrude served as a replacement for imports, one important destination would be the northeastern states that presently have about a million barrels a day of refinery capacity supplied by imports, but no crude pipelines other than one from Portland, Maine, to Montreal. This problem of transportation should be carefully evaluated before an incentive policy contemplating a significant long-run expansion of syncrude production is formulated.

5. Government Participation in Investment

The government can stimulate the development of specific industries by participating in investment in varying degrees. The most direct participation in investment is government ownership of industrial plants. The government can participate to a lesser extent by sharing investment costs with private enterprise or by guaranteeing private loans.

a. Government Ownership

Under a program of direct government ownership of industrial plants, the plants are constructed and operated by private enterprise under contracts with the federal government. After the development of the industry or, as the national need for the industrial output decreases, private firms would have the option of leasing or purchasing the facilities.

This approach to the rapid development of an urgently required industry is illustrated by the U.S. synthetic rubber industry in World War II. The rapid Japanese advance early in 1942 cut off the greater part of Allied supplies of natural rubber. Over the next two and a half years, to late 1944, 51 plants for producing various types of synthetic rubber and their ingredients from petroleum were built in the United States. The capital cost, some $600 million, was funded by the federal government; running costs and profits of sales were for government account. The plants were run by large private firms (because large firms alone possessed the necessary technical knowledge) on a fee basis which was, in effect, a substitute for profits. Of course, in war time there was a ready market for all the synthetic rubber that could be produced; indeed, the United Kingdom, which had agreed to take rubber from the United States rather than produce it for itself, remained somewhat short of supplies.[2]

After the war, 22 of the synthetic rubber plants were disposed of in fairly short order, but the others remained in federal ownership. A market for synthetic rubber was assured by regulating by law the amount of natural rubber that might be used in various finished goods. As time went on, and the quality of the synthetic rubber improved, manufacturers became willing to take more than was legally obligatory, and in 1953 the obligation was ended. In the same year an act was passed (P.L. 205, 83rd Congress, 1st Session, Chapter 338) establishing a Disposal Commission to sell off the remaining 29 rubber-producing facilities, and by the middle of 1955 this process was virtually complete. The plants were disposed of mainly by sale to the companies that were operating them on behalf of the government, although there were one or two exceptions, and one or two unsalable plants that had to be put on a care and maintenance basis. Particular care was taken to ensure that the purchasers would reserve part of their production for small business. The proceeds of the sales realized the federal government more, on paper, than the cost of building the facilities in the first place (if no allowance is made for the fall in the value of the dollar between 1942 and 1955). The day-to-day conduct of the businesses was also profitable.

Aluminum is another example of this approach. During World War II, the output of aluminum was greatly enlarged through the mechanism of government-owned plants constructed and operated by private enterprise under contracts with the U.S. Reconstruction Finance Corporation. At the end of the war, aluminum production was sharply curtailed and uneconomically located capacity was retired. Government aluminum plants were declared surplus for lease or sale. The lease or sale program was designed to dispose of facilities to producers other than Alcoa, which until 1940 was the sole producer of aluminum in the U.S. and had been subject to antitrust action.

However, the analogy between either synthetic rubber or aluminum and any prospective synthetic liquid fuel is not close. Both rubber and aluminum were required urgently for wartime needs in large quantities; the raw material was plentiful, and the technology was known. By contrast, synthetic crude would be a marginal addition to total energy supplies at best for many years, if only because of actual availability of the raw material, be it coal or shale.* Moreover, the investment required per unit of output is many times greater than that required for synthetic rubber or aluminum. The approach used in synthetic rubber to assure a market after World War II could be applied to synthetic crude, either by requiring acceptance of syncrude or purchase of an entitlement. However, this procedure does not seem justified, given its administrative complexities and the relatively small syncrude output involved in the near term.

b. Grants-in-Aid

The government could participate in investment to a lesser extent than in either synthetic rubber or aluminum by sharing, on a grant basis, the investment costs with private enterprise. Direct or convertible grants, if they are large enough, and if they can be used, in effect, to offset costs in excess of market price, might provide the necessary incentive for commercialization of synthetic fuels production.

*These limitations are most likely to arise from environmental restrictions; from shortages of labor and transport facilities; from demand for more urgent needs, such as electricity generation; and from political opposition in the western states.

However, this indirect approach to subsidy has political drawbacks and would require extensive government surveillance; furthermore, under this arrangement, it would be difficult to assess the potential for production of syncrude on a private enterprise basis.

c. Loan Guarantees

A third way the government can participate in investment is through loan guarantees, which could be provided for some percentage of the required amount. Unlike the other types of participation, a loan program does not require a direct commitment of federal funds; federal funds are only committed in the event of default on the loans. Although loan guarantees are not direct government investments, they do allow the private market to invest under conditions of risk and uncertainty. Such guarantees have been used to stimulate home, farm, and small business loans. There is usually a limit on the rate of interest, and in times of tight money the margin to lenders is not particularly attractive. Furthermore, unless there is a 100 percent guarantee, the lender must assume a portion of the risk and in any event he is usually required to exercise prudent lending practices. In addition, the reporting and paperwork required under these programs is regarded by many as inordinate. The specific requirements of a loan guarantee program established for synthetic crude production, therefore, would govern its acceptability to lenders. However, given the current level of uncertainty, such a program is unlikely to provide sufficient incentive to potential procedures of syncrude to stimulate commercialization of synthetic fuels production.

There have been two recent proposals for government action to stimulate the development of a synthetic fuels industry. The first is a loan guarantee program applicable only to the development of a synthetic fuels industry. The second is contained in a broader program designed to supplement and encourage private capital investment to meet the energy needs of the nation.

