AN EMPIRICAL STUDY OF THE MARKETABILITY OF COAL IN TODAY'S ENVIRONMENT

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Page in Study: 60　　Candidate for Degree of Master of Business Administration

Major Field: Business Administration

Purpose of Study: Having prior experience as a Rail Operations Analyst and currently performing the duties of a Distribution Analyst, it is out of both interest and concern that this study evolved. It is my hope to utilize all or a portion of this paper to enhance my job responsibilities, and in turn, improve Phillips' position in the coal market.

Findings and Conclusions: The market potential for coal exists. However it will take an aggressive campaign to increase coal's market share. Until this is done, though, coal cannot become the dominant energy source desired.

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AN EMPIRICAL STUDY OF THE MARKETABILITY OF COAL

IN TODAY'S ENVIRONMENT

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CHAPTER I

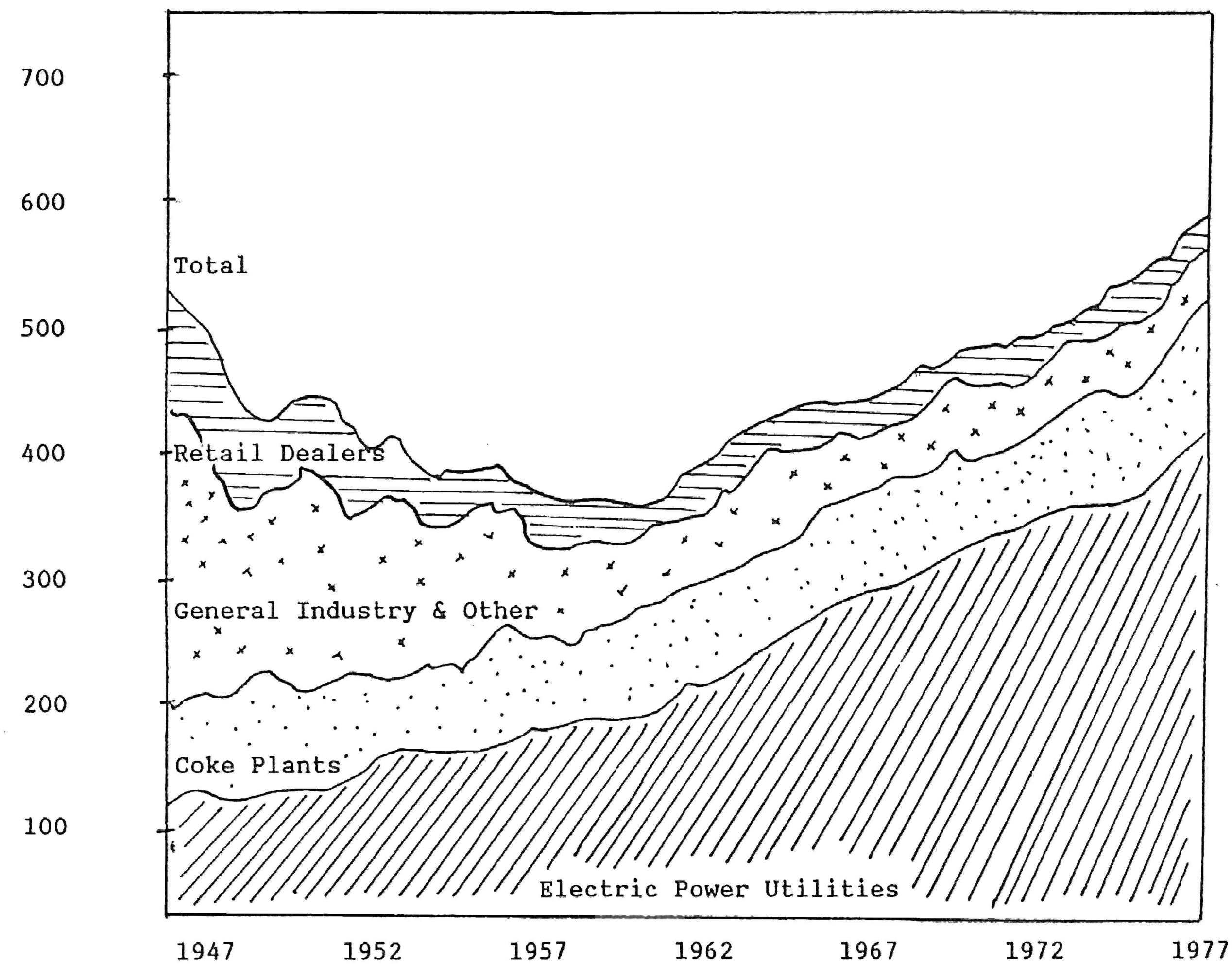
INTRODUCTION

Coal, America's most abundant fossil fuel, helped the country shift to an industrialized nation in the late nineteenth and early twentieth centuries. It remained the country's principal fuel until World War II, then peaked at its end. Coal production has since been on a long decline; it simply could not compete with cheap and convenient oil and natural gas. However, the Arab oil embargo in the early 1970's and the realization of America's growing dependence on foreign oil rekindled interest in coal.

Estimates of America's recoverable reserves are as high as 438 billion tons - nearly one-third of the world's known supplies. The United States has enough coal, if one looks only at the physical resource itself, for any reasonably expected level of production, for at least the next hundred years.(41) Yet coal now provides only 18 percent of the energy consumed in the U.S.(39), or the equivalent of 7000 barrels per day, used almost exclusively to generate electricity, as reflected in Figure 1. As a result, even though production levels have been improving along with the rise in oil prices, demand for switching to coal-burning facilities has yet to pick up.

FIGURE 1

U.S. CONSUMPTION OF BITUMINOUS COAL AND LIGNITE



Source: Energy Information Administration, Annual Report to Congress, Volume III, 1977 (Washington, D.C.: Government Printing Office, May 1978), p. 78.

In April, 1977, President Carter proposed his National Energy Plan giving coal a key role. Calling for an 80 percent increase in coal production by 1985, he proposed an expanded program of research and development and pushed for the conversion from scarcer fuels to coal. The plan outlined a coal conversion program which, in modified form, became the Powerplant and Industrial Fuel Act of 1978. It proposed the levying of a tax to raise the cost of oil and natural gas to utility and industrial users, while at the same time providing an investment tax credit for coal conversion programs. New power plants and major fuel burning installations were to be barred from burning oil or natural gas as a boiler fuel, but could acquire temporary or permanent exemptions. A general exemption could be granted due to lack of alternative fuel supplies, site limitations, environmental requirements, or inadequate capital. Existing plants with the capacity to burn coal also were to be prohibited from burning oil or natural gas.(41)

In May, 1979, the Carter Administration submitted a second National Energy Plan to Congress. The Department of Interior was directed to accelerate coal leasing on federal lands in the West. Increased funding for low-cost efficient mining technology was promised, as well as support for coal slurry pipeline legislation. This second plan also recommended intervention by the Interstate Commerce Commission (ICC) to promote marginal cost pricing for coal transportation.

Another important legislative development was the enactment of the Railroad Revitalization and Regulatory Reform Act of 1976. Its primary purpose was to restore the nation's debt-ridden railroad industry to financial health and to reduce the burden of economic regulation. Its major provisions (1) restrict regulatory jurisdiction to market dominant situations to foster competition and place maximum reliance on the marketplace; (2) direct the ICC to make a continuing effort to assist rail carriers in achieving adequate revenues; and (3) call for the enactment of new procedures and concepts for railroad costing and pricing.(16)

Despite these legislative efforts to develop coal as a dominant alternative resource, the results have been disappointing. Coal has been hemmed in by political issues arising over what the public views as the side effects of producing as well as using this product. The coal industry sued the Carter administration, claiming the rules were too strict. However, the 1980 election ejected these environmentalists from policy-making positions. Then, the industry began suing the Reagan administration for making the regulations too lax. Recently, an amendment to an Interior Department funding bill has been proposed which would ban federal coal leasing permanently. (This bill was in direct response to a report by the General Accounting Office that a 1982 lease sale in the Powder River Basin may have returned $100 million less to the federal treasury than dictated by fair market value.)(29) Yet, before the United States can benefit from a further increased coal supply, another important issue is at stake: The country will need to more fully develop an efficient, economical, and environmentally acceptable system for moving coal.

It is the belief of the writer that the coal industry is faced with a "Catch 22" situation whereby it has failed to promote its product. The United Mine Workers of America (UMW) has also failed to carry substantial political weight due to its own internal conflicts. Consequently, the industry lacks the political support it needs to improve the transportation systems. Improving these systems will ultimately make coal more economically attractive.

This paper will examine the industry and transportation systems available to it. Concluding with recommendations to improve the marketability of coal, it is the belief that the enactment of these recommendations will effectively demand the attention of Congress to enact the necessary legislation.

Literature. The literature on coal mining and its subsequent transportation was considered according to the following types:

1. Descriptive writings--acticles in trade publications and public texts based on past experiences and knowledge
2. Case studies--publications by trade organizations based on studies of selected cases and circumstances
3. Government reports--legislative bills, committee hearing summaries, and reports
4. Field research--includes comparative case studies and interviews

As a part of this study, requests were sent to 30 companies asking for information concerning their respective marketing plans. The majority replied by stating current plans were either delayed or disbanded.

CHAPTER II

UNTAPPED POTENTIAL

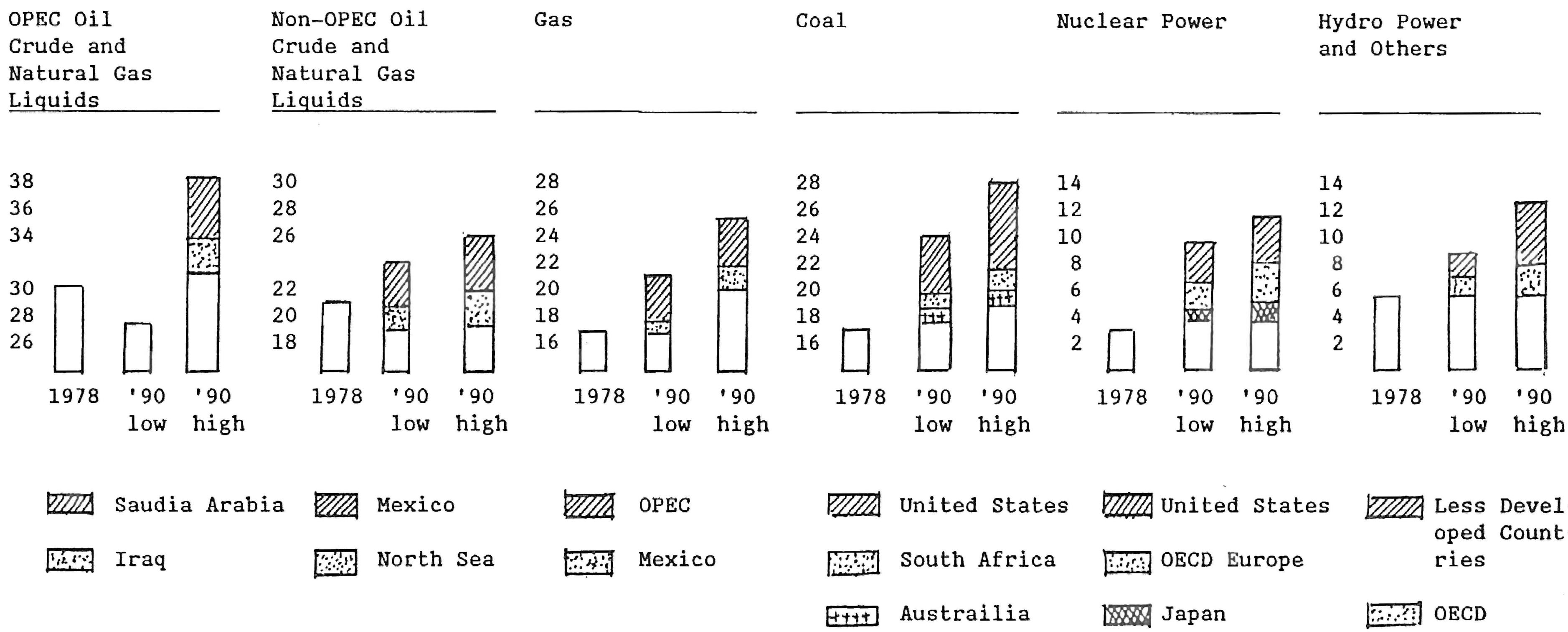
> To lessen our dependence on imported oil, they say, requires a balanced program of adopting reasonable conservation measures ... an investigation of the potentials of each energy source, an analysis based on the real world of political and institutional constraints in contemporary America, not on the disembodied world of econometric models and technological forecasts.(42)

Table 1 shows estimates of the availability for 1990 of oil (foreign and domestic), gas, coal, nuclear power, and renewable sources (hydro and solar, for example). For energy supplies other than oil, the largest increase could come from new coal production, mainly in the United States.

