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Western coal gasification and local financial needs

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WESTERN COAL GASIFICATION AND LOCAL FINANCIAL NEEDS

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CHAPTER I

WESTERN COAL RESOURCES

Coal is an energy resource developed during the last 200 million years from the residue of plant life which grew in swamp areas at, or near, what was sea level during the Pennsylvanian Era. One of these areas was located in the junction of Montana, Wyoming and North Dakota. This region contains the largest quantity of coal known in any single coal area, totaling over 1.5 trillion tons. This amounts to 45 per cent of the coal in the United States, and 12 per cent of the 11.9 trillion tons of coal in the entire world.

This coal bed was named after an old fort located near the junction of the Missouri and Yellowstone Rivers, and is called the Fort Union Formation. This formation consists of three members: the Tongue River, the Lebo, and the Tulloch Members. The only member containing significant quantities of coal is the Tongue River Member, which runs from near Sheridan, Wyoming, through Montana to North Dakota. It is the Tongue River Member of the Fort Union Formation which constitutes what this paper defines as the Western Coal Reserves of the United States.

United States Coal Resources

The United States Department of the Interior has estimated the total remaining coal resources of the United States to aggregate 3.2 trillion tons. This amounts to 27 per cent of the 11.9 trillion tons of what is roughly estimated to be world coal reserves. A breakdown of world coal resources by country is included as Appendix 1.

It is important to note that only about half of the estimated 3.2 trillion tons of U.S. coal resources are based on estimates obtained from mapping and exploration. The other half is made up of estimates based on inferences or extensions from mapped areas. The 3.2 trillion ton coal resource must therefore be viewed as only an estimate, though the best one available.

A quantification of the amount of coal resources lying within the three state area of Montana, North Dakota and Wyoming is provided in Table 1. Most of this coal is included in the Fort Union Formation. This exhibit shows that these states contain 56 per cent of the nation's subbituminous coal and 98 per cent, or almost all, of the lignite coal, and 45 per cent of all the coal located within the U.S. A complete state-by-state breakdown of coal resources is provided in Appendix 2.

TABLE 1

WESTERN COAL RESOURCES

(Millions of Tons)	Mapped and Explored and Above 3,000 Feet					Estimated Total Coal Resources
	Bituminous	Sub-Bituminous	Lignite	Other	Total	
Montana	2,299	131,877	87,525	0	221,701	378,701
North Dakota	0	0	350,680	0	350,680	530,680
Wyoming	12,699	108,011	0	0	120,710	545,710
Total	14,998	239,888	438,205	0	693,091	1,455,091
Western Coal Percent of U.S.	2.2%	56.0%	97.9%	-	44.4%	45.3%
United States	671,049	428,210	447,647	12,969	1,559,875	3,210,060

SOURCE: National Coal Association, Coal Facts 1974-75, p. 75.

In reality, the mineable coal in the U.S. is much less than the 1.6 trillion tons of mapped and explored coal, due to legal, environmental, economical and technological factors. In fact, the Bureau of Mines has determined that of the 1.6 trillion tons of mapped and explored coal in this country, only 394 billion tons of coal lies above 1,000 feet below the ground, and is sufficiently thick to be potentially mineable.[1] While this is a substantially reduced amount, it still represents a tremendous amount of coal. A state-by-state estimate of coal above 1,000 feet is provided as Appendix 3. The information shown in this appendix is summarized in the following Table 2. This shows that western states contain about 83 per cent of the mineable subbituminous coal, 85 per cent of the mineable lignite, and 105 billion tons or about 27 per cent of the total mineable coal in this country. By definition, coal resources which are identified, and are economically and legally mineable, are classified as Coal Reserves. This estimate can be further reduced to reflect coal mining recovery rates.