The Senate version of the ERDA Authorization Bill (HR3474) included a $6 billion loan guarantee program for the development of a 350,000 B/D (56,000 m^3/D) synthetic fuels industry. Since the addition of this provision, ERDA has requested an additional $5.5 billion: $600 million for plant construction; $4.5 billion for price supports; and $400 million for loan guarantees to communities that would have to cope with the new industry.

Legislation creating an Energy Independence Agency (EIA) was submitted to Congress by the President in October 1975. The EIA, which will have a 10-year life, would have financial resources of $100 billion, consisting of $25 billion of equity and $75 billion of debt. Financial outlays are intended to be recovered by the government and would be used to support projects that would contribute directly and significantly to energy independence and that would not be financed without government assistance. Financing could take a variety of forms including direct loans, loan guarantees, guarantees of price, purchase and leaseback of facilities, and purchase of convertible or equity securities. Emphasis would be placed on loans and loan guarantees, and government ownership is authorized only for limited periods and under specified conditions.

These proposals indicate an awareness, at least on the part of the Administration, that significant investment in synthetic fuels is unlikely in the near term without government assistance. However, there appears to be little support for these programs on the part of many legislators and industry spokesmen. There is considerable controversy concerning the size, scope, and timing of a synthetic fuels program, which is itself part of the larger controversy regarding a national energy policy. Any decision with respect to financial involvement by the government must await resolution of these controversies.

D. Conclusions

The combination of high cost seemingly irremedial uncertainty make synthetic fuels investment unsuitable for private business. If synthetic fuels are to be produced in significant amounts in the near future, government assistance will probably be necessary. There is considerable disagreement among Congress, the President and industry regarding the degree of government participation in the synthetic fuels industry. Even if a variety of inducements could be provided, it is not clear whether private investment could be attracted, especially since most inducements are subject to considerable uncertainty in that they can be modified or eliminated at short notice. The need for long-term commitment to firm energy policies was emphasized by respondents to the NSF/FEA study. Such commitment would be particularly important for synthetic liquid fuels production because of the large investment requirements and uncertain future market. However, by its very nature, Congress cannot commit itself to firm, long-term policies, and its record with "long-term" policies in the past does not instill confidence.

If the government decides that development on a commercial scale is desirable, it would seem appropriate for it to finance a commercial plant or plants. The government has already become heavily involved in the financing of a demonstration plant under the terms of a contract between the Energy Research and Development Administration (ERDA) and Coalcon*

*Coalcon is a joint venture formed by Union Carbide and Chemical Construction and has recruited members of a consortium being formed to build and operate the demonstration plant.

of New York. The initial funding for plant design and engineering will be provided by the government and costs of construction, evaluation, and operation will be shared equally by the government and industry. Total government funding will be $137 million, and the private sector will contribute $100 million. The plant is expected to be operating by 1983 and will convert 2600 tons/day (2.4×10^6 kg/D) of coal into 3900 B/D (4100 m^3/D) of liquid product and 22 million cubic ft (620,000 m^3/D) of pipeline-quality gas per day.* This plant is very small compared with the sizes considered suitable for commercialization elsewhere in this study.

If commercialization is determined to be required before the results of this demonstration are in, the government will probably have to furnish the capital to build the plant (and possibly to open an associated mine), arrange for the transportation of the product to refineries (building pipelines if necessary) and enter into contracts with a firm or firms for the day-to-day management of the plant on a fee basis, and for the purchase of the product at a range corresponding to the difference in quality between it and competing conventional crude. Although this rate might represent a premium over the market price, it seems clear that it would have in it a large element of subsidy. These tasks would have to be carried out by one or more of the big companies in the industry.

This undertaking would inevitably involve the government in the industry in a variety of complicated ways that it would doubtless prefer to avoid. As the NSF/FEA report makes clear, government involvement would also be unpopular with the oil companies. For example, one of the

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*This represents about an equal division of energy in liquid and gaseous forms.

companies surveyed observed that it would be a disincentive to synthetic fuels development activities by the private sector, although it is difficult to believe that anyone making this observation had looked carefully into the question of comparative cost. Another company observed that the most likely outcome would be that "the government would end up as the sole owner of an unprofitable plant," which is perhaps much nearer the mark. However, government financing of a commercial plant would provide a firmer basis than now exists for estimating the likely costs of synthetic liquid fuels production and for establishing a policy regarding the role of these fuels in the future supply of domestic oil. If successful, the experience gained in the synthetic rubber program could be used to turn the activity over to the private sector.

REFERENCES

1. "Synthetic Fuels Incentives Study," NSF and FEA, final report by International Planning Management Corporation, Bethesda, Maryland (November 13, 1974). The study included 13 large oil companies, 4 small independent oil and research and development companies, 4 utilities, and 2 banks.

2. J. Hurstfield, The Control of Raw Materials (U.K. Official History of World War II, London, 1953), pp. 171, 292, 298.

11--NATIONAL ECONOMIC IMPACTS OF THE SYNTHETIC FUELS INDUSTRY

By John W. Ryan

A. Introduction

The production of synthetic fuels from coal or oil shale results in impacts at several levels in the economy. The chief impacts are those associated with the employees (and their families) of the mining and processing facilities. The secondary economic impacts are those that result, in turn, from the primary development. These include the induced growth of and competition with other industries. Most commonly discussed are the supporting industries that gather around the primary development. However, there are many supporting and supplying industries that will provide goods and services from a distance; many of these are already established and are unlikely to relocate. The demands for the goods and services of these supporting sectors will be substantial under the levels of resource development required by the SRI scenarios.