An 18-month intensive study by researchers from 16 countries was conducted and the results were released in May, 1980. The summary of the World Coal Study (WOCOL) stated that OPEC's policy makes it all but inevitable that energy-consuming countries will have to make do with less oil--and at a rising price for the next two decades. Wind, water, and solar power will not grow fast enough to take up much of the slack. Nuclear energy, beset by a series of delays and setbacks, may prove to be politically unacceptable. What is left is coal.

TABLE 1

INCREMENTAL ENERGY AVAILABILITY IN THE NONCOMMUNIST WORLD IN MILLIONS OF BARRELS OF OIL OR OIL EQUIVALENT PER DAY



Low:
Sluggish Response

High:
Vigorous Response

Source: Andre Benard, "World Oil and Cold Reality," Harvard Business Review, p. 92.

The United States does have an abundance of coal; however, coal is not without an abundance of problems. The three major types of barriers to the utilization of coal--which are environmental, human, and systematic--stand in the way of heavy reliance on coal as an alternative to imported oil.

Environmental. The main concern is the potential hazard of burning coal whereby emitting carbon dioxide into the atmosphere. In 1977 the National Academy of Sciences warned in a report that a warming of the earth's temperature due to the "greenhouse effect" from increased carbon dioxide emissions might pose a severe, long-term global threat. The Academy added, "The climatic effects of carbon dioxide release may be the primary limiting factor on energy production from fossil fuels over the next few centuries."(32) However, WOCOL director Carroll Wilson stressed that the most dire predictions about carbon dioxide effects are based on a projected growth rate of 4.2 percent a year in energy use. WOCOL predicts that consumptions will increase at less than half that rate for the rest of the century, largely because of conservation.(40)

Other problems in question are (1) the possibly serious public health consequences of long-term exposure to low levels of air pollutants, and (2) the risk of further damage to aquatic and terrestrial systems caused by "acid rain" resulting from increased coal combustion. These include emissions of sulfur dioxide, nitrogen oxide, trace elements (including arsenic, cadmium, mercury, lead, flourine, and beryllium); thermal and chemical discharges into water; and the solid-waste disposal problems of coal ash.(9)

Human. Certain hazards are inherent in coal mining because of the presence of such explosive and deadly gases as methane and carbon dioxide and because of the possibility of cave-ins and falls of rock. In December 1969, the passage of the Federal Coal Mine Health and Safety Act marked the most significant federal legislation addressing health and safety in the coal industry. Its requirements included the establishment of "maximum allowable levels of respirable coal dust and methane gas, and safety standards for roof control, ventilation, electrical equipment, blasting and explosives, and general operating procedures."(16) The statute also increased coal production costs and critics have pointed to its passage as the major cause, since 1969, of the steady reduction of the coal industry's productivity. See Table 2. In the labor-intensive coal business, productivity can mean the difference between profit and loss.

The Congressional Office of Technology Assessment reported estimates that a tripling of coal production by the end of the century would result annually in nearly 400 fatalities and 42,000 disabling injuries among coal workers (almost three times the current rates), not counting the "thousands of workers" who would be disabled by various respiratory diseases (known collectively as black-lung disease).(9)

TABLE 2 (16)

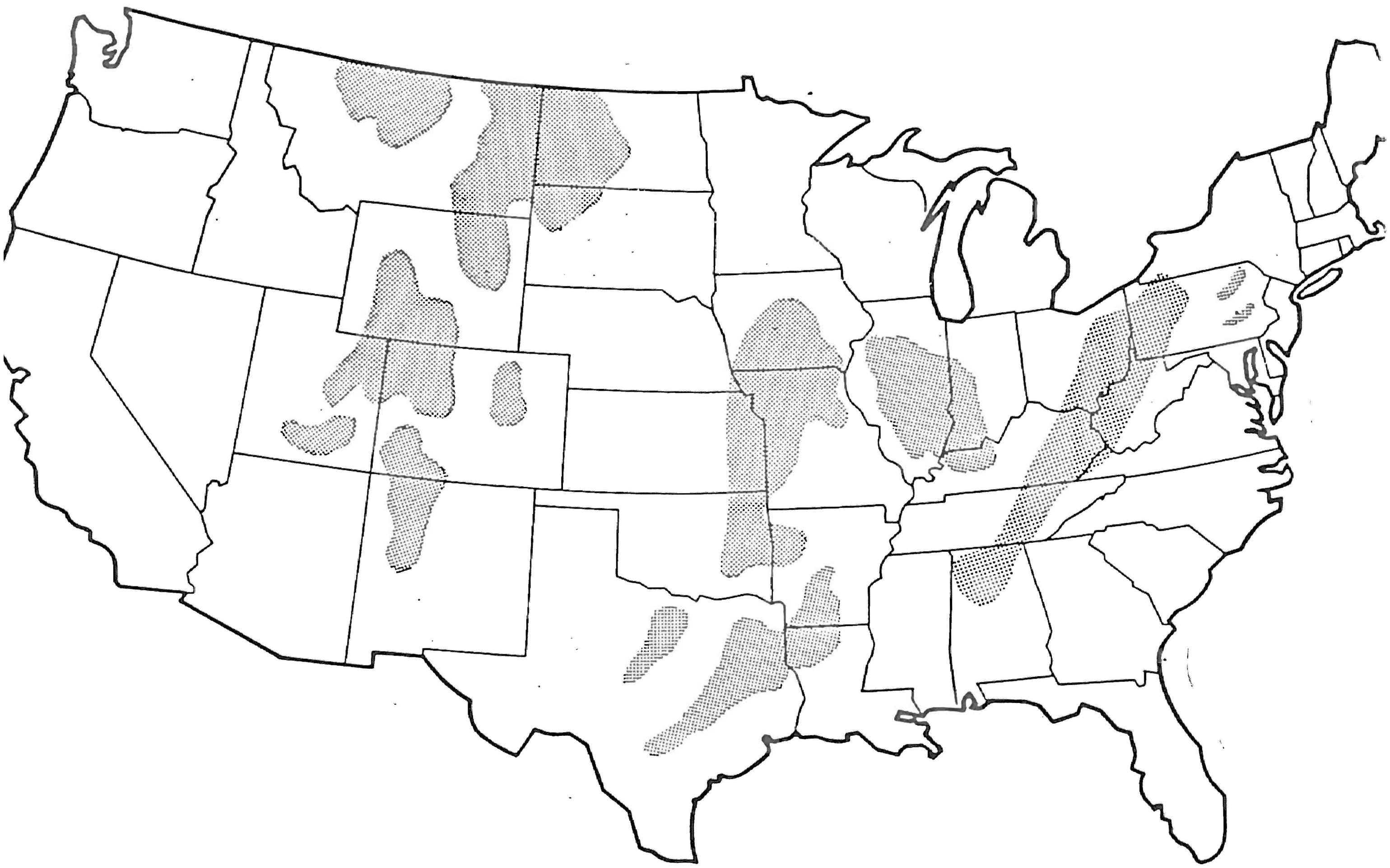
ACCIDENT AND PRODUCTIVITY EXPERIENCE FOR U.S. COAL MINES, 1967-1977

	Fatality[1] Rate	Injury[1] Rate	Productivity[2]	Employees	Est. Prod.[4] Per Day	Fatality[4] Per Prod. Day	Injury Per Prod. Day
				UNDERGROUND			
1967	0.53	24.02	15.07	103.993	1,567,175	0.83	37.64
1968	0.80	23.13	15.40	98.831	1,521,997	1.22	35.20
1969	0.47	24.04	15.61	97.395	1,520,336	0.71	36.55
1970	0.65	28.07	13.76	102.379	1,408,735	0.92	39.54
1971	0.54	35.09	12.03	97,740	1,175,812	0.63	41.26
1972	0.44	36.06	11.91	109,396	1,302,906	0.57	46.98
1973	0.37	32.20	11.66	100,843	1,175,829	0.44	37.86
1974	0.37	25.34	11.31	113,169	1,279,941	0.47	32.43
1975	0.40	31.18	9.54	137,060	1,307,552	0.52	40.77
1976	0.39	40.53	8.50	137,316	1,167,186	0.46	47.31
1977	0.39	45.54	8.58[3]	141,411	1,213,306	0.47	55.25
Percentage Change							
1967-77	-0.26%	+90%	-43%	+36%	-23%	-43%	+47%
				SURFACE			
1967	0.12	4.99	35.17	24,064	846,331	0.10	4.22
1968	0.13	5.49	34.24	24,400	835,456	0.11	4.59
1969	0.14	4.79	35.71	25,323	904,284	0.13	4.33
1970	0.12	5.42	36.26	31,103	1,127,795	0.14	6.11
1971	0.09	5.91	35.88	33,344	1,196,383	0.11	7.07
1972	0.08	5.53	36.33	35,364	1,284,774	0.10	7.10
1973	0.06	4.63	36.67	30,475	1,117,518	0.07	5.17
1974	0.08	4.20	33.16	44,491	1,475,322	0.12	6.20
1975	0.10	5.28	26.69	57,562	1,536,330	0.15	8.11
1976	0.06	5.78	25.50	55,993	1,427,822	0.09	8.25
1977	0.07	5.53	27.34	65,254	1,784,044	0.12	9.87
Percentage Change							
1967-77	-0.42%	+10%	-22%	+171%	+111%	+20%	+134%

[1] Expressed in fatalities and disabling injuries per million tons.
[2] Expressed in tones mined per worker per shift.
[3] Preliminary estimate.
[4] Productivity multiplied by number of employees
[5] Fatality rate mutiplied by production per day divided by 10^6.
[6] Injury rate multiplied by production per day divided by 10^6.