TABLE 2

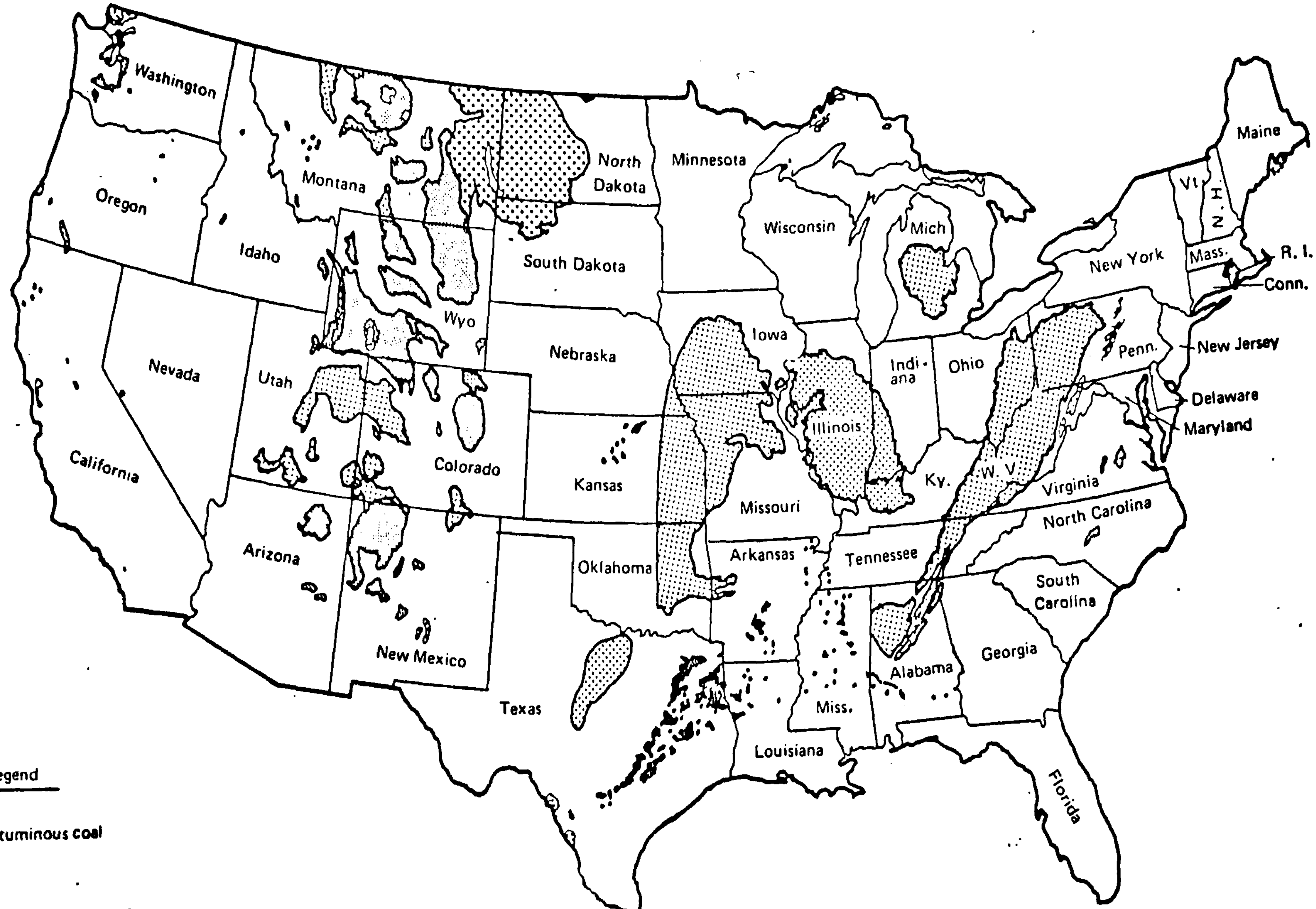
MINEABLE COAL

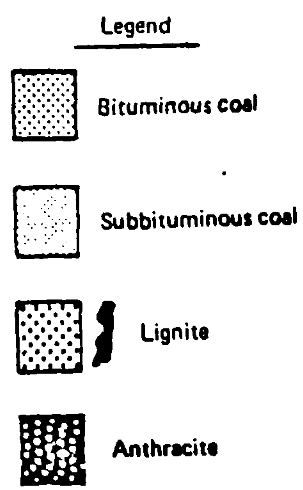
(Millions of Tons)	Bituminous	Sub-Bituminous	Lignite	Total
Montana	862	31,228	6,878	38,968
North Dakota	-	-	36,230	36,230
Wyoming	3,975	25,937		29,912
Total Western	4,837	57,165	43,108	105,110
% Western	1.8%	82.8%	84.9%	26.7%
Total U.S.	261,510	69,080	50,781	394,106

SOURCE: E.H. Reichl, U.S. Energy Outlook: Coal Availability, Report by the Coal Task Group of the National Petroleum Council, 1973, pp. 116-119.

The National Petroleum Council has further refined the estimate of mineable coal, or 394 billion tons, to determine what it termed "Recoverable Reserves".[2] In doing this, the Council first separated underground coal resources from surface resources. Using information from the Bureau of Mines, it determined underground coal as 349 billion tons, and surface coal as 45 billion tons. The underground coal resource amount was further reduced to reflect the 50% recovery experience estimated for underground mining by the Bureau of Mines, and to eliminate the intermediate or marginally economically mineable thickness as bituminous and subbituminous seams. This adjustment produced resulting underground Recoverable Reserves of 105 billion tons. Almost all coal is recoverable from surface mining, therefore, the surface coal reserve remained the same, at 45 billion tons. In total, then, there are now estimated to be only about 150 billion tons of economically recoverable coal reserves in the United States. The adjustment in the 394 billion ton estimate of mineable U.S. coal to determine the 150 billion tons of recoverable coal reserves also causes a reduction in the estimates for Western Coal Reserves. Due to the primarily strippable nature of western deposits, however, the western estimate would not decline as much.

MAP OF UNITED STATES COAL FIELDS





SOURCE: Chase Econometric Associates, Inc., <u>Coal: New Technologies Reversing Declining Demand,</u> December 1973, p. 3-3.

Western Coal Resources

While each state seems to have its own estimate of strippable coal reserves, for the purposes of this report, the basis for estimating the quantity and quality of strippable coal reserves will be the Bureau of Mines, Information Circular No. 8531 (IC8531), produced in 1971, entitled "Strippable Reserves of Bituminous Coal and Lignite in the United States". According to the Bureau of Mines, of the estimated 45 billion tons of strippable coal reserves, bituminous coal amounts to 13.6, subbituminous coal amounts to 24.3, and lignite coal amounts to 17.1 billion tons. A state-by-state breakdown of strippable coal reserves is included as Appendix 4. The information in this appendix is summarized in the following Table 4, which shows strippable western coal reserves of subbituminous coal amounting to 17.4 billion tons, or 72 per cent of the national total, and lignite reserves of 5.6 billion tons, or 79 per cent of the national total. Combined strippable western subbituminous and lignite coal reserves total 22.9 billion tons, or 51.0 per cent of the approximately 45 billion tons of national strippable coal reserves. Because western coal has a lower BTU content than eastern coal, it would account for a lower proportion of national coal energy than the proportion based on tonnage.

TABLE 4

STRIPPABLE RESERVES

(Millions of Tons)	Bituminous	Sub-Bituminous	Lignite	Total
Montana	-	3,400	3,497	6,897
North Dakota	-	-	2,075	2,075
Wyoming	-	13,971	-	13,971
Total	-	17,371	5,572	22,943
Per Cent of U.S.		72.4%	78.8%	51.0%
U.S.	13,597	24,318	7,071	44,986

SOURCE: Bureau of Mines, Strippable Reserves of Bituminous Coal and Lignite in the United States, Information Circular 8531, pp. 15-16.