This chapter discusses the availability of materials and equipment and describes the impacts in geographic regions distant from the location of the primary mining and processing facilities. The nature of the impact and general magnitude of the demand are discussed, along with the geographic location of the major supplying industries. Specific forecasts of impacts are not attempted because there are too many influences outside of the system of synthetic fuels production.

B. <u>Interindustry Relationships</u>

The principal sectors supplying the coal mining industry (and by inference the future oil shale mining industry) can be determined from the total requirements table of the 1967 input-output (I-O) matrix of the U.S.[1] The coefficients in this table specify the <u>direct</u> plus <u>indirect</u> output of other industries needed to produce a dollar's worth of coal delivered to final demand. For example, the coefficient for mining machinery (sector 45.02) is 0.026; this means that for every thousand dollars of coal sold in 1967 to final demand, purchase of $26 of mining machinery is required. Table 11-1 lists the 20 coal supplying sectors with the largest total requirements coefficients.

The largest coefficient in Table 11-1 belongs to the coal industry itself; for every dollar of coal delivered to final demand, another 0.15 dollar's worth is consumed by sectors that in turn supply the coal mining industry. Nonindustrial sectors with large coefficients are real estate and miscellaneous business services. These reflect the importance of land purchases and leases and of repair services, such as welding and armature rewinding. Legal services are classified under sector 73.03, miscellaneous professional services, with a coefficient of 0.010.

Several manufacturing sectors appear in Table 11-1. Blast furnaces and basic steel products (sector 37.01) have the largest coefficient and, therefore, can be expected to be of utmost importance for expanded coal production. Other sectors that one would expect to be important are construction and mining machinery. Chemical industries (sectors 27.01 and 27.04) appear primarily because of the importance of blasting materials in mining.

Petroleum refining is classified as a manufacturing sector according to I-O classifications, although it actually represents oil as a

Table 11-1

ECONOMIC SECTORS PROVIDING INPUTS TO THE COAL MINING SECTOR, RANKED BY SIZE OF 1967 TOTAL REQUIREMENT COEFFICIENT

Source: Reference 1.

Rank	Industry Title	Coefficient	Input/Output Sector Code
1	Coal mining	1.148	7.00
2	Real estate	0.075	71.02
3	Blast furnaces and basic steel products	0.037	37.01
4	Wholesale trade	0.034	69.01
5	Miscellaneous business services	0.034	73.01
6	Electric utilities	0.031	68.01
7	Mining machinery	0.026	45.02
8	Petroleum refining	0.020	31.01
9	Screw machine products and bolts, nuts, rivets, washers	0.017	41.01
10	Miscellaneous chemical products	0.017	27.04
11	Maintenance and repair construction	0.016	12.02
12	Construction machinery	0.015	45.01
13	Industrial chemicals	0.014	27.01
14	Imports	0.013	80.00
15	Reclaimed rubber and miscellaneous rubber products	0.012	32.03
16	Railroads and related services	0.011	65.01
17	Crude petroleum and natural gas	0.011	8.00
18	Miscellaneous professional services	0.010	73.03
19	Insurance	0.010	70.04
20	Logging camps	0.009	20.01

source of energy analogous to the coal, natural gas, and electric utility sectors. The coefficient for petroleum refining is 0.020, while that for electric utilities is 0.031. These high values reflect the direct importance of petroleum products and electricity to coal mining, as well as their importance to all sectors supplying the coal mining industry.

Input-output tables reveal the relative contribution of various sectors to the output of coal mines. However, potential constraints on the expansion of the coal industry depend largely on the size of coal industry demand compared with other demands for the capacity of each supplying sector.

The level of aggregation in the input-output table is a source of difficulty. The aggregation can obscure key parts of selected industries. One attempt to overcome this problem is reported in Bureau of Mines Information Circular 8338, "The Interindustry Structure of the U.S. Mining Industries - 1958," which contains detailed tables listing materials and purchased services for coal and other mining industries. For example, this more disaggregated table reveals that the reclaimed rubber and miscellaneous rubber products sector is important because of the miscellaneous rubber products (SIC 3069) component, which includes conveyor belting and rubber hoses.

Thus, in summary, the interindustry relationships given in input-output tables are useful to identify the major inputs needed by the coal mining sector, especially from indirect suppliers of the coal mining sector that could easily by overlooked otherwise. The next section expands the analysis to discuss the demand levels for specific equipment and the potential for bottlenecks.

C. Materials and Purchased Services Used by the Coal Industry

The availability of goods and services used in energy production was analyzed by the Materials, Equipment, and Construction (MEC) Task Force of Project Independence,[2] which covered all energy sectors; this paper, however, is concerned only with coal and oil shale. Other demands on supplying sectors from other energy sectors cannot be discussed in detail but may have an effect on the availability of materials for coal production.

1. MEC Task Force Projections

The MEC Task Force considered two scenarios in their analysis:

1. BAU, "Business-as-Usual" scenario of the Project Independence Coal Task Force.
2. AD-C, "Accelerated Development" scenario of the Coal Task Force, as constrained by the availability of walking draglines.

Figure 11-1 shows coal production for the maximum credible implementation scenario (MCIS) developed for this study added to that of the Ford Energy Policy Project's Historical Growth scenario (HG1) without synthetic liquids from coal. Together, the scenarios call for 3.6 billion tons of coal consumption in 2000. The 1990 production for the BAU and AD-C scenarios of the MEC Task Force are shown in Figure 11-1 as two points at 1.3 billion tons and 1.8 billion tons, respectively. Because the AD-C scenario is approximately equal to the total for HG1 plus MCIS in 1990, the conclusions of the MEC Task Force can be applied directly--assuming (1) that the split between underground and surface mining remains approximately the same between 1990 and 2000, and (2) that trends in capacity expansion continue to 2000.