U.S. COAL FIELDS

Figure 2



Area	Principal Coal Type	Reserve Tonnage*	Avg. % Sulfur	Avg. BTU Content
N. Great Plains	Subbituminous	182,400	1.0%	9400 BTU/lb
Rocky Mountain	Bituminous	33,000	0.7	11600
Central	Bituminous	104,100	3.5	10300
Gulf Coast	Lignite	26,400	1.8	6500
Appalachia	Bituminous	113,000	1.8	13000

*Millions of short tons

Systematic. The distribution of U.S. coal reserves is shown in Figure 2. This geographic distribution definitely affects the transportation network that links the production and consumption of coal. In 1975 about 65 percent was shipped rail, 11 percent by water, 12 percent by truck, 11 percent used at mine-mouth generating plants, and 1 percent by other methods. Transportation is one of the most important and most overlooked elements of cost in coal economics. Many times the transportation and handling costs of coal exceed the cost of mining and may account for 80 to 90 percent of the delivered cost.(2)

Coal mined in the U.S. is usually categorized as either Eastern or Western. About 54 percent of coal by weight (but only 30 percent by heat content) is estimated to lie west of the Mississippi.(41) Western coals are generally less polluting although they also provide less energy per pound. Coal is ranked according to its carbon content with anthracite, bituminous, subbituminous, and lignite the highest to lowest ranking orders. Other important characteristics include moisture, sulfur and ash contents, and volatility. Typical properties of these four grades are shown in table 3.

TABLE 3: TYPICAL PROPERTIES OF COAL

Coal Type	Heating Value BTU per Pound	Percent Moisture	Ash Content	% Volatiles	% Sulfur
Anthracite	12600 - 14400	3	Low	2 - 8	Below 1%
Bituminous	11700 - 13500	3 - 15	Low	25 - 40	0.5% to 4%
Subbituminous	6300 - 11700	15 - 25	Moderate	33 - 50	0.5%
Lignite	3600 - 7200	20 - 50	High	25 - 55	0.4%

Much of the Eastern coal is extracted by underground mining, the method used when coal is found at depths of 150 feet or more below the surface. The two techniques for mining underground are "room and pillar" and "longwall." The room and pillar technique is by far the more prevalent, currently accounting for 80 percent of underground mining output. This technique consists of cutting panels ("rooms") into the coal seam. As the coal is extracted, pillars of coal are left in place to hold up the roof. Long pins called roof bolts must also be drilled into the roof to keep it from collapsing--a time--consuming process. Initially, as much as half of the coal remains underground. Later, some of the pillars are removed, increasing the recovery rate.

The longwall technique uses hydraulic-powered supports to prop up the roof of the mine while large mechanically driven shearers cut away at the coal. Since there are no pillars, this technique extracts a greater amount of coal than the room and pillar technique. After the coal is recovered in longwall mining, the supports are removed and the roof is allowed to collapse safely. This technique is used where the geological formation above the coal seam allows controlled and uniform settling.

The second method, surface mining, is used where coal is found up to 150 feet beneath the surface--the major method used in the West. In such instances, the overburden (soil and rock) above the coal seam is removed so the shovels and scrapers can extract the coal. After the coal is mined, reclamation of the land begins. The pit is refilled with the overburden material and soil is spread on top so that the land is returned to its approximate original contour as required by the Surface Mining Act of 1977.(24)

Underground mining recovers only 50 to 60 percent of a seam's coal, whereas up to 90 percent may be recovered through surface mining. In 1977, the average productivity of surface mines was slightly less than three times that of underground mines and yet surface mines produced about 60 percent of total U.S. output.(42)

Both Eastern and Western coal have their own distinct advantages. Most Appalachian and midwestern coal is bituminous with a high heat content. A ton of bituminous coal contains the energy equivalent of about four barrels of U.S. crude oil. Much of the western coal is subbituminous and has a lower heat content by weight. Each ton contains the energy equivalent of roughly three barrels of oil. Therefore, even though there are less minable coal reserves east of the Mississippi, their total heat content is greater than that of western coal reserves. Western coal, on the other hand, is relatively low in sulfur. The sulfur content of coal in the U.S. generally ranges from 0.2 to 7.0 percent by weight. Western coal contains only one percent sulfur average by weight, emitting fewer sulfur compounds per ton of coal burned. In addition, it is less expensive to produce western coal, which is mostly extracted through surface mining. However, this is partly offset by its lower heat content and the higher cost of transporting western coal to the major coal users.

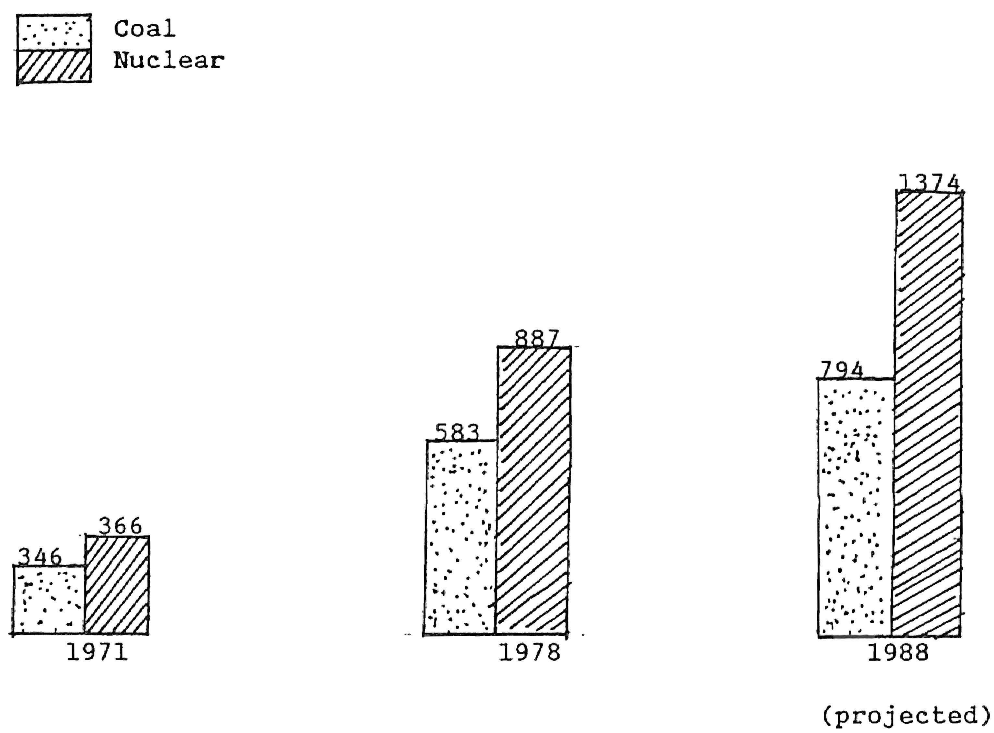
The largest users of coal are utilities. Currently, more than 70 percent of all domestic coal is consumed as a boiler fuel for electric power generation; however, coal's total share of the utility market is just 44 percent.(11) The one factor, though, that is likely to have the greatest impact on the utilities' use of coal is the viability of nuclear energy. The accident at the Three Mile Island nuclear plant as well as soaring capital costs of construction are making them economically less favorable. Figure 3 illustrates the widening gap in construction costs.

Yet utilities have made no wholesale move to coal. This is primarily due to an overall slowdown of the U.S. economy, with an electrical growth demand of two to three percent in the next five to ten years.(44) Other factors tending to constrain the growth of utilities include government air-pollution regulations and licensing procedures (which increase costs) and related difficulties in raising capital for new plants.

Until 1960, the coal industry consisted primarily of coal-mining companies and a few steel firms and utilities. It was also regional, isolated, and confined almost entirely to east of the Mississippi. In the late sixties, however, demand from utilities began increasing. Petroleum firms became major forces in the coal industry as they began to buy operating coal companies, acquired coal reserves, and established totally new coal subsidiaries. By the midseventies, other types of large companies joined oil firms in starting or increasing production, bringing in a still larger base of corporate, managerial, and technical resources. Table 4 presents the top private firms in regard to U.S. Coal reserves.

FIGURE 3

POWER PLANT CAPITAL COSTS
(In 1979 Steam-Plant $/kW,
With Real Interest During Construction)



Source: Charles Komanoff, Science (May 8, 1981) (32)

TABLE 4

U.S. COAL RESERVES, 1981
(Million of Tons)

Company[1]	Reserves	% of Total
Burlington Northern	14,700[2]	5.2
Consolidation (Conoco)	13,700	4.8
Rocky Mountain (Union Pacific)	10,000	3.5
Exxon	9,200	3.2
Peabody Coal (Peabody Holding	8,560	3.0
Phillips Petroleum	8,000	2.8
North American	5,600	2.0
El Paso Natural Gas	5,200	1.8
Island Creek (Occidental	3,800	1.3
Mobil	3,500	1.2
Amax	3,300[3]	1.2
Pittsburg & Midway (Gulf)	2,600	0.9
U.S. Steel	2,300	0.8
Atlantic Richfield	2,200	0.8
Sun Oil	2,200	0.8
Westmoreland Coal	1,949	0.7
Bethlehem Coal	1,800	0.6
Old Ben (Std. of Ohio)	1,713	0.6
NERCO	1,700	0.6
Clinchfield Coal (Pittston)	1,700	0.6
Tenneco	1,700	0.6
Texaco	1,650	0.6
Central Appalachian	1,600	0.6
Ker-McGee	1,500	0.5
R&F Coal (Shell)	1,460	0.5
Can Pac Minerals	1,410	0.5
Norfolk & Western	1,400	0.5
Utah Int'l (Gen. Electric)	1,300	0.5
Donan Joint Venture	1,224	0.4
Texas Utilities	1,150	0.4
Eastern Gas	1,058	0.4
Hillman Coal & Coke	1,000	0.4
Houston Natural Gas	1,000	0.4
Kaiser Steel	1,000	0.4
Western Energy (Montana Power)	1,000	0.4
NICOR	1,000	0.4
Northern Coal	1,000	0.4
Armco	934	0.3
Tennessee Valley Authority	855	0.3
Kentucky River	800	0.3
U. S. Total	284,185[4]	100.0
Oil Firm Total[5]	53,223	18.7

TABLE 4 (Continued)

U.S. COAL RESERVES, 1981

1 Private companies only. The U.S. government owns over 100 billion tons, the largest single share of total reserves (at least 40 percent of the U.S. total).

2 Approximately 5.8 billion tons of Burlington Northern's reserves are leased to coal companies. We are unable to determine if other firms report these leased reserves as their own.

3 20.6% owned by Standard of California.

4 The figure for U.S. total coal reserves indicates an upward revision for coal reserves over previous years' reserves. In 1981, The U.S. Department of the Energy released a study updating earlier estimates of the demonstrated reserve base of coal in the U.S. The Department of Energy estimates this base as equal to 474,556.2 million tons--an increase of 36 billion tons over the January 1, 1976 estimate made by the Bureau of Mines, U.S. Department of Interior. If standard recovery rates of 50 percent is applied for underground coal reserves (times 318,199.7 million tons) and 80 percent for surface reserves (times 156,356.6 million tons), then an estimate is determined of 284,185 million tons for actual recoverable coal reserves using today's technology.