Montana Resources

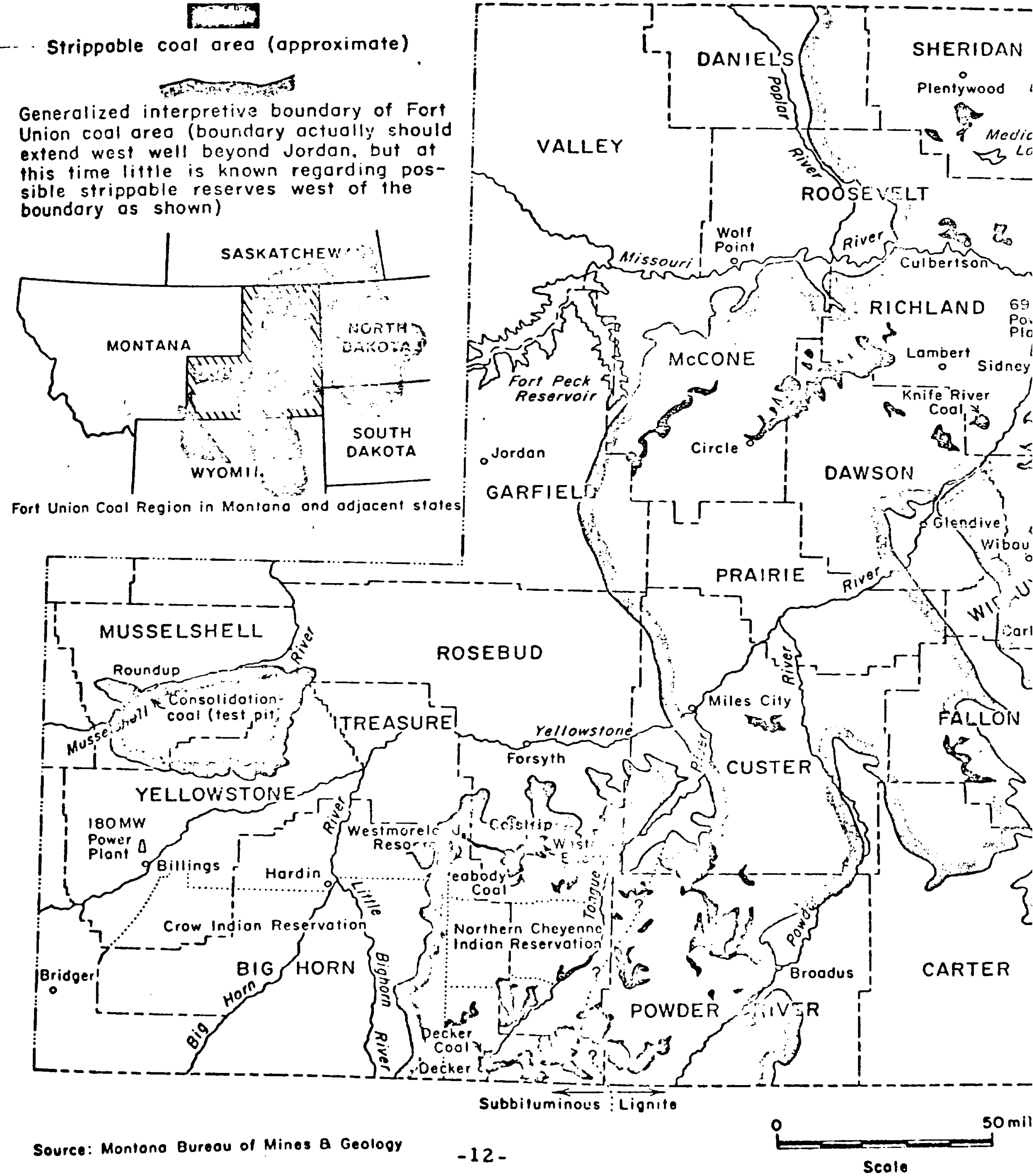
Almost all of the Montana coal deposits suitable for strip mining are located in the southeastern portion of the state. According to the primary reference source on coal resources of this paper, the Bureau of Mines Information Circular 8531, this area contains about 6.9 billion tons of strippable subbituminous and lignite coal reserves. These reserves are contained within an area encompassing a ten county area, as is illustrated in Table 5. The strippable coal contained in this area represents about 30 per cent of the western coal reserves, or about 15.4 per cent of the total strippable coal reserves of the U.S.

Table 6 provides a county-by-county breakdown of Montana coal resources. It is to be noted that about one-half of Montana's strippable coal resources are subbituminous, while the other half is lignite coal. All of the subbituminous coal is located within a contiguous four-county area composed of the Big Horn, Custer, Powder River and Rosebud Counties. Powder River County contains by far the largest amount of strippable subbituminous and lignite coal.

Southeastern Montana's coal resources, which comprise a portion of the Tongue River Member of the Fort Union Formation, generally lie in coal beds ranging between twenty to thirty feet in thickness, but coal beds in some areas range upward to eighty-five feet thick. The coal deposits vary in size from 10 million tons to nearly 2 billion tons, with four deposits individually containing more than a billion tons. According to Information Circular 8531, there are thirty-two separate coal deposits in southeastern Montana. This number corresponds to that provided in a study by the Montana Bureau of Mines and Geology.[3] According to the Montana Bureau, most southeastern Montana coal is low in sulphur and has a low to moderate ash content. The heat content of the coal ranges between 6,500 BTU's per pound and 9,852 BTU's per pound. The lower heat content displayed by Montana coal adversely impacts its suitability for use in certain electric power plant boilers. It may also cause western coal to exceed current air quality standards based on BTU content rather than weight. However, this shortcoming can be offset somewhat by drying the coal or by mixing it with higher BTU coal. Low heat content is not a problem in using coal in gasification. In addition, this restraint may be removed by the relaxation of air quality standards that appear necessary to insure continued availability of electricity. A listing of individual coal deposits is provided in Appendix 5.