The future availability of the selected items was based on Department of Commerce analyses of production capacity for the commodities

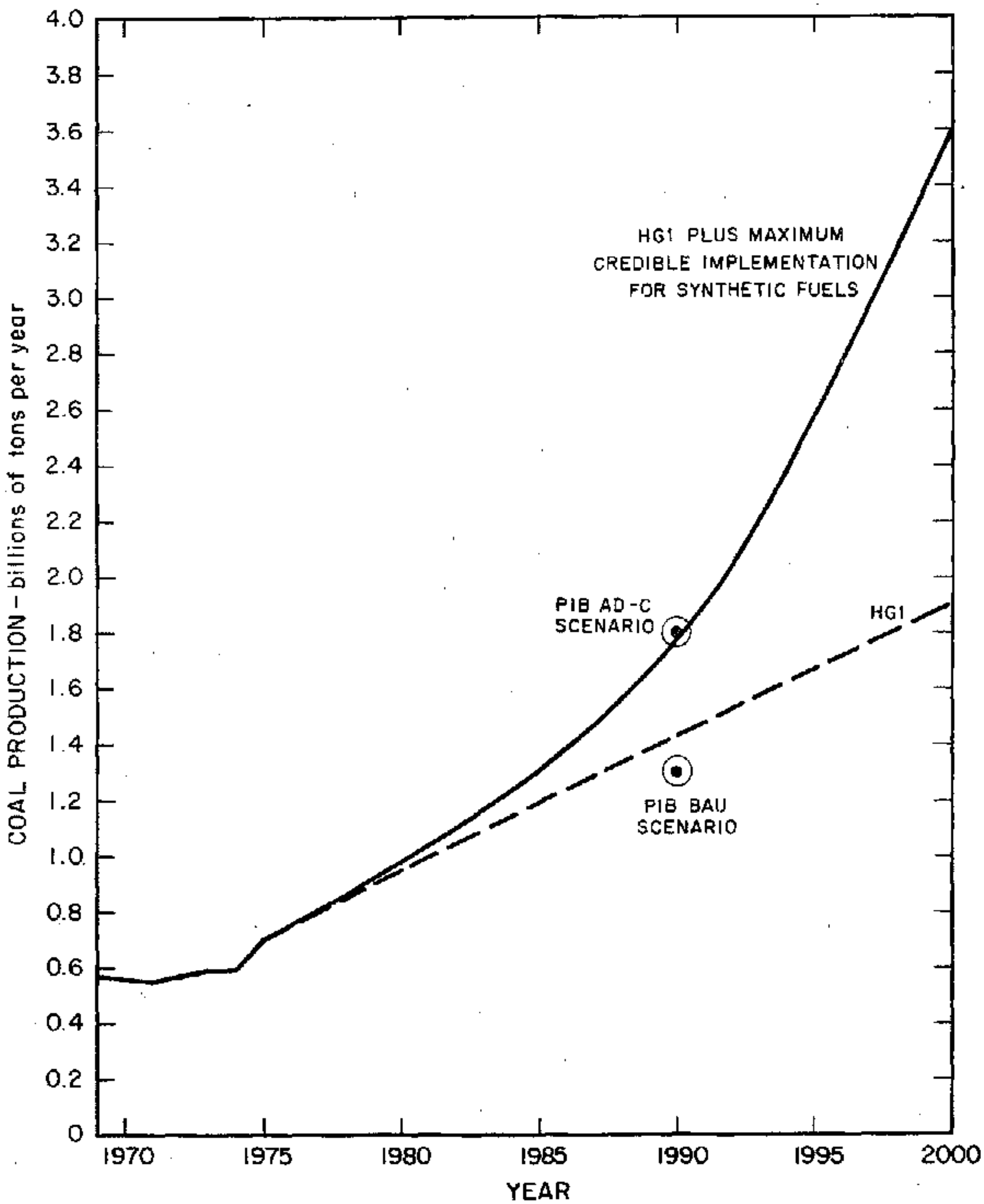


FIGURE 11-1. FUTURE COAL PRODUCTION LEVELS FOR PROJECT INDEPENDENCE SCENARIOS AND THE SRI MAXIMUM CREDIBLE IMPLEMENTATION SCENARIO (PIB: Project Independence Blueprint; HG1: Ford Energy Policy Project Historical Growth 1)

involved. Export demand (a fraction of capacity) was assumed to continue at current levels, with the remainder of production available for domestic consumption. MEC estimated the portion sold to the energy sectors by techniques such as trend line extrapolation, input-output, and contacts with manufacturers.

The MEC investigated basic materials, such as steel and cement; intermediate materials, such as forgings, castings, and explosives; equipment components, such as compressors, pumps, and valves; and major equipment, such as continuous miners and draglines. Potential problems for the future expansion of coal mining were found in:

- Steel
- Walking draglines
- Castings and forgings.

However, problems are not expected for:

- Continuous miners
- Construction equipment
- Crushers
- Explosives
- Mine roof bolts
- Power shovels.

Before discussing the problem areas further, however, the analysis behind other coal-related categories will be considered.