5 Major oil firms in this total are: Ashland, Atlantic Richfield, Belco, Standard of California, Cities Service, Conoco, Diamond Shamrock, Exxon, Great Basins, Gulf, Husky, Kerr-McGee, Louisiana, Land & Exploration, MAPCO, Merchants Petroleum, Mid-Continent Resources, Mobil, Occidental, Phillips, Quaker State, Reading & Bates, R. L. Burns, Shell, Standard Oil of Ohio, Sun, Tenneco, Texaco, Transcontinental, W. R. Grace. Other oil firms hold coal reserves, but each would have less than one million tons. Their inclusion would have a negligible effect on market shares.

Source: Keystone News Bulletin, U.S. Department of Energy, Demonstrated Reserved Base of Coal in the U.S. on January 1, 1980 (U.S. Total).

Most eastern coal reserves are privately owned; on the other hand, 60 percent of western reserves are owned by the federal government and an additional 20 percent of privately owned is dependent on access across federal lands for its production.(16)

Labor Situation

The trend of employment in mines has been generally downward. In 1925 a total of about 750,000 men were engaged in coal mining in the U.S., but by the early 1960's the number had fallen to about 160,000.(15) The decrease in employment has been particularly marked in the anthracite industry. As employment has fallen, the productivity of the individual miner has increased, largely through mechanism.

The coal industry has a highly skilled and dedicated workforce that has increased productivity to the extent that labor costs have not grown since 1978. This is due partly to the fact that fewer mines are producing and the less efficient mines are among the ones that have shut down. Yet productivity also appears to be improving due to the growing realization by both labor and management of their mutual role in attaining a healthy, stable industry.

In recent years, labor-management relations within the coal industry have been strained because of internal factors, such as dissension among leaders of the union and an influx of young, inexperienced workers. More than half of the miners are under 40.

Many have gone to college then back to the mines for the high wages of up to $100 a day.(15)

The UMW presently has 220,000 members.(8) The UMW's share of U.S. coal production has dropped from 70% to 50% since the early 1970's. It has lost ground competitively not only to foreign coal in export markets but also to more cheaply-mined western coal.

The UMW has not been effective at organizing coal miners in the Western states. It is thought that the UMW had spent some $10 million to bring in a grand total of just 542 new members from the West - which is only 17% unionized. The UMW members see nonunion coal as a major threat to their jobs, one reason UMW joblessness stands at 41,000.(15)

Strikes have hurt UMW's efforts to organize expanding coal fields in the Western U.S., which are now producing 56% of coal output. The industry has been affected with a pattern of contract strikes in recent years--44 days in 1974, 111 days in 1978, and 72 days in 1981.(8) The lesson many industries learned from the UMW's decision to strike is that coal from the Eastern U.S. still cannot be counted on as a reliable source of energy.

A stronger union with an ability to keep its members disciplined, could be good for the traditionally fragmented industry. The objective is to restore competitiveness to the industry. In order for U.S. coal to compete in domestic and world markets, the cost of labor must relate directly and proportionately to productivity. On the other hand, more effective organizing will enable the UMW to increase its bargaining leverage.

CHAPTER III

TRANSPORATION: AN UNNECESSARY CONFLICT?

> We are not so displeased as surprised. When you think that the U.S. put a man on the moon, you'd think that it would have modern railroad and pier facilities. But the technology is 30 to 50 years out of date.
>
> Eric Thibau, Commercial Attache' of the French Embassy in Washington(7)

With the apparent inevitability of a greater dependence on coal for energy in the United States, a huge development effort will be required--new mines, more miners, and an expanded system for transporting coal to the plants where it will be burned or converted into liquid or gaseous forms. Table 5 shows the projected transportation requirements by the year 2000.

TABLE 5

COAL TRANSPORTATION REQUIREMENTS, 1976-2000
Percentage by Mode

	Percentage by Mode		Average Haul	
	1976	2000	1976	2000
Convention Train	34%	14%	490 MI.	520 MI.
Unit Train	23%	50%	580	990
Coal Barge	29%	17%	650	440
Coal Truck	14%	9%	50	50
Slurry Pipeline	0	10%	0	980
Total Coal	100%	100%	480	940

Source: Mr. J. R. Stephens, Project Development Coordinator, Petroleum Supply Division of Petroleum Products Group, Phillips Petroleum Company.

Most of the coal is now carried by railroads, and they have taken the position that they will be able to keep up with any increase in the traffic. The increasing dependence on the railroad will be especially great in the West because its low sulfur coal can be surface-mined as well as because of the expected growth in the use by Western utilities. This makes the railroad the key means of transportation since it is already in place, although not necessarily with sufficient capacity, where there are no navigable waterways.

Truck transportation is mostly used from mine mouth to processing for shipment. Trucks do make distritution to small, short-distance customers; however, this service should decline toward the year 2000 as distances increase and customers get larger.

Uncertain is the ability of the railroads to carry the expected growth of coal traffic in the West. The principal rail carriers of Western coal are the Burlington Northern, Chicago and Northwestern, Union Pacific, and the Denver and Rio Grande. To service the large surface mines of the West, these railroads are increasingly using unit trains, which consist of a chain of about a hundred hopper cars with each carrying a hundred tons of coal. Fifty percent of the coal carried by rail now moves on unit trains, and a potential problem is the availability of sufficient coal cars and locomotives to meet the demand. For example, in 1976 the Burlington Northern used about fifty-five such trains per week; by

1985 it will require as many as two hundred.(27) The hundred-car trains are expensive as well as the maintenance needed to keep the tracks in running condition. Norman M. Lorentzsen, president of the Burlington Northern, has stated that fuel costs have risen by 301 percent since 1967 and wages have increased by 174 percent.(38)

The new demand on railroads to carry coal places enormous stress on their capital expenditure requirements for hopper cars, locomotives, physical plant improvements, and maintenance facilities. However, both government and industry groups believe that, if demand for coal expands at the projected rate, the capital will become available for upgrading the railroads and other parts of the transportation system. In the May 1980 report of the WOCOL, government and industry participants concluded that "the amount of capital required to expand production, transport and user facilities to triple the use of coal (by the year 2000) is within the capacity of domestic and international capital markets."(1)

Railroads also face other problems. First, Western railroads create their own set of environmental and social hazards. Frequent unit trains can rumble through towns, disrupting whole communities. Auto traffic is delayed and various studies project an increased number of train-related accidents. The cost of bypassing these communities altogether presents a significant and still largely unknown factor in the economics of coal rail transportation.

Second, there is some chance that the railroads might not carry all the increased output of the West, for they face potential competition from slurry pipelines. In a slurry pipeline system, coal is pulverized to the consistency of sugar and then mixed with an equal amount of water to form a slush-like mass that can be pumped through an underground pipeline three or four feet in diameter. When it reaches its destination, the slurry is put through a dewatering plant where the coal powder and water are separated by a centrifuge. The powder can then be burned as fuel by a power station, while the water can be used in the utility's cooling system. To avoid pollution, the waste water can then be allowed to evaporate.(30)

In many ways, slurry systems have major advantages over rail transport of coal. Not only are they nonpolluting and inconspicuous, once installed they are also highly reliable. The Black Mesa pipeline, a 273-mile pipeline which runs from Kayenta, Arizona to the Mohave Generating Station in southern Nevada, has been out of action for less than one percent of its time in service.(19)

The Congressional Office of Technology Assessment has reported that the potential advantage of slurry pipelines lies in the fact that the volume of coal that can pass through the pipeline can be increased considerably without a corresponding rise in operating costs.(52) Pipeline operating costs are relatively stable while railroad costs are not. The reason is that the railroads are burdened with high labor costs partly due to union work rates.

Bechtel, Helman, and Kansas-Nebraska Natural Gas Company, partners in a coal slurry venture called Energy Transporation Systems, Inc. (ETSI) projected in one study that slurry rates would not rise over one percent a year versus nearly five percent for the railroads.(18)

Construction of a pipeline invariably requires the crossing of routes on lands controlled by other transport systems--principally the railroads. The railroads have fought legislation at both the federal and state level that would give slurry pipelines the right to eminent domain across land owned by the railroads. Pipeline sponsors, though, through successful court suits and state legislation are gradually obtaining eminent domain power. The Congressional Office of Technology Assessment, asked by several committee chairmen to look into the matter of eminent domain, concluded that "coal slurry pipelines do represent under some specific circumstances the least costly available means for transporting coal" and without a right of eminent domain pipelines would have difficulty competing with railroads.(32)

The railroads, which depend on coal-hauling for 11 percent of their revenues and even more of their profits, readily concede that slurry lines will be attractive enough to steal much of their coal business, possibly driving several railroads to bankruptcy. Louis Menk, chairman of Burlington Northern, has said that competition from the proposed ETSI pipeline alone could cut the railroad's revenues by $150 million a year. Burlington Northern has already spent nearly 600 million on the transformation into the nation's leading hauler of Western coal (BN hauls approximately two-thirds of all Western coal) and has yet to have any of it returned. Complete plans included BN having to invest $1.2 billion in new track, centralized traffic control, and locomotives by the end of 1983--including upgrading 800 miles of track between Billings, Montana and Lincoln, Nebraska and laying 116 miles of new railroad at a cost of $1 million per mile.(31)

The decision to build slurry pipelines is not likely to be decided solely on the basis of cost. The Congressional Office of Technology Assessment pointed out in a report that a decision depends on the weights that are assigned to other issues. The report identifies three major groups of issues.

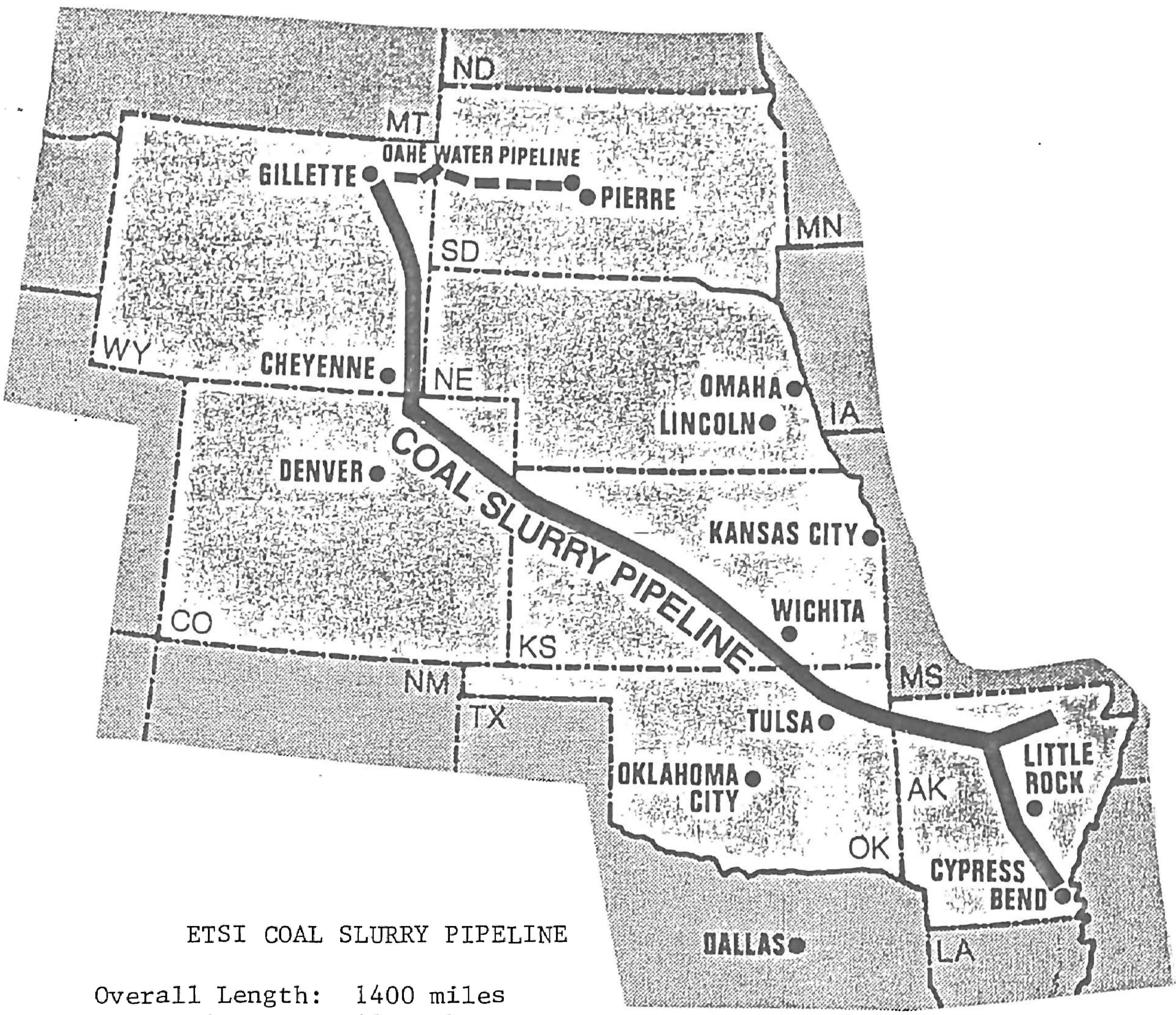
> The first group concerns the desirability from social, economic, and environmental standpoints of developing an industry for carrying coal by pipeline. The second concerns the extent to which the present regulatory and institutional arrangements would have to be changed to provide forthe allocation of coal traffic between pipelines and railroads in a way that would represent the least cost to society. The third concerns the balance between state and federal control over such matters as the allocation of water resources, the ownership of land and the protection of the environment.(32)