TABLE 5

MAP OF FORT UNION COAL AREA IN EASTERN MONTANA



Source: Montana Bureau of Mines & Geology

TABLE 6

MONTANA COAL DEPOSITS BY COUNTY

County	Strippable Reserves (Millions of Tons)
Subbituminous:	
Big Horn	1,009
Custer	64
Powder River	1,405
Rosebud	922
Total	3,400
Lignite:	
Custer	347
Dawson	180
McCone	410
Powder River	1,245
Richland	109
Roosevelt	204
Rosebud	80
Sheridan	460
Wibaux	462
Total	3,497
Grand Total	6,897

SOURCE: Bureau of Mines, Information Circular 8531, pp. 93-95.

North Dakota Resources

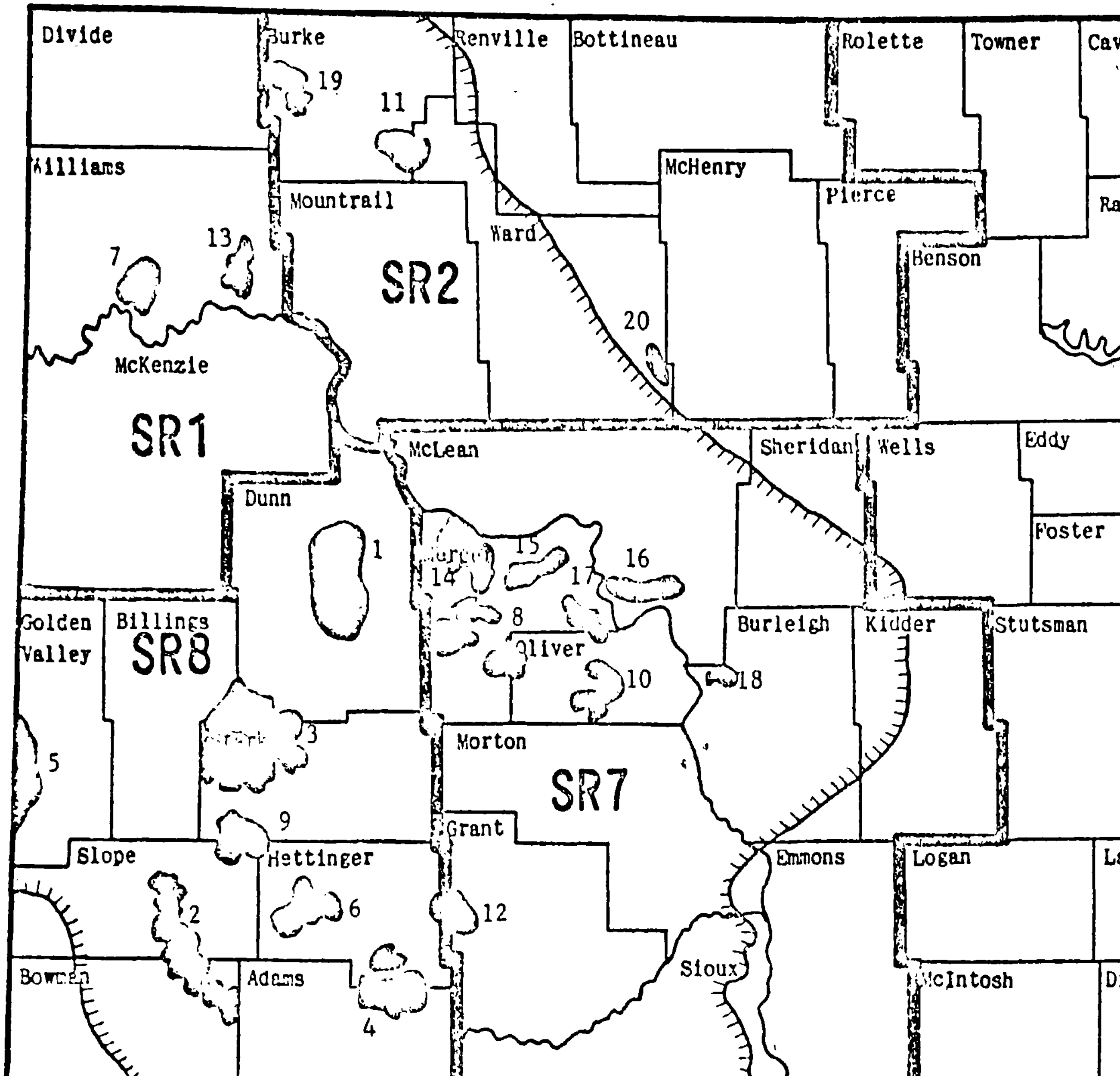
Almost all North Dakota coal resources are lignite in nature, and are located in the western half of the state--commencing with a north-south line running through Bismarck. North Dakota coal amounts to about 2 billion tons, or 9 per cent of the western coal reserves.

According to Information Circular 8531, there are twenty-two economically strippable coal deposits in the state, located throughout a thirteen county area. The general location of these deposits is provided in Table 7. The counties containing the most strippable coal are Slope, Stark, Bowman and Golden Valley, located in the southwestern portion of the state, and Mercer County, northwest of the Mandan/ Bismarck area. A summary of coal resources by counties in provided in Table 8, by deposit in Appendix 6.

The lignite coal beds of North Dakota range in thickness from a few inches to twenty-five feet. These are covered with a clay over-burden ranging between twenty to seventy feet deep in most cases. On average, North Dakota coal overburden amounts to sixteen feet. In determining the quantity of economically mineable coal in Information Circular 8531, only coal beds over five feet thick, under less than fifty feet of overburden, were included. Slightly over 80 per cent of North Dakota strippable coal is classified as low sulphur.