The MEC Task Force made various assumptions in its analysis.* For example, although the demand for continuous miners depends on the coordinate availability of horizontal and vertical boring machines, the

*To fully understand the MEC assumptions about the supply situation, the reader should refer to the MEC Task Force Report for each category.

latter two were not analyzed or discussed in detail. It should be noted that continuous miners are made to mine specifications and not available from open inventory. About 94 percent of the continuous miners produced in 1973 and 1974 were shipped to the coal mining industry, but in the period to 1990 the MEC estimates that the percentage will drop to 86 percent. About 95 percent of mine roof bolts will go to coal mines. Assuming that roof bolt supplies are not again disrupted by price controls, as they were in 1972 and 1973, the MEC foresees sufficient flexibility to expand roof bolt production in existing facilities. This should remain true even if legislation greatly curtails surface mining and forces an increase in underground mining. The estimates for categories that sell to end users besides mining are not as critical because productive capacity that has historically gone to other sectors could, in principle, be diverted to the coal industry. This is true of construction equipment,* explosives, crushers, and power shovels, where less than 50 percent of output goes to coal mining.

a. Steel

The MEC Task Force found that there would be a shortage of steel supplies available in the energy sector if no more than the historical percentage of steel output went to energy industries. Based on the historical distribution of steel between energy and nonenergy uses, a 7.3 percent availability to energy industries was selected as a conservative estimate, while an upper value of 11.1 percent was chosen on the basis of figures for the first half of 1974. The results are summarized from the MEC report in Table 11-2.

*Especially now that the interstate highway system is nearing completion.

Table 11-2

PROJECTED STEEL AVAILABILITY
(Millions of Tons)*

	1980	1990
Steel mill capacity	125.9	150.2
Available to energy sector:		
@ 7.2%	9.1	10.8
@ 11.1%	14.0	16.7
Requirements:		
Scenario BAU	10.3	13.4
Scenario AD-C	11.6	14.6

*Note 1 ton is about 907 kg.

Source: Project Independence Materials, Equipment and Construction Task Force.

Table 11-2 shows that the requirements for scenarios BAU and AD-C of the MEC fall between the 7.2 percent and 11.1 percent production values. Thus, with synthetic liquids included, the energy sector will need to purchase a greater proportion of steel output than it has averaged historically. Steel for the coal industry, including production allocated to liquid synthetic fuels, reaches 6 percent of energy sector requirements in 1980. This is such a small portion of total steel demand that it is unlikely that coal mining will be seriously affected by shortages of gross steel capacity; however, as discussed below, specialty products may prove constraining.

b. Ferrous Castings and Forgings

Castings and forgings are usually discussed together because of the similarity of their production. Production capacity is fragmented among several industries producing diverse products, which leads to great difficulties in estimating current capacity for castings and forgings.[2] Clearly, future capacity depends on availability of steel, capital, labor and energy, but a major portion of future capital expenditures must be oriented towards compliance with regulations on health, safety, and environmental quality. Unfortunately, the small size and low profitability of many firms in these industries make them unattractive to capital sources. Even though the MEC Task Force was unable to develop quantitative estimates of availabilities and requirements for castings and forgings--because it found that even though the industry is operating multiple shifts, delivery times are growing and shortages are developing--it concluded that expansion of energy production was likely to be constrained.

c. Walking Draglines

The MEC Task Force concluded that walking draglines would be the limiting item in accelerating coal output. Indeed, their AD-C was derived by scaling the "Accelerated Development" scenario of the Coal Task Force of Project Independence that called for 2.8 billion tons of coal in 1990. The MEC concluded that in 1990 only 1.8 billion tons could be produced because the availability of draglines would constrain future development of surface mines. Thus, since the sum of HG1 and MCIS scenarios correspond to the AD-C scenario, walking draglines can be expected to inhibit synthetic fuels development.

Behind this conclusion are the following facts:[2]

- Orders now on the books are sufficient to keep the industry at full production through 1979.

- Producers plan to ship 45 draglines in 1977--up from 21 in 1974. (MEC Task Force estimates 1980 annual capacity at 50 to 55 units.)
- Historically, 25 percent of the walking draglines have been exported (helping to balance capital outflows from the United States).
- Manufacturers have been able to raise capital for expansion in the past.

Unfortunately, the MEC Task Force does not present the details of its supply/demand estimates, so the basis for its conclusion is not readily apparent. In fact, a simple analysis of the supply situation compared with the number of mines necessary to meet the 1990 production levels of the AD-C scenario suggests that dragline production should be more than sufficient. The details of the estimate made for this study are given in Appendix A.

2. Overview

The level of economic activity of the moment can influence an analyst's views of material shortages. The work of the MEC Task Force was conducted in mid-1974 during a period of material shortages and long delivery times. The recessionary situation of early 1975 was quite different; except for the energy sector, there was considerable idle capacity and unemployment. It might be expected that the fraction of future production capacity available to energy sectors is likely to increase as suppliers turn to that market, seeking to cultivate stable and growing markets. Thus, historical relationships are likely to change as the economy shifts back to growth, with more emphasis on capital goods sectors and less on consumer durables, such as automobiles.

D. Conversion Facilities

Possible constraints on the construction of three processing operations for the production of synthetic liquid fuels are considered here:

- Coal liquefaction plants
- Oil shale retorts
- Methanol plants.

The input-output approach used above cannot be used to identify the major supplying industries to the future synthetic fuels industry since the data do not exist. Moreover, after exploring possible parallels with the petroleum refinery sector in the input-output data, it was concluded that the analogy was not strong enough to justify elaboration. However, engineering analyses have provided estimates of the needed materials and equipment. Liquefaction plants and oil shale retorts require similar amounts of steel for large-scale operations; however, methanol production requires almost twice the steel per unit of output (see the construction scaling factors in Chapter 6).

Coal liquefaction is a highly complex process requiring large pressure vessels and high-quality piping; both require numerous pumps and compressors. Consequently, the construction of coal liquefaction plants is more likely to meet with materials and equipment shortages than construction of oil shale retorting facilities.

Availability of steel plate for pressure vessel construction is limited. According to the Project Independence Task Force Report on Synthetic Fuels from Coal, only one steel company presently has the capability to produce steel plate in large widths;[3] lead times in 1974 were reported to be 2 years.