Pipeline developers must contend with environmentalists who object to slurries because of the vast amounts of water that would drain away from areas that are already water-short. A 1,100 mile slurry pipeline proposed by Houston Natural Gas Corporation would use enough water to supply 40,000 people per year. Company officials counter by saying that no drinkable water will be used. Their intention is to drill for brackish or saline water unfit for human consumption or agriculture.(19)

The proposed ETSI pipeline alone would require 4.9 billion gallons a year,(30) which is a highly emotional issue with many ranchers. However, the State of Wyoming has given ETSI permission to take what it needs from subterranean pools in the Madison formation, a geological basin alongside the Big Horn Mountains whose water is too salty for home use or farming (See Figure 4). Hydrologists fear, though, that pumping the five billion gallons yearly from the formation in Wyoming could adversely affect ground water supplies in that state and South Dakota. Many agree that a slurry pipeline would put far less pressure on the water supplies than most other methods of using the coal. Evaporation loss, alone, is ten times the amount ETSI will utilize annually; but if the first pipeline proved profitable, others would surely follow and a rash of lines could than deplete the water supplies.

Other factors, such as environmental regulation, court litigation, and environmental impact statements, have also slowed down the rush to mine Western coal. At a meeting in July 1979 of the Western Governors Conference, the ten Western states represented served notice that they want a "cautious approach" to coal development. They want compensation for environmental damage and a

Figure 4



ETSI COAL SLURRY PIPELINE

Overall Length: 1400 miles
Diameter: 40 inches
Water Line: 270 miles
Pump Stations: 19 (every 80-100 miles)

Source: Oilstream Economic Report, vol. 10, February, 1983.

national conservation effort at least as aggressive as the current drive for synthetic fuels.(36)

Inland and coastal waterways. Waterways, where they exist, provide the most efficient and least expensive means of moving coal. However, there are no waterways serving many areas where coal needs to be moved.

Barging, for the most part, is used to move coal from producing mines near the rivers to power companies, industrial consumers, and steel plants. Over a million tons of coal per year move by barge down the Ohio, Missouri, and Mississippi Rivers. It has been projected that barge traffic on these rivers is nearing practical limits, with locks being the prime bottleneck for increases in coal shipments. Elimination of bottlenecks are now becoming more difficult because of environmentalists and other pressure groups.

The probable limit to expansion of coal traffic in the inland waterways is lock capacity. Major traffic jams have already been occurring at strategic spots such as the southern Illinois area where the Mississippi, Missouri, Illinois, Ohio, Cumberland, and Tennessee river traffic flows converge. Inadequate lock sizes are causing these delays.

In addition to barge facilities, port facilities are also insufficient. While experts predict that America's vast coal reserves could become an important export product, the use of coal is being hampered by the U.S.'s inadequate and outdated transportation system. The export demand for coal in Europe increased by nearly 100% from 1981 to 1982, yet buyers were unhappy about the delays in delivery.(7) The sudden surge in demand put a strain on existing pier facilities, leading to port congestion and excessive waiting time. U.S. piers have little storage capacity, so that railroad cars stocked with coal wait weeks to be unloaded.

The vast majority of coal moving out of the U.S. goes over a group of ports located between the mouth of Chesapeake Bay and New York. These are served by eastern railroads (Conrail, Chessie, and N & W) that gather coal from producing areas in the Appalachians. This group of ports handled a little over three-fourths of all U.S. exports, with more than half of the U.S. total moving through the Hampton Roads area--which includes the Virginia ports of Newport News and Norfolk.

Aside from these ports about 20 million tons go to Canada by rail and through the Great Lakes ports. Minor volumes are shipped through Mobile, New Orleans, Long Beach, Portland, and others. Listed in table 6 are some of the important U.S. coal ports.

It was impossible to foresee the market shift which created the transportation logjams that hamper the growing export market. However, this is a short-term situation resulting from the sudden increase in demand, and it will be alleviated over the course of the next several years as the current plans to put new port facilities in place are completed and as export demand slackens. New coal

TABLE 6

COAL EXPORT PIERS

Port	Coal Piers	Draft	Max. Ship.	Serving Railroad	1980 Volume	Rated Cap.
Newport News	No. 14 & No. 15	45'	80 MDWT	C & O	18.3	21.8
Baltimore	Curtis Bay	40'	70 M	B & O	11.0	15.0
Baltimore	Canton	31'		Conrail	1.0	
Norfolk	No. 5 & No. 6	48'		N & W	31.9	33.0
Philadelphia	Greenwich	40'		Conrail	1.4	2.5
Philadelphia	Pt. Richmond	35'		Conrail	0.2	
Mobile	McDuffle	40'		ICG	4.6	5.5
New Orleans	Plaquemines					
Davant	Electrocoal					7.0

ports have been considered at Savannah, GA, Morehead City, NC, and Charleston, SC. Port officials in New York City, Houston and Galveston, Texas, and Wilmington, Delaware have also considered the addition of coal-handling equipment.

Ocean freight rates are dependent on vessel size as with other commodities. Because of shallow drafts, U.S. ports are restricted to smaller vessels which increase freight costs. The largest collier calling at a Hampton Roads port in 1980 was 84,000 dead weight ton (DWT) and most vessels are in the Panamax class. Nearly all shipments to the Far East are in Panamax class vessels as the longer voyage around Cape Horn offsets the savings in a larger vessel. Average rates in 1982 for vessels used are reflected in table 7.

Railroad and port officials are working together to upgraderail and port facilities. Island Creek Coal Company of Kentucky and Consolidation Coal, a Pittsburg firm, are investing 170

TABLE 7

SINGLE-TRIP OCEAN FREIGHT RATES PER LONG TON OF COAL

(35,000 - 60,000 D.W.T.)

Source: American Tanker Rates

	U.S. North to Hatteras	U.S. $/Long Ton to: U.S.
Gulf to:		
Dunkirk/Hamburg Range	$14.00/$20.00	$17.00/$22.00
North Spain, Atlantic Coast	$14.00/$19.00	$17.00/$21.00
Spanish Med.	$16.00/$21.00	$19.50/$23.00
Port Talbot or Redcar, U.K.	$14.00/$20.00	$17.00/$22.00
FOS, France	$13.00/$17.00	$16.00/$21.00
Constantza, Romania	$24.00/$29.00	$26.00/$30.00
Japan	$27.00/$30.00	$27.00/$30.00
Pohang, S. Korea	$27.00/$30.00	$27.00/$30.00
Alexandria, Egypt	- /$25.00	. /$27.00
Lazaro Cardenas, Mexico	$14.00/$16.00	$14.00/$16.00
West Coast Italy	$14.00/$18.00	$16.00/$21.00

New Castle, Port Kembla or Sydney, Australia to:	
Dunkirk/Hamburg Range	$23.00/$26.00
North Spain	$23.00/$26.00
West Coast Italy	$24.00/$28.00
Port Talbot or Redcar	$25.00/$29.00
U.S. Gulf or U.S. Atlantic	$15.00/$17.00
Japan	$15.00/$17.00
Vancouver, including Roberts Bank, Canada to:	
Dunkirk/Hamburg Range	$20.00/$23.00
Japan	$13.00/$15.00
East Coast Canada (St. Lawrence River)	$16.00/$18.00

million dollars to improve Baltimore's port.(5) Consolidation also bought the Canton Terminal in Baltimore, adding 10 to 20 million tons of shipping capacity there.(7)

Foreign buyers are trying to skirt congestion problems by loading at different ports. France's Association Technique de l'Importation Charbonnaire, which does all that country's coal buying, is considering investing in coal-terminal expansion in New Orleans.(45)

If more such steps are taken, predictions are that exports of steam coal alone could reach 200 million tons a year by the end of the century. An expected increase in U.S. metallurgical coal in Japanese and European steel mills would add to that demand.

CHAPTER IV

MARKETING: AN AFTERTHOUGHT?

Since the mid-seventies, the government and others have placed much emphasis on coal as an alternative to imported oil. However, the results of attempts to develop coal has been disappointing. Whereas domestic oil and natural gas are constrained by geology, coal is hemmed in by political issues. The political conflict has arisen over what the public sees as the side effects of producing and using this energy source.

Today coal provides 18% of U.S. energy, or the equivalent of 7,000 barrels per day (MB/D). The National Energy Plan introduced by the Carter administration called for an increase in coal supply between 1976 and 1985 that would provide the equivalent of an added 7.9 MB/D of oil. The experience of the past few years, though, makes it appear unlikely that the rapid growth indicated in the Plan can be achieved.

An important reason for slower growth is external costs in the form of environmental and health problems. In particular, there are acid drainage from mines, the disruption of life in western communities by unit trains hauling coal, and when it is burned, the release of sulfur dioxide and a host of other pollutants. Perhaps most serious of all in the long run may be the unknown consequences for future generations of increasing the temperature of the atmosphere by producing carbon dioxide.

Some of these problems can be dealt with, for example, through the installation of scrubbers by utilities (to remove sulfur dioxide), the building of overpasses over railroad tracks, and the return of strip-mined land to its original contour and condition. However, there has been controversy over costs and their allocation, and agreement is not yet politically in sight.

Attention is being given to making coal burn cleaner. Another area for continued research is fluidized-bed combustion in which coal is burned in a bed of granular particles held in suspension in a air stream. Other promising areas are gasification and liquefaction. These latter two areas are attractive because a structure already exists to transport oil or gas.