TABLE 7

MAP OF NORTH DAKOTA STRIPPABLE COAL DEPOSITS



Code	Name of Deposit	Strippable Reserves, Million Short Tons
1	Dunn Center	1,500
2	Bowman-Gascoyne	1,372
3	Dickinson	798
4	Mott	500
5	Beach	450
6	Regent	400
7	Avoca	380
8	Beulah-Zap	380
9	North New England	280
10	Center	253
11	Niobe	146
12	New Leipzig	105
13	M & M	100
14	Renner's Cove	78
15	Hazen	71
16	Washburn	30
17	Stanton	21
18	Wilton	15
19	Noonan-Kincaid	15
20	Velva	5
	TOTAL	6,794

SOURCE: N. Dalsted and F. Leistritz, "North Dakota Coal Resources and Development Potential", North Dakota Farm Research, July-August 1974, p. 5.

Major Strippable Deposit

Boundary of Commercial Lignite Deposits

TABLE 8

NORTH DAKOTA COAL DEPOSITS BY COUNTY

County	Strippable Reserves (Millions of Tons)
Lignite:	
Billings	66
Bowman	213
Burke	61
Burleigh	12
Dunn	41
Golden Valley	224
McLean	24
Mercer	312
Oliver	121
Slope	594
Stark	286
Ward	4
Williams	117
Total	2,075

SOURCE: Bureau of Mines, Information Circular 8531, pp. 98-100.

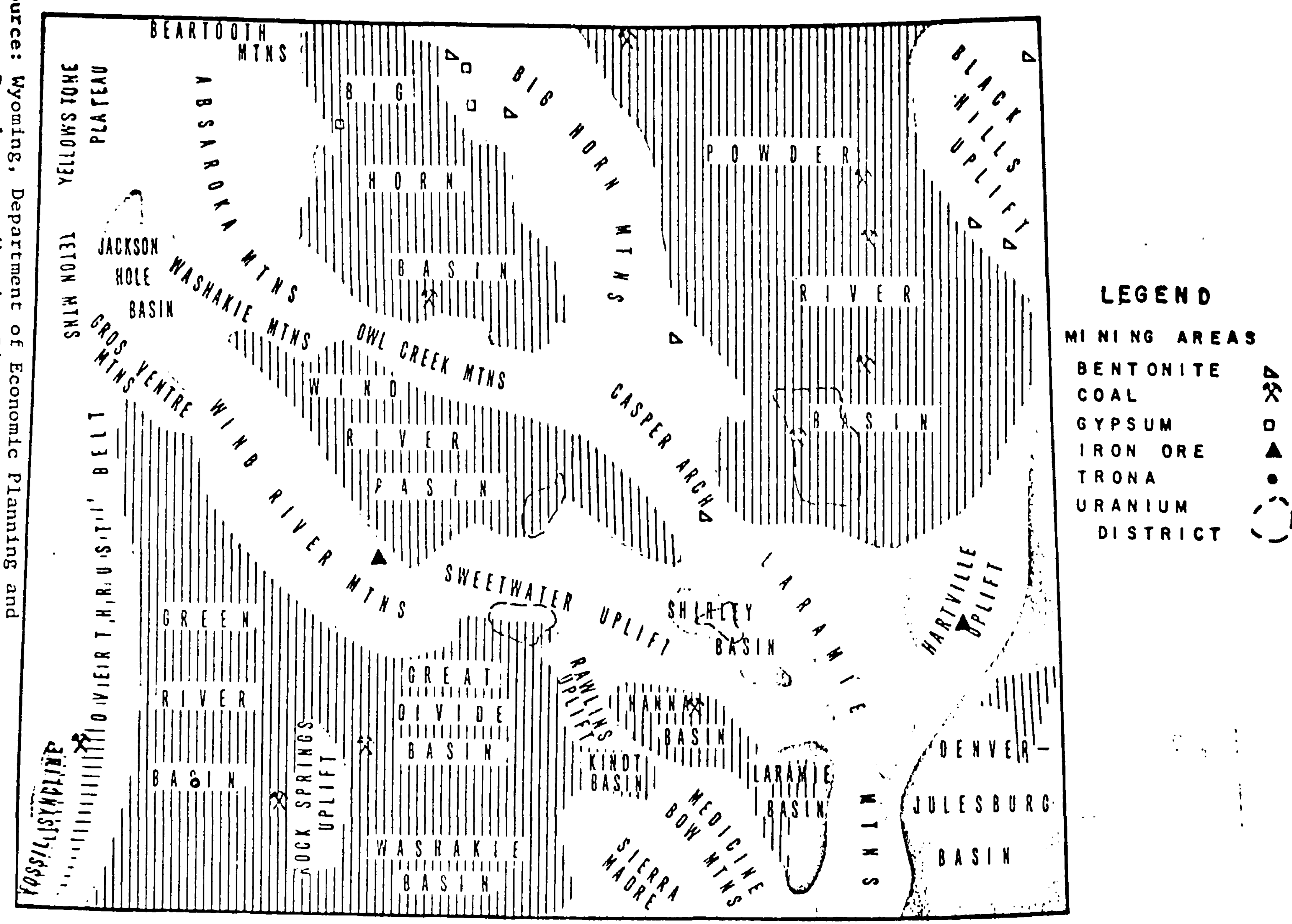
Wyoming Resources

The Tongue River Member of the Fort Union Formation juts into northeastern Wyoming and contains a major part of the state's strippable coal reserve. While a number of counties located throughout eastern and southern Wyoming contain strippable coal reserves, almost all of Wyoming reserves are located in Campbell County in the northeastern part of the state, around Gillette, Wyoming. A breakdown and location of Wyoming coal reserves by county is provided in Table 9 and Table 10.