Even if the necessary steel plate were available, fabrication of pressure vessels poses another bottleneck. Most of the capacity able to produce heavy-walled pressure vessels needed in coal liquefaction is currently committed to nuclear power facilities, and it is unlikely that large amounts of capacity will be available for coal liquefaction without substantial additions to capacity.[3] The major fabricators are currently committed through the 1970s. The present competition for materials is not likely to change significantly over the long term under current U.S. policy. Even in the 1990s when the scenarios of this study show rapid growth in coal liquefaction, the demand for nuclear power is expected to remain a strong competitor for steel suitable for pressure vessels.

Future production of pumps and compressors depends on the availability of castings and forgings as opposed to plant capacity. The engineering lead times for synthetic fuels plants is longer than the time needed to tool up for increased production of these goods.[2]

Material constraints on oil shale retorts and methanol plants seem less critical. While large amounts of steel are required, the necessary pressure vessels are smaller and easier to fabricate. Consequently, there are more mills capable of producing the necessary steel products. The availability of castings and forgings is a possible bottleneck in this portion of the synthetic fuels production chain as well.

E. Transportation

The impacts in the transportation sector depend very much on the location of mines and conversion facilities. Coal liquefaction may either be done at the mine (mine-mouth) or the coal may be shipped to a remote liquefaction plant by rail or slurry pipeline. (See Chapter 19.) There is no transportation problem for the oil shale industry because processing must be performed at the mine to be economic, and the synthetic crude can be shipped by pipeline using relatively short branch lines to connect with existing crude pipelines.

Regulatory policies will be a key factor. Present air quality standards will increase demand for low sulfur western coal, and the distance to utility markets will increase the demand for rail facilities. If western states pass regulations prohibiting development of conversion facilities, then rail shipments or slurry pipelines will be necessary to move coal to distant liquefaction plants.

1. Railroad Equipment

Presently, railroads haul 78 percent of all coal, and this amounts to approximately 20 percent of all rail traffic.[4] Under their "Base Case" scenario, Project Independence calculations show that rail shipments of coal will more than double by 1985 to a level of 730 million tons per year.[4] The resulting supply/demand balance for locomotives and hopper cars for 1985 is shown in Table 11-3.

Table 11-3

CUMULATIVE DEMAND AND SUPPLY ESTIMATES FOR LOCOMOTIVES AND HOPPER CARS TO 1985--PROJECT INDEPENDENCE BASE CASE

		Manufacturing Capacity	
	Required	Minimum	Maximum
Locomotives	10,465	14,600	19,100
Hopper cars	274,800	180,000	310,000

Source: Reference 4.

Table 11-3 indicates that there would be sufficient locomotives if all new production could be used to move coal. Total requirements are over two-thirds the estimated minimum productive capacity to 1985, leaving only one-third of the new locomotives to be used by the other 75 (or more) percent of rail traffic. Hopper cars are in even tighter supply according to Project Independence; the projected requirements for coal shipments are 88 percent of the maximum production through 1985, and 50 percent greater than the minimum.

Because of slight differences in coal production rates and time horizons assumed in the MEC and this study, it was necessary to adjust the MEC's railway equipment projections upwards by 22 percent. This yields an upper-bound estimate of locomotive and hopper car requirements. This gives a requirement for 335,000 hopper cars and exceeds the maximum estimated production capacity shown in Table 11-3.

The production of railroad equipment requires that steel goods be available in sufficient quantities. For example, a typical 100-ton hopper car requires 30 tons of steel, but castings and forgings needed for wheels and axles, truck side frames, and couplings are likely to be in limited supply. Thus, the gross availability of steel may not constrain coal car production as much as the lack of specialty products.

Financing of new equipment will be a definite problem for deficit-plagued railroads. However, institutional changes affecting the ownership of rail cars are occurring; in particular, utilities and other large coal users are now purchasing cars directly to guarantee their shipments. This trend, coupled with equipment leasing, will alter the nature of railroad financing in the future.

2. Coal Slurry Pipelines

The use of slurry pipelines will not drastically alter the materials and equipment requirements for coal transport. Indeed, the Project Independence analysis concluded that slurry pipelines ". . . are not going to offer major savings in total dollar investment, steel or in labor."[4] However, they may drastically alter the institutional structure of the coal transportation industry. (See Chapter 19.)

F. Geographical Distribution of Sectors Supplying Synthetic Liquid Fuels Industry

The impacts of rapid development of coal and oil shale resources to make synthetic liquid fuels will extend to most of the major manufacturing areas of the United States. However, the magnitude of the impacts is not likely to be large compared with the total economic activity in an area--in contrast to the situation in western mining areas where rapid growth rates are expected because of the small current base population.

1. Mining and Construction Equipment

Firms manufacturing mining and construction equipment will be considered together, since many construction equipment items, such as power shovels and front-end loaders, are used by the coal mining (and future oil shale) industry.

Two-thirds of the total employment in the construction machinery (SIC 3531) and mining machinery (SIC 3532) industries is located in the 6 states listed in Table 11-4. Within these states, plants are concentrated in the vicinity of Chicago, Cleveland, and Milwaukee; smaller metropolitan areas of importance in Illinois are Peoria and Springfield; and in Ohio, Bucyrus and Marion. The manufacture of mining equipment is a much smaller industry having only 22,000 employees versus 132,000 for construction equipment. Only four states are major producers--Ohio, Wisconsin, West Virginia, and Pennsylvania. As coal mining in the West grows, some new plants will be opened. For example, Bucyrus Erie, one of the three firms that manufacture walking draglines, has opened a plant in Pocatello, Idaho.