Detailed market opportunity analysis has been conducted by government and private industry alike involving coal conversion. As these studies evolved, the best market opportunities appear to be low to medium BTU* fuel gases produced on site for specific

*BTU stands for British Thermal Unit--the heat required to raise the temperature of one pound of water of $1^{o}F$ at or near $39.2^{o}F$. Gas with an energy value exceeding 900 BTU per cubic foot (cf) is generally labeled high-BTU gas. Low-BTU gas has a heating value of 100-200 BTU/cf and medium-BTU gas, 300-650 BTU/cf.(41)

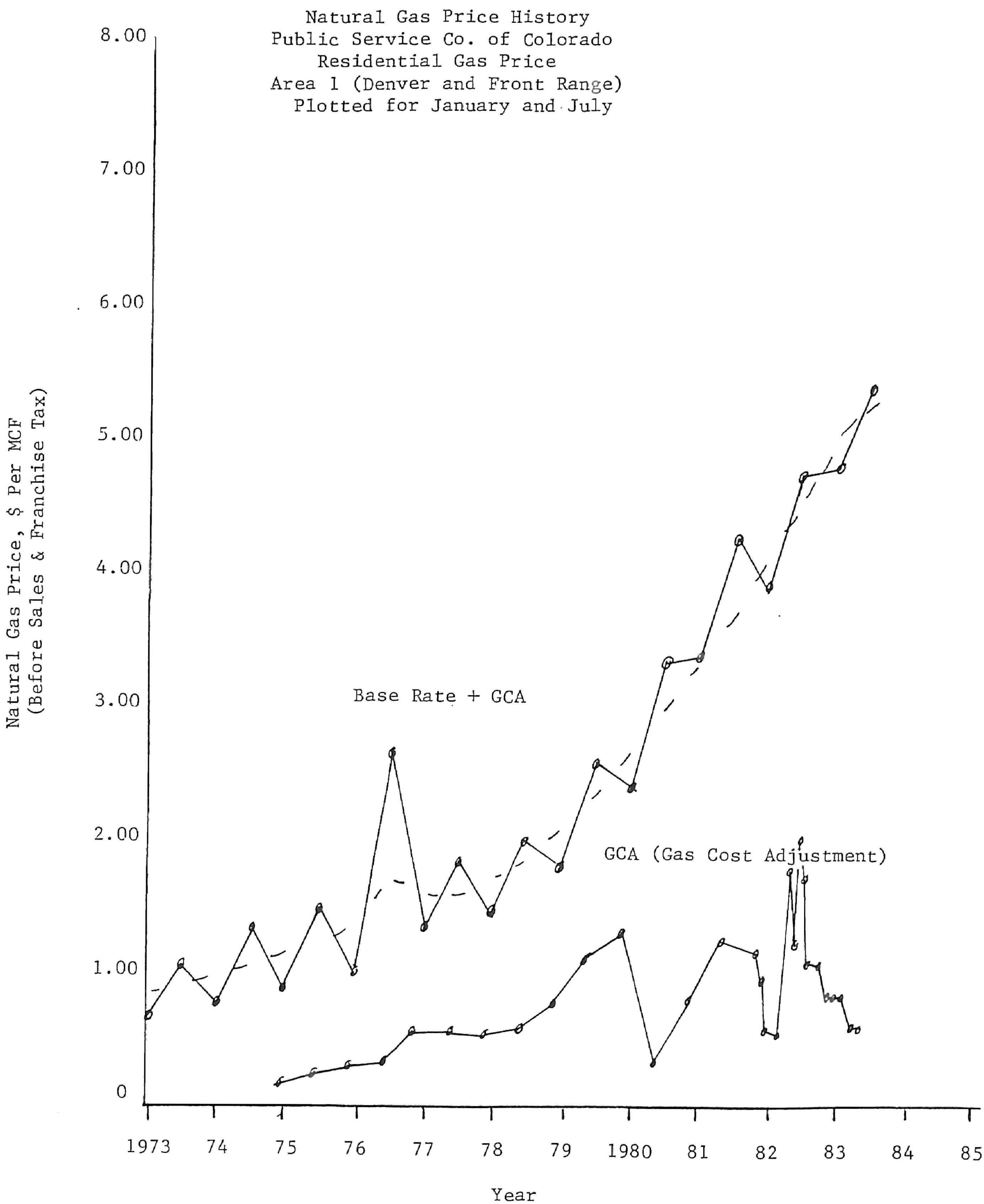
industrial/utility customers. The technology exists today, commercially proven both in the U.S. and around the world to make these conversions. Shortage of captial due to the 1981-82 recession, uncertainty in competing fuel price forecasts, as well as outdated thinking and inertia against change, have held back conversions.

The price of natural gas in selected regions has already passed the breakeven point for economic production of low and medium Btu gas, primarily in the following areas: 1) in the brick, block, glass, and ceramic industry; 2) in selected primary metals, pulp, and paper (lime kilns); and 3) in primary industrial minerals (e.g. phosphates, soda ash). In addition, due to the incentives for cogeneration of electricity in the Public Utilities Regulatory Policies Act of 1978, a great deal of coal use should be anticipated in the future, particularly in such industries as chemicals and steel.

As a quick rule of thumb, low BTU gas (LBG) from coal can be produced for \$2.50/MM BTU plus the cost of delivered coal. If coal delivers at \$1.50/MM BTU, then LBG can be produced for \$4.00/MMBtu, including capital recovery. Natural gas prices have exceeded \$4.00/MMBtu in many places in the U.S. (see Figure 5).

Contrary to recent press, industry is moving forward with synthetic fuels but not necessarily at the levels indicated a few years ago. A few big projects (such as Great Plains, Coolwater, and Tennessee Eastman) are being built with Federal backing. 1) Under

Figure 5


Natural Gas Price History
Public Service Co. of Colorado
Residential Gas Price
Area 1 (Denver and Front Range)
Plotted for January and July
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0
Natural Gas Price, $ Per MCF
(Before Sales & Franchise Tax)
Base Rate + GCA
GCA (Gas Cost Adjustment)
1973
74
75
76
77
78
79
1980
81
82
83
84
85
Year

the Great Plains project, the primary product involves methane which will be sold to pipeline gas transportation companies. 2) The Cool Water Project involves electricity which will be sold to an electrical utility company; and 3) the Tennessee Eastman project, whereby the primary product is a synthesis gas, which will be converted into chemicals. Yet the synfuels industry for the 1980's is going to be more dispersed, involving customer-specific needs in geographic areas of high cost natural gas oil. Major projects in energy parks or involving the creation of synfuel products for liquid fuels is more distant--beyond 1990.

Of all coal-based liquid synfuels, the most promising appears to be methanol. Ford Motor Company, Du Pont (which purchased Conoco, Inc. in 1981), and a few others are taking the lead in this area. Fleet uses such as BankAmerica in California will occur first to be followed by mass marketing. Although Du Pont has currently delayed its plans for marketing methanol, the early planning stages visualized that the automotive market would be used in a limited area--one state or a group of adjacent states--so that they could provide the requisite service station outlets without going to national distribution immediately. As the demand expanded, additional service station outlets would be provided. This strategy is similar to the development of the diesel fuel and unleaded gasoline markets, although other factors provided the driving force for marketing these products.

With the prices of more traditional fuels falling, the future of synfuels is once again being questioned. However, one should only look back a few years when oil was $3.00 per barrel and gas was $0.20/MCF. Today, oil hovers at $30.00/bbl and gas exceeds $4.00/MCF to $5.00/MCF in several areas of the country. Given the volatile international political environment, a major disruption in oil supply could still easily happen. Natural gas deregulation effects are quite complex, but generally, prices are projected to rise faster than inflation (two to three percent). A 1984 Data Resources, Inc. industrial sector natural gas price forecast for the Mountain I region, which includes the massive overthrust production area, projects a 1990 price of $4.71/MCF and a year 2000 price of $6.69/MCF (in constant 1983 dollars). In current dollars, assuming about six percent per year inflation, these equate to $7.19/MCF and $18.46/MCF respectively (see figures 6 and 7.)

Steam Coal Market

The primary steam coal demand will be for high BTU bituminous coal with a low sulfur content generally below 1.5 percent. Also, coal deposits that are favorably located on good inland transportation systems will have the competitive edge.

From the viewpoint of the customer, he is purchasing BTU's on a net-delivered cost basis. High quality coals with good heating value will be at a disproportionate competitive advantage against