Campbell County contains the state's two most significant strippable coal deposits--the 30 to 130 feet thick Rolland coal bed and the 10 to 40 feet thick Felix coal bed. These two coal beds run for more than one hundred miles along the east flank of what is called the Powder River Basin, running through Campbell County. The second largest coal containing county of Wyoming is Johnson County, which adjoins Campbell County to the west. While this county's coal reserves are not as large as those of Campbell County, it does contain coal beds which average one hundred feet in thickness and locally may be as much as 220 feet thick. These coal beds are located at Lake DeSmet near Buffalo, Wyoming, on the west flank of the Powder River Basin.

The average thickness of Wyoming coal deposits is a high 67 feet and varies between, on average individual coal beds, 6 to 130 feet. The almost 14 million tons of strippable Wyoming coal represents about 60 per cent of the western coal reserves, and about 32 per cent of the strippable coal reserves in the United States. In addition, 13.3 billion tons of the total strippable Wyoming coal reserves are low sulphur in nature, and subbituminous coal in quality. This amounts to 96 per cent of the total. A list of coal deposits is provided in Appendix 7.

TABLE 9
MAP OF WYOMING COAL DEPOSITS



Source: Wyoming, Department of Economic Planning and Development, Wyoming Directory of Manufacturing and Mining (Cheyenne, Wyoming: Department of Economic Planning and Development, 1969).

TABLE 10

WYOMING COAL DEPOSITS BY COUNTY

County	Strippable Reserves (Millions of Tons)
Subbituminous:	
Campbell	12,160
Carbon	101
Converse	253
Johnson	800
Lincoln	140
Sheridan	114
Sweetwater	403
Total	13,971

SOURCE: Bureau of Mines, Information Circular 8531, pp. 120-21.

Characteristics of Western Coal Reserves

An important characteristic of the western coal reserves is their generally low sulphur content. By definition, low sulphur coal contains less than 1 per cent by weight of sulphur content. Of the 45 billion tons of total strippable coal reserves, 31.8 billion tons or 71 per cent, is low sulphur, 9 per cent is medium sulphur, and 20 per cent is high sulphur coal. The sulphur content of coal is important to an evaluation of its potential for development, due to the limitations on sulphur content of coal burned in electrical generation plants under the Clean Air Act of 1970. These federal regulations limit the amount of sulphur that may be admitted into the atmosphere by such plants to 1.2 pounds of SO_2 per MMBTU's burned in coal fired facilities.[4]

Of the approximately 31.8 billion tons of the strippable low sulphur coal in this country, about three-fourths is subbituminous, 17 per cent is lignite coal, and 9 per cent is bituminous coal. About 70 per cent of the total 23.5 billion tons of low sulphur subbituminous coal of this country is located in the states of Montana and Wyoming (See Table 11). In addition, about 84 per cent of the low sulphur strippable lignite coal reserves of this country are located in the states of Montana and North Dakota.

In total, then, these three states contain about 66 per cent of the 31.8 billion tons of low sulphur coal located in this country.

While almost all, or 92 per cent, of the western coal reserves have a sulphur content of less than 1 per cent by weight, it is important to note that this low sulphur content by weight does not necessarily qualify all western coal for use in coal-fired electrical generating plants. This is because the federal sulphur content limitations are based on sulphur content released into the air per BTU. Western coal generally has a significantly lower caloric value, or BTU per pound level, and ranges between 5,500 to 11,500 BTU's per pound of coal. [5] In comparison, eastern bituminous coal averages between 10,800 and 13,800 BTU's per pound. [6] The lower BTU's of western coal could disqualify a large proportion of western coal from being burned in electrical generating plants under current Federal regulation. [7]

The relatively low heat value of western coal also makes such coal unsuitable for use in the boilers of many existing coal-fired electrical generating plants. [8] The low heat content, especially of lignite coal, makes long distance transportation uneconomical. In addition, lignite coal does not hold up well but crumbles when transported by rail.

TABLE 11

STRIPPABLE LOW SULPHUR COAL

(In Millions of Tons)	Bituminous	Sub-Bituminous	Lignite	Total	Low Sulphur Coal as a % of Total Coal
Montana	-	3,176	2,957	6,133	88.9%
North Dakota	-	-	1,678	1,678	80.9
Wyoming	-	13,377	-	13,377	95.7
	-	16,553	4,635	21,188	92.3
% of U. S.	-	70.4%	84.3%	66.6%	
U. S.	2,800	23,500	5,500	31,800	70.7
% Total U. S.	8.8%	73.9%	17.3%	100%	

SOURCE: Bureau of Mines, Information Circular 8531.

Summary

The Fort Union Formation is estimated to contain about 1.5 trillion tons of coal. This is estimated to be about 12 per cent of the world's coal resources, and 45 per cent of those of the United States. Due to its relative proximity to the surface and to its generally low sulphur content, western coal represents 66 per cent of this nation's strippable low sulphur coal reserves.

The use of western coal as a feedstock for coal gasification is attractive from several standpoints. First, the enormous western coal reserves assure an adequate supply of gasification feedstock over the expected lives of the proposed gasification plants, this being about twenty-five years. Second, the ability to strip mine, rather than underground mine, western coal offers greater worker productivity and substantial savings in terms of mining expense. Third, western coal is non-caking in nature, eliminating the need for expensive preparation prior to use in first-generation technology coal gasification plants.

The availability of an adequate supply of coal, suitable as a gasification feedstock, is a fundamental consideration in determining the location of a mine-mouth gasification plant. This chapter has shown that the immense western coal reserves represent an attractive source of supply for coal gasification. This has been confirmed by the announced plans of various companies to construct gasification plants within the states of Montana, North Dakota, and Wyoming.