Table 11-4

EMPLOYMENT IN CONSTRUCTION EQUIPMENT AND MINING EQUIPMENT INDUSTRIES BY STATE, 1972

	Employment (thousands of employees)	
State	Construction Equipment	Mining Equipment
Illinois	45.7	0.9
Ohio	13.7	2.2
Iowa	12.1	n.a.*
Wisconsin	10.7	2.8
Pennsylvania	5.9	5.0†
West Virginia	n.a.	1.8
Total U.S.	132.1	21.7

*n.a. = not available.
†Estimated for this study.

Source: Dept. of Commerce, Bureau of the Census, 1972 Census of Manufacturers.

There are a few items of mining equipment that are currently produced by a limited number of firms. Two prominent examples are draglines and continuous miners having, respectively, only three and five producing firms. A third example is off-highway trucks; the 1974 Buying Directory of Coal Age lists 20 manufacturers, but only 10 are major factors in the manufacture of large coal hauling trucks used at surface mines.

2. Explosives

Approximately 45 percent of the U.S. output of explosives is used by the coal mining industry, and the vast majority (96 percent) is consumed by surface mines.[2] In 1967, the eight largest companies accounted for 91 percent of total shipments. The only significant concentration of plants is in New Jersey, where Hercules, Inc., has three plants and duPont has one.

3. Railroad Equipment

The manufacture of and market for locomotives in the United States is shared by General Electric Co., and the Electro Motive Division of General Motors Corp., with plants located at Erie, Pennsylvania, and Chicago, Illinois, respectively. GM captured over 75 percent of domestic orders in 1974, but GE supplied 100 percent of the foreign orders for locomotives.[5]

Freight cars are manufactured by several companies, including divisions of the railroads themselves. On December 1, 1974, order backlog stood at nearly 91,000 cars.[5] Open hopper cars suitable for coal represented 27 percent of this backlog, although they constitute only 20 percent of the total current fleet of cars. Thus, the fraction of hopper cars (both open and covered) in the freight car fleet is increasing.

Ten firms dominate the freight car manufacturing industry, but not all of them manufacture open hopper cars.[2] The conversion of other car production lines to coal hopper cars could be accomplished readily if demand warranted. Moreover, Pullman-Standard, a major manufacturer of coal cars, has recently completed a new production line in Butler, Pennsylvania (employing 3,000), to make hopper cars for the Burlington Northern; this company is planning a similar production line at its plant in Bessemer, Alabama.[6]

The impact of increased demand for railroad equipment will most likely be concentrated in current producing areas.. These are the Chicago-Gary-Hammond region of Illinois and Indiana and medium-sized towns in the western Pennsylvania region. These Pennsylvania producers are all within the sphere of influence of Pittsburgh (although not in the SMSA itself). Other regions that can expect impacts less concentrated than the above are St. Louis, Missouri; Seattle, Washington; and Bessemer, Alabama (near Birmingham).