Figure 6

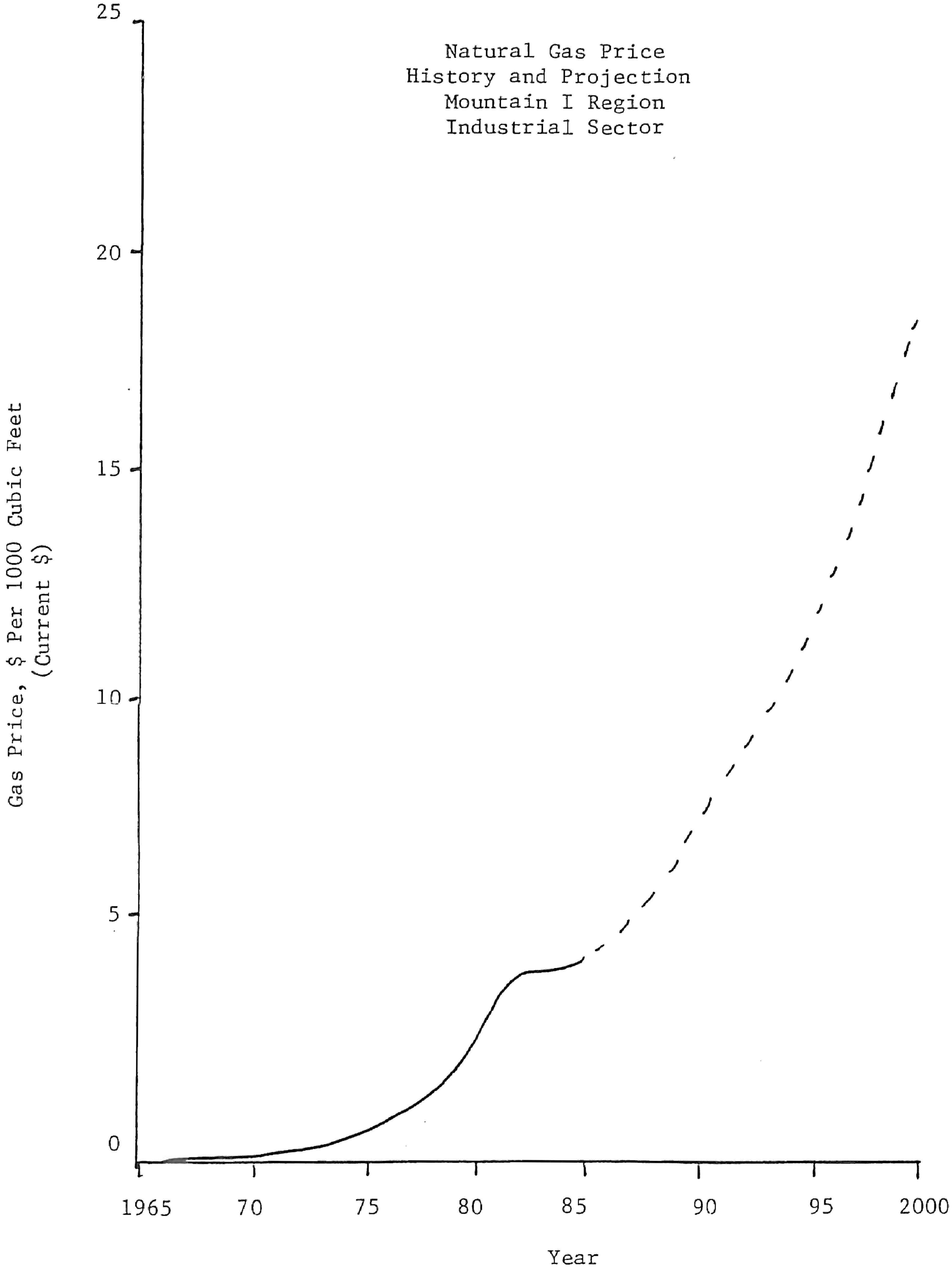
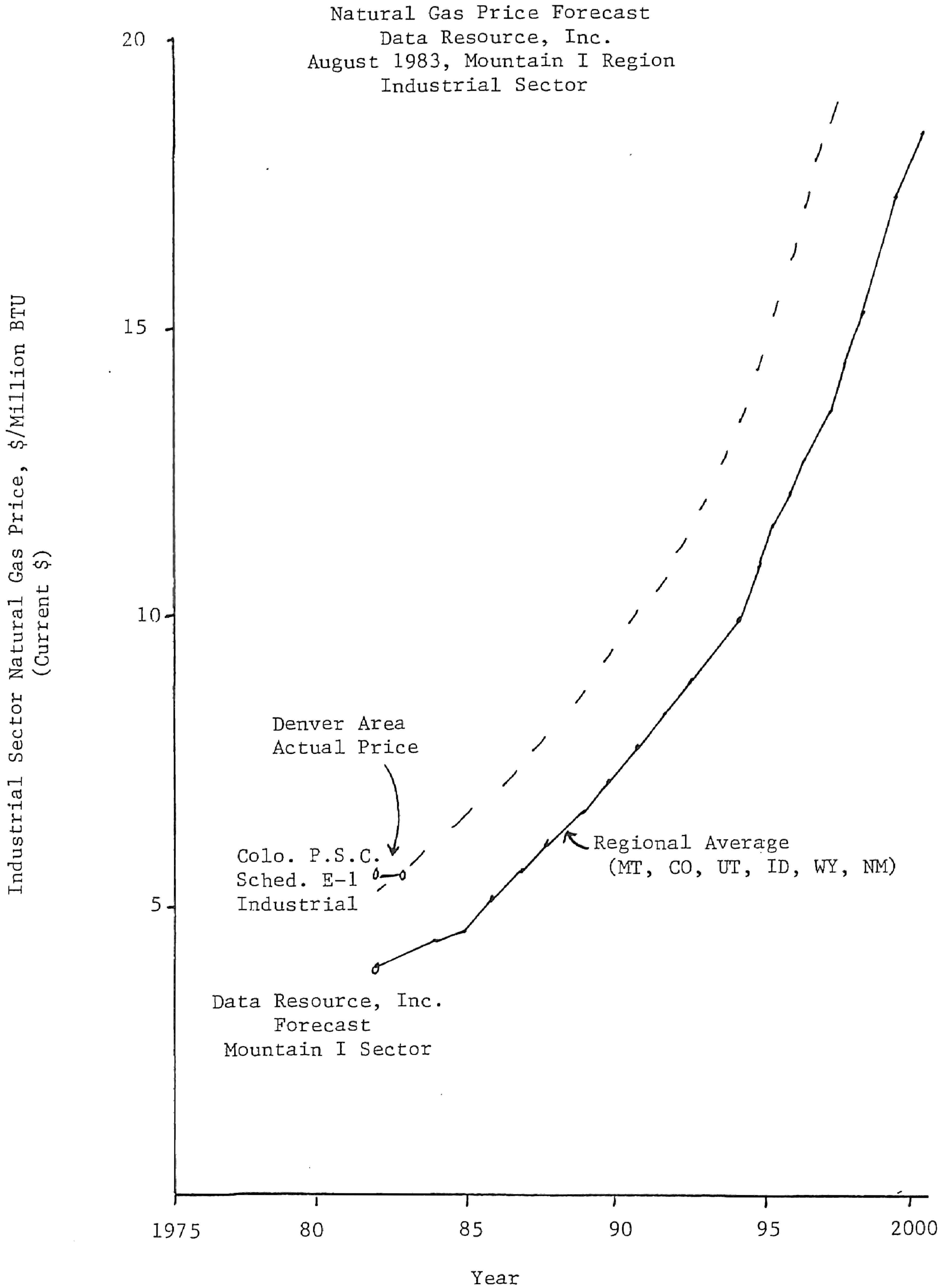

Natural Gas Price
History and Projection
Mountain I Region
Industrial Sector
25
20
15
10
5
0
Gas Price, $ Per 1000 Cubic Feet
(Current $)
1965
70
75
80
85
90
95
2000
Year

Figure 7


Natural Gas Price Forecast
Data Resource, Inc.
August 1983, Mountain I Region
Industrial Sector
20
15
10
5
Industrial Sector Natural Gas Price, $/Million BTU
(Current $)
Denver Area
Actual Price
Colo. P.S.C.
Sched. E-1
Industrial
Regional Average
(MT, CO, UT, ID, WY, NM)
Data Resource, Inc.
Forecast
Mountain I Sector
1975
80
85
90
95
2000
Year

the lesser value coals. This is because transporation costs are a good portion of the entire delivered costs. With lower value coals, more tonnage must be shipped for a given BTU output, and this increases the overall costs more than is readily apparent. For example, consider a low sulfur 13,000 BTU West Virginia coal selling for $37.00 per ton at mine mouth. With inland freight of about $18.00 per ton, this coal could be landed at Hamburg for $61.00 per ton or $2.35 per million BTU's. For a hypothetical coal having the same transportation cost picture but with a heat content of only 11,000 BTU per pound, 18 percent more coal will be needed for the same heat output and freight must be paid on the added volume. To be competitive with the higher quality coal, the lower grade must be priced at $27.70 per ton at the mine mouth; a price reduction of over 36 percent results from a difference of 18 percent in BTU content.

If the low value coal were also not favorably located for relatively cheap transportation, the disadvantage would be even more keenly felt. With the mine producing the 11,000 BTU coal located at Chelsea, Oklahoma, combined inland and ocean transportation through Mobile would amount to $33.00 per ton. To be competitive with the West Virginia coal, it would have to be priced at less than $19.00 per ton. Even worse, the freight on enough 8400-BTU Gillette, Wyoming coal, to give the same heating value as West Virginia coal, would amount to over $70.00--which clearly would make this coal uncompetitive with present conditions. Of course, these low value coals could compete very well in domestic markets where freight is not such a factor.

Sulfur is another matter for increasing concern among overseas customers. Europeans, in particular, are becoming more and more concerned about sulfur emissions as they pose health hazards as well as cause damage to their many beautiful and historic marble statues and buildings. Most European countries already have emission codes and these are likely to be tightened in the future. Low sulfur coal will be more in demand than the grades with more sulfur.

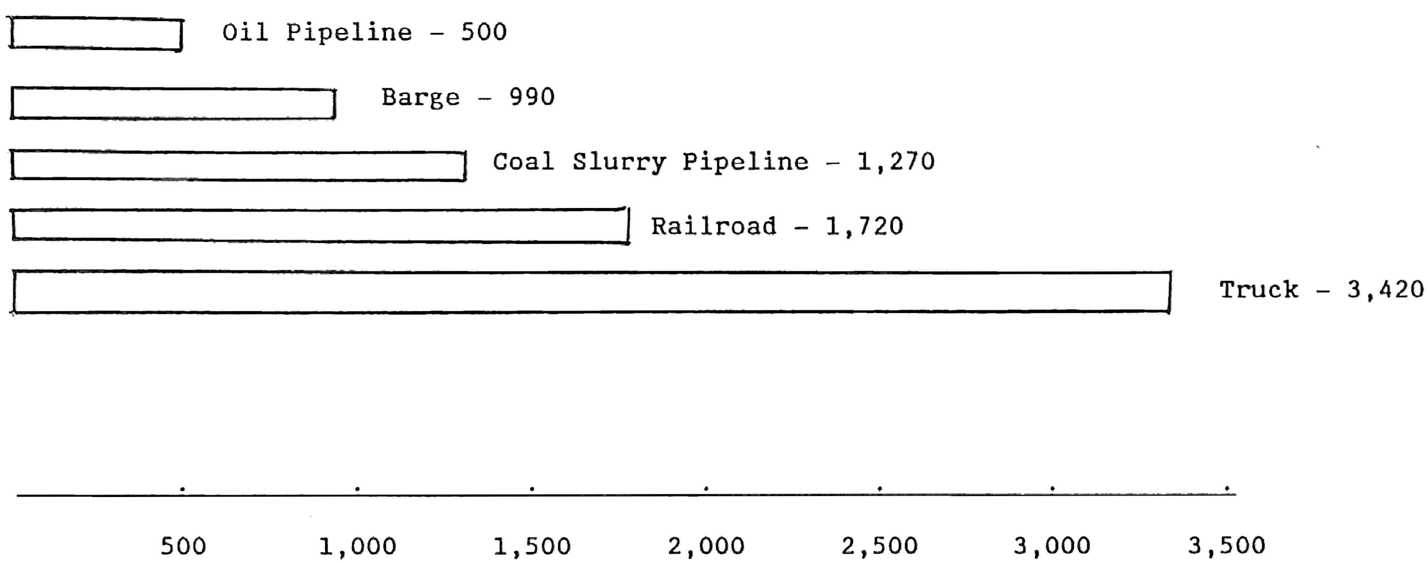
In the near term, though, the region most favorably situated to participate in the export market is the Southern Appalachian basin including parts of West Virginia, Kentucky, and Virginia. This is the only area at present with an adequate transportation system, good ports, and competitive quality coal. Over the long term, as transportation and ports are improved, Western coal from certain areas will likely become a major factor, particularly as heavy demands deplete some of the better Appalachian reserves.
Figure 8 exemplifies one of the determining factors of transportation costs.

How is Coal Marketed?

Coal is priced and sold domestically and in international trade, primarily on long-term contracts that call for delivery of

FIGURE 8

BTU's OF ENERGY REQUIRED TO MOVE ONE TON OF FREIGHT ONE MILE



Source: Congressional Budget Office 1982 specified volumes of coal with certain chemical and physical characteristics over the contract life. Coal not bought on long-term contract is sold on the spot market where prices are free to fluctuate according to forces of supply and demand at that point in time.

Most coal in the United States is sold under a long-term contract of 20 to 30 years. Utilities are anxious to secure long-term contracts since utility plants are engineered to utilize coal with very specific characteristics. Using a different type of coal usually results in lower levels of efficiency. About 80 percent of utility coal purchases are made under long-term contract.(28) This coal is generally priced at a basic price with an escalator to account for higher production and transportation costs. Customers for metallurgical coal also try to secure long-term supply arrangements to satisfy their needs of high quality met coal.

Most large coal companies maintain their own sales staffs that handle all coal sales between their company and its customers. Some companies will additionally act as brokers for other companies. Smaller coal companies commonly rely on independent coal brokers who charge sellers a fee for their services.