Chapter I

Footnotes

1 John G. McLean, Chairman, Report of the National Petroleum Council's Committee on U.S. Energy Outlook, U.S. Energy Outlook, p. 143.

2 Ibid.

3 Montana Bureau of Mines and Geology, Quality and Reserves of Strippable Coal, Selected Deposits, Southeastern Montana: Bulletin 91, p. 1.

4 Chase Econometric Association, Coal: New Technologies Reverse Declining Demand, pp. 3-25.

5 Montana Department of Intergovernmental Relations, Coal Deposits in Montana, March 14, 1974, p. 4.

6 Chase Econometric Association, Coal: New Technologies, pp. 3-7.

7 The New York Times, "Strip Mining in West Facing Obstacles", March 24, 1975, p. 20C.

8 Chase Econometric Association, Coal: New Technologies, pp. 3-27.

CHAPTER II

STATUS OF WESTERN COAL DEVELOPMENT

History of Coal Development in the U.S.

Coal was first discovered in the United States in the late 1600's, with commercial mining beginning around the mid-1700's. Due to the abundance of forest wood, coal development grew slowly at first in this country.[1] By 1885, coal had overtaken wood as the nation's leading source of fuel, and production continued to surge through the first decades of the 1900's. Due to the industrialization of the United States, coal production increased strongly, culminating in a then-record 651 million tons of annual production in 1918. At that time, coal accounted for about 80 per cent of all fuel consumed in the U.S. About that time, natural gas and oil began to experience increased utilization in heating and transportation, and the coal industry went into a depression, in which it remained until World War II. Coal production increased strongly during the War, and immediate post-War years, and topped out at 688 million tons in 1947. Again in the late 40's, the industry declined as the rail industry switched from coal to diesel power. The increasing use of coal as a source of electrical power caused an increase in coal production from a post-War low of 402 million tons in 1961 to 603 million tons in 1970. Failure to develop planned nuclear power plants on schedule partially accounted for the rapid growth in coal use by the utility industry. Due to new air quality standards instituted in the early 1970's, coal production again declined as greater use was made of fuel oil imports. Due to this, coal production fell to 552 million tons in 1971, before increasing to 590 million tons in 1973, with greater use of low sulphur coal.[2] Coal operations in the U.S. are currently centered in the eastern half of the country. In 1972, the Appalachia area contained over 90 per cent of all mines and produced 65 per cent of total coal production. The two largest coal producing states were Kentucky and West Virginia, which alone accounted for 40 per cent of 1972 production. Other large coal producing states were Pennsylvania, Illinois and Ohio.[3]

At the end of 1972, there were 4,879 active bituminous and lignite coal mines in the U.S. Nine of these mines were located in Montana, fourteen in North Dakota, and eighteen in Wyoming, for a total of forty-one mines located throughout the three state area containing the western coal reserves.[4]

Bituminous and lignite coal production in 1971 totaled 552 million tons, of which 21.2 million tons were produced in Montana, North Dakota and Wyoming. This represents slightly less than 4 per cent of total 1971 coal production. As is shown in the following table, western coal production has been increasing rapidly and in 1973 amounted to slightly over 5 per cent of U.S. production. It is to be noted that about 23 per cent of 1971 production was generated by the fifty largest coal mines. Among these are five mines from the states of Montana and Wyoming, ranking 6, 18, 20, 26, and 45th.[5]

TABLE 12
BITUMINOUS COAL PRODUCTION
(THOUSANDS OF TONS)

	1971	1972	1973
Montana	7,064	8,221	9,950
North Dakota	6,075	6,632	7,400
Wyoming	8,052	10,928	13,600
	21,191	25,781	30,950
Per Cent of U.S.	3.8%	4.3%	5.1%
U.S. Total	552,192	595,386	591,000

SOURCE: National Coal Association, Coal Facts, 1974-5.

In 1971, coal served as the energy source for producing about 44 per cent of all electricity generated by U.S. utilities. In generating this electricity, U.S. utilities used 332 million tons of coal, or 60 per cent of total 1971 coal production. About three-fourths, or 73 per cent of the coal burned by U.S. utilities in 1971 came from surface mines.[6] As is summarized in the following table, the three-state area of Montana, North Dakota and Wyoming, with South Dakota and Washington, provided about 20.7 million tons of the coal used by electric utilities in 1971. This represents about 6 per cent of total coal used by utilities and about 90 per cent of western coal production. All the coal produced in these states which was shipped to electric utilities came from surface, rather than deep mines.

TABLE 13

COAL CONSUMPTION BY ELECTRIC UTILITIES

	1971 Coal Production	Electric Utilities
	(thousands of tons)	
Wyoming	8,052	6,970
N.D. & S.D.	6,075	5,430
Montana & Wash.	8,896	8,342
	23,023	20,741
Per cent	4%	6%
U.S. Total	552,192	332,163

SOURCE: National Coal Association. Impact on Surface-Mined Bituminous Coal and Lignite on U.S. Energy Sector, 1972.