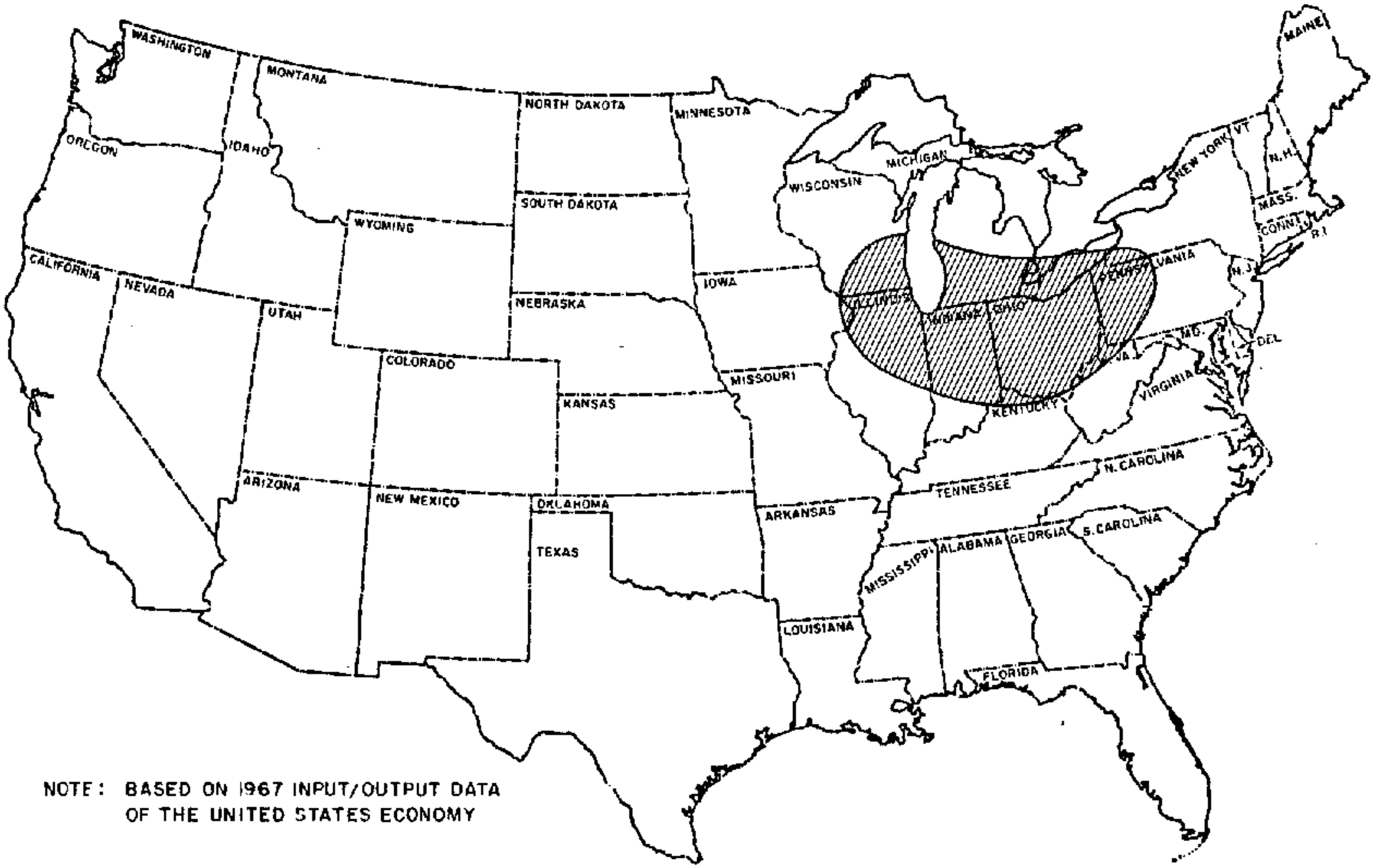
4. Steel

In the above discussion of the relationship of energy growth and steel demand, the main conclusion was that energy-related steel demand will be a relatively small portion of total capacity. Consequently, the geographical impacts will be minor and can only be discussed in general terms. Assuming no rapid shutdown of aging facilities to meet environmental regulations, the current steel producing centers will probably be dominant to the end of the century. These major production centers are Pittsburgh, Pennsylvania; E. Chicago/Gary, Indiana; Baltimore, Maryland; Buffalo, New York; and Youngstown, Ohio. All are in highly developed metropolitan economies, so that any growth will have little percentage impact. If traditional steel markets diminish in the future (such as might result from smaller cars using increased fractions of plastic), then energy-derived demand could help to maintain steel industry output and employment. In general, however, the state of the steel industry will depend more on the nation's overall economic strength than on demand derived from energy industries.

5. Summary

Although little can be said to pinpoint future changes in the locational patterns of the four industries that are important to the future development of coal resources, it is unlikely that any rapid changes will take place. Heavy industrial centers in the United States have developed where raw materials, labor force, energy, and transportation are available; once established, institutional inertia slows the pace of change.

For the most part, the supplying industries discussed throughout this paper are located in a crescent-shaped region around the southern edge of the Great Lakes, stretching from Milwaukee on the west to Pittsburgh, as shown in Figure 11-2. Historically, this is the region that has supported coal mining and heavy industry, and it appears that it will continue to do so in the future.



NOTE: BASED ON 1967 INPUT/OUTPUT DATA
OF THE UNITED STATES ECONOMY

FIGURE 11-2. PRIMARY CONCENTRATION OF MAJOR-INDUSTRIAL SECTORS EXPECTED TO SUPPLY THE COAL AND OIL SHALE INDUSTRY

Appendix A

ESTIMATION OF DEMAND FOR WALKING DRAGLINES

Using data from the MEC Task Force and assuming sufficient materials are available, as shown in Table A-1, about 400 draglines should be available from 1975 to 1990, even assuming no expansion beyond the MEC estimate of 1980 production levels.

The number of surface coal mines that would have to be opened to produce 1.8 billion tons of coal was estimated as follows. Underground production is assumed to double from 0.3 billion tons in 1974 to 0.6 billion tons in 1990. The 1.2 billion tons of surface production was assumed to come from 300 mines: 100 east of the Mississippi River, each producing 2 million tons annually; and 200 western mines, each producing 5 million tons annually. (The estimate of draglines needed will be conservative if it is assumed that all these mines are new.)

Without delving into details concerning overburden thickness and stripping ratios, a straightforward comparison shows that an average of 1.33 (400/300) draglines per mine could be produced to 1990. According to a Bureau of Mines cost analysis,[7] more than one dragline would be necessary only in rare cases, such as a 5-million-ton per year lignite mine in North Dakota. Most of the model mines described have only one dragline for removing overburden and use power shovels for mining coal and loading trucks. Moreover, in some mines, such as the open pit Belle Ayre mine in Wyoming, draglines are not used.

However, a large increase in power shovel production cannot be expected since they are manufactured mainly by the same firms that make walking draglines.

Table A-1

ESTIMATION OF DRAGLINE PRODUCTION
1975-1990

Year(s)	Annual Production (units)	Total Units
1975	25	25
1976	30	30
1977-79	45	135
1980-89	50	500
Total produced 1975 to 1990		690
Exports @ 25%		-175
Noncoal @ 20%		-103
Total available for coal		412

Source: Reference 2.

REFERENCES

1. "Input-Output Structure of the U.S. Economy: 1967, Volume 3, Total Requirements for Detailed Industries," U.S. Dept. of Commerce, Bureau of Economic Analysis, Washington, D.C., U.S. Government Printing Office (1974).

2. "Availabilities, Requirements, and Constraints on Materials, Equipment and Construction," Federal Energy Administration, Project Independence Blueprint, Final Task Report (November 1974).

3. "Synthetic Fuels from Coal," Federal Energy Administration, Project Independence Blueprint, Final Task Report (November 1974).

4. "Project Independence Report," Federal Energy Administration (November 1974).

5. L. S. Miller, "Some Counter-Cyclical Optimism," Railway Age, p. 5 (January 27, 1975).

6. "Pullman Delivers First of 'New Family' Open-Tops," Railway Age, p. 23 (February 24, 1975).

7. "Cost Analyses of Model Mines for Strip Mining of Coal in the United States," Bureau of Mines, Information Circular 8535, U.S. Government Printing Office, Washington, D.C. (1972).