Historically, international coal trade has involved mostly metallurgical grade coals for cokemaking. However, as energy requirements expand in energy-deficient nations, these nations are coming to rely increasingly on imports of steam coal from the major coal-producing nations.

Coal prices naturally fluctuate with supply and demand factors from time to time. They also depend strongly on coal quality, location, and other conditions. To give a representative picture of steam coal pricing, the table 8 illustrates approximate spot market prices during the first few months of 1981.

Currently the demand for coal hinges predominantly on the generation of electricity, and expectations are that this demand will remain flat through the 1980's. Electricity sold to industry is the crucial factor in electrical generation and the amount of coal-fired capacity the utility industry uses.

Emphasizing the importance of the industrial sector's electricity is the two percent national decline in total electricity use during the 1981-1982 recession. The decline of the industrial component of electricity consumption was worse, dropping by eight percent as steel, auto plant, and other factories shut down. However, the residential and commercial components were actually increasing their electricity use by about two percent,(28) meaning the overall decline was due solely to the shrinkage in industrial use.

What will greatly help is legislation such as that which was approved recently by the New York State Senate, aimed at encouraging utilities to construct alternative energy generation facilities orc onvert oil-fired plants to burn coal. The legislation would permit utilities to include in their rate base the costs of converting oil-fired plants to coal, wind or solar. The utilities could then

TABLE 8

INTERNATIONAL SPOT STEAM COAL PRICES

Country/Port	BTU/LB	% Sulfur	% Ash	Price*
U.S. Norfolk	11,500	Below 1.5	15.0	$47.73
	11,500	1.5	16.0	$40.00-44.09
Baltimore	12,000	Below 1.5	13.5	$44.55
Mobile	11,300	1.3	15.5	$41.36
Poland Gdansk	11,300	1.0	13.5	$40.90-49.32
S. Africa Richards Bay	12,500	1.0	13.0	$39.77
	11,900	1.0	15.0	$38.41
Australia Newcastle	12,000	Below 1.0	13.0	$41.36-51.36
	11,500	1.0	15.5	$38.18-48.18
Europe ARA**	11,200	1.5	15.0	$63.18
	11,000	1.5	15.0	$52.27-61.36
	11,300	Below 1.0	1.5	$62.73
	11,500	1.0	15.0	$65.00
	12,200	Below 1.0	12.5	$67.73
	12,000	1.5	15.0	$65.45
	12,500	Below 2.0	13.2	$68.64
Spain	11,200	1.5	17.0	$63.64
	11,700	1.0	13.0	$65.45
U.K.	11,500	1.75	14.0	$60.90
Germany	12,000	1.35	12.5	$69.55
	11,500	1.1	13.5	$66.82
	12,200	1.2	13.5	$71.82
Taiwan	12,000	1.8	16.5	$57.73

*Prices in U.S. Dollars per short ton. Add or subtract 27.3¢ per ton for each 100 BTU above or below stated specs. Add or subtract 27.3¢ for each 0.1% sulfur deviation from specs.

**Amsterdam, Rotterdam, Antwerp

could then avoid paying interest on construction loan financing. The crux of this bill is to deliver alternative sources to oil-fired generation to consumers at the lowest and fastest possible cost.(53)

The potential applications of coal gasification and liquifaction processes extend far beyond utilities. The force behind the interest in cogeneration is that it shows significant improvement over conventional generation in fuel efficiency. In conventional electrical generation, fuel is burned in a boiler to produce steam, which is fed to a steam turbine to drive a dynamo. Typically only 35 percent--and sometimes as little as 28 percent -of fuel is converted into electricity. However, an industrial steam user, since it using the steam directly for heat, converts more than 80 percent of fuel's energy value into useful steam.

A cogeneration plant supplies electricity and steam with an overall fuel efficiency of 70 to 80 percent. In topping-cycle cogeneration, by far the most prevalent type, the fuel is used to generate steam or burned and the steam or hot gas is expanded through a turbine. The cycle operates much like the one in an electric-generating station, except that the heat-laden exhaust is put to work in process use.

The economic benefit of using a combined cycle in a cogenerating plant lies basically in its ability to produce more power than an ordinary steam or gas turbine cogeneration plant. Whereby a conventional steam turbine cogeneration plant can produce 72 kw/million BTU and a gas turbine plant can produce 200 kw/million

BTU, the combined-cycle plant can turn out 265 kw/million BTU. In addition, cogeneration becomes even more attractive as fuel costs rise.(11) Table 9 summarizes the relationship of cogeneration to industry.

Merchant Ships

Because of rising oil prices, coal appears ready for a return to the merchant ship business. World shipping presently consumes nearly four billion barrels of oil a year, about seven percent of total world oil demand.(6) With oil at $200 a ton and coal only $50, the annual fuel bill of a ship that uses 30,000 tons of oil a yearequivalent to 48,000 tons of coal-would be $6 million for oil but only $2.4 million for coal.

Only a few of today's merchant ships, now almost wholly diesel-powered, are scheduled for replacement by 1999. If world trade is to become less dependent on the whims of oil suppliers, the propulsion system of today's ships will have to be converted from diesel to coal-fired steam engines. Conversion to coal is practical for container ships of all sizes because much of their cargo is carried above deck. However, conversion is not likely to be economical for bulk carriers of less than 70,000 tons because the coal-handling and storage facilities would take up too much cargo space. The cost of equipping a 20,000 ton container ship with a new boiler, stokers, bunkers, and appropriate coal-handling equipment

TABLE 9

HOW INDUSTRY RELIES ON COGENERATION

Industry	Plants With Cogeneration	Cogeneration Capacity (Mega Watts)	Share of Cogeneration Capacity
Chemicals and Allied Products	62	3,438	23.1%
Pulp and Paper	136	4,246	28.6
Petroleum and Coal Products	24	1,244	8.4
Rubber and Misc. Plastic Products	3	76	0.5
Stone, Clay, and Grass	6	115	0.8
Primary Metals	39	3,589	24.2
All Other	101	2,150	14.4
TOTAL	371	14,858	100.0

1982 Data Source: U.S. Dept. of Energy

would be about $10 million, which owners would recoup through reduced fuel costs in less than four years.(6)

Home heating. Another market segment is homeowners who are turning to coal for home heating. More than 100,000 coal stoves are being sold annually, and sales of the fuel in quantities small as 25 pounds were brisk enough to cause shortages in many parts of the East during the winter of 1980.(45)

Export Business. Many predictions are that exports of steam coal alone could reach 200 million tons a year by the end of the century. However, there is uncertainty of the future export potential because of reduced world demand due to energy conservation; recession in the markets which Pacific Rim countries try to fill-autos, televisions, and other finished products; the history of long strikes by union miners, and an insufficient transportation system.

The UMW is hoping to regain unity and stability under the leadership of Richard Trumka. However, its inability to join forces with Western coal miners thus far suggests that it will be a while longer before the mine workers receive the political clout they need.

The transportation system, as it exists today, is simply insufficient and, therefore, more costly to the shipper. Transportation costs will continue to plague the industry, especially the Western coal industry, and producers will have to work harder to increase sales in the future.

Producers must look first to utilities that are using only small percentages of their coal-fired capacity. These will be the first to re-enter the coal market when electricity demand improves. The producers must also aggressively scout utilities with new power plants planned or conversions anticipated. The marketing effort should also be directed toward the large industrial user. These may be the only industrial users which would be able to realize recovery costs for conversion over a reasonable period of time, providing attractive tax incentives are available.

The conclusion drawn from the survey of 30 coal companies (Exhibit I) is that effort has been placed on technology--technology without a market plan. Companies such as the Black Hills Power and Light Company (Rapid City, SD), Solvent Refined Coal International, Inc. (Denver, CO), and E.I. Dupont (Wilmington, DE) are three examples of those companies whose projects have been delayed indefinitely. Mr. Phil L. Israel, Senior Vice President of Operations for Transcontinental Oil Corporation (headquartered in Shreveport, LA) stated that "these projects are much too costly for companies of less then $1 billion in assets without government support."

The advantage of having a mix of fuels is not having all of the eggs in one basket. This offers some protections against any fears of monopoly pricing, strikes, embargoes, and weather effects. If the environment is really protected, there is no strong objection to synthetic fuels by environmentalists.

The market potential exists. To do anything but fight for market share would be a serious mistake made by producers. Mr. W. B. Watson, Feedstocks Planning Manager for E. I. Dupont, wrote (in response to the questionnaire) that "our plans for marketing synthetic fuels have not progressed to that point" and could, therefore, not be specific. It is feared that this is the position of the majority of coal producers--that marketing is indeed an afterthought. Unless the coal industry plans to fight, it will continue to hover uncertainty.

CHAPTER V

CONCLUSION

Despite its abundance, the shift to coal as a dominant alternative resource has been slow. Coal has been hemmed in by political issues arising over what the public views as the side effects of producing as well as using this product. Also, before coal can even be considered economically attractive, reducing transportation costs is a necessity.

High transportation costs result from an inefficient system which, in turn, results from the lack of political support necessary to make the changes. The industry will not receive this support until the coal producers effectively develop their market.

The market, as developed in this report, includes utilities, industrial users, merchant ships, home heating , and export. The various requirements which should be considered in the development of proper strategies are shown in table 10.

During the research process, it was determined that the coal industry, as a whole, had a set of unique problems which must be addressed before individual market strategies could be analyzed. These problems are categorized as environmental, human, and systematic: (1) the emission of air pollutants and the warming of the earth's temperature, (2) the increase of fatalities and injuries

TABLE 10

MARKET REQUIREMENTS

Markets	Low Sulphur	BTU'S	Price	Transportation
Utilities	1	1	1	2
Industrial Users	1	1	1	2
Merchant Ships	4	1	2	1
Home Heating	3	2	1	5
Export	1	2	2	1

1 Very important
2 Important
3 Somewhat important
4 Possibly important
5 Not important

among coal workers, and (3) the problems associated with the geographic distribution of coal--mainly its transportation. Many of the problems can be solved with new technology and proper legislation. However, future legislative activity needs to ensure the furtherance of improving negative environmental impacts; promotion of coal to reduce the use of other fuels; and oversight to ensure that existing legislation is being appropriately implemented. The volatility of the oil industry will also help in keeping the future of coal a mixture of promise and risk.

The United States has the coal. The market potential exists. However, its abundance does not automatically assure a growth in coal consumption. An aggressive yet calm and reasonable approach in the short term, and an overall long-term focus that would include a program to burn coal indirect combustion as a liquid or gas, will permit more freedom in meeting energy needs. Until this is done, coal will not become the dominant energy source desired.

EXHIBIT I

P.O. Box 1371
Bartlesville, OK 74005
August 16, 1983

Peabody Coal Co.
301 N. Memorial Drive
St. Louis, MO 63102

Dear Sir:

I am in the process of completing my M.B.A. requirements at Oklahoma State University. My thesis on the future of synfuels (primarily coal) is in the market analysis stage. I am writing to your company to request possible information on this subject.

With the prices of more traditional fuels falling, the future of synthetics is once again being questioned. I am aware, however, that in spite of falling fuel prices, some synfuel projects are now moving toward commercial operation requiring some formalized marketing program. Specifically, I am in need of information concerning any market plans you may have that could be shared to add creditability to my report.

Your assistance in providing any information available for publication will be greatly appreciated.

Sincerely,

Phyllis E. Kern

CHAPTER VI

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VITA

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