Montana

Current Situation

Coal mining in Montana first began in the 1860's. Early coal uses included serving as a heat source in the home and blacksmith forges, as well as semi-coking coal in the early metals industry and as a fuel for railroads.[7] Almost all early coal mining in western and central Montana was done underground, and in 1918 over 4,000 coal miners were employed in Montana.[8] A major user of Montana coal in the early days was the Northern Pacific Railroad, now the Burlington Northern, Inc., which mined coal from underground mines near Red Lodge to fire its locomotives.[9] In 1924, a company called The Northwestern Improvement Company began surface mining coal from the Rosebud coal bed near Colstrip, Montana, to supply coal for the locomotives of the Northern Pacific Railroad.[10] Production peaked in 1944 at nearly 5 million tons. The mine continued to operate until the mid-1950's when it was closed, as coal was no longer needed for steam locomotives with the dieselization of the rail industry.[11] In 1959, the Montana Power Company purchased the town of Colstrip, along with mining leases and equipment, from the Burlington Northern, Inc. A subsidiary of Montana Power, the Western Energy Company, reopened the mine in 1968. Initially, the coal production of the mine was shipped by unit train to the 180 megawatt steam generation plant at Billings, and some coal was exported to the Upper Midwest.[12]

In 1967, Montana coal production totaled around 336,000 tons. Since that time, coal production has increased rapidly and in 1973, amounted to 10.7 million tons. Most of the growth in coal production is attributable to expanded operations at the three largest mines. The Knife River mine in Richland County produces around 320,000 tons of coal annually, which is used exclusively to power a Montana-Dakota Utilities electrical generating station near Sydney, Montana.[13] The following table shows 1973 coal production for the major Montana coal mines and Montana coal production since 1967. It excludes any production for the new Westmoreland Resources Mine at Sarpy Creek in eastern Big Horn County, which was scheduled to begin production in 1974. This mine is estimated to have an eventual productive capacity of around 4 million tons per year. A more complete list of Montana coal mines is provided as Appendix 8.

TABLE 14

MONTANA COAL MINES AND PRODUCTION

Mine	Coal Production (thousands of tons)
1973:	
Western Energy	4,254
Peabody Coal Company	1,972
Decker Coal Company	4,159
Knife River Coal Company	313
Others	24
	10,721
1972	8,243
1971	7,072
1970	3,512
1969	1,018
1968	507
1967	336

SOURCE: Montana Energy Advisory Council, Coal Development Information Packet, pp. 20-23.

Coal Use

Currently, there are only two major coal users in the state of Montana, these being the Montana-Dakota Utilities generating plant at Sidney, which uses about 320,000 tons per year, and the Montana Power Corette plant at Billings, which burns about 500,000 tons per year. Annual coal production in 1973 totaled about 10.7 million tons. Of this, about 1.5 million tons were consumed by the two power plants just mentioned and other users, and 9.8 million tons of the Montana coal production in 1973 was exported out of the state.[14] The development of the extensive export demand for Montana coal can be attributed to two main factors, these being its low sulphur content and low extractive cost. These factors, with the availability of large quantities of western coal enabling the negotiation of long term contracts, indicate the potential for further increases in Montana coal exports. It is to be noted that the advantages of western coal are accompanied by a number of important disadvantages. Among these are the low BTU content, high moisture content, and extreme distances between Montana and coal using markets in Illinois (900 miles), Missouri and Wisconsin (900 miles), and Minnesota, Kansas and Eastern Nebraska (600 miles). Even with using unit trains to haul Montana coal over these extreme distances, transportation still represents the greatest share of the delivered price of coal mined in Montana. As an example, about 75 per cent of the cost of Montana coal exported to Chicago is accounted for as railroad charges.[15] A list of Montana coal producers is provided as Table 15. This shows that all the larger Montana coal mines are exporting coal.

TABLE 15

MONTANA COAL USE

Montana Coal Producer	Montana Coal Consumer: Location	Montana Coal Consumer: User
Western Energy	Billings, Montana	Montana Power
	St. Paul, Minn.	Northern States Power
	Havanna & Hammond Illinois	Wisconsin Power & Light
	Joliet, Indiana	
	Other	
	Coal Strip Plants(I & II)	
	Coal Brokers in Minn.	
Peabody	Cohasset, Minn.	Minn. Power & Light
Decker	Havanna, Illinois	Commonwealth Edison
Westmoreland	Minneapolis, Minn.	Northern States Power
	Dubuque, Iowa	Interstate Power Company
	LaCrosse, Wisc.	Dairyland Power Coop
	Madison, Wisc.	Wisconsin Power & Light
Knife River	Savage, Montana	Montana Dakota Utilities
		Sidney Power Plant

SOURCE: Rosebud-Treasure County Situation Statement, "Know This About Coal".

The longest distance Montana coal is currently being transported amounts to about 900 miles, to coal markets in Illinois and Indiana. Combining rail with water transportation serves to expand the feasible distance over which Montana coal can be economically transported. In 1973, the Burlington Northern Railroad made a test rail to barge run in which Montana coal was transferred by unit train to East St. Louis, Missouri, where it was transloaded to barges and hauled down the Mississippi and up the Ohio Rivers as far as Wheeling, West Virginia. The burning tests then conducted were satisfactory and plans were made for transloading Burlington Northern coal on eastbound barges.[16] in the summer of 1973 the Detroit Edison Company signed a contract with the Decker Coal Company of Montana. The company intends to haul Decker coal via Burlington Northern unit train to a new coal dock in the Duluth-Superior area for transloading to coal ships bound for the company's St. Clair station.[17] In June of 1974, it was announced that three industrial companies have agreed to build a new $25 million coal trans-shipment facility at Superior, Wisconsin. The primary customer for the coal that will be shipped to this station will be Detroit Edison. With an initial capacity in 1976 when the plant opens of ten million tons, this is expected to eventually increase to 20 million tons.[18]

Numerous companies have displayed an interest in Montana coal. These range from mining companies to electric power companies and natural gas pipeline companies interested in coal gasification projects.

The announcements regarding electric generating and coal gasification plants that several of these companies have already made, the large number of prospecting permits that are outstanding in the state, and the large quantity of yet undeveloped coal reserves held by the various companies, indicate both a strong interest in the development of western coal and a high probability that further development will take place.

According to the North Central Power Study, a report which was intended to locate suitable electric generating plant sites, twenty-one of the forty-two suitable strippable coal sites for 1,000 megawatt or more electric generating plants were located in the State of Montana.

A list and map showing these locations are provided in Appendices 9 and 10. The suitability of the Montana coal deposits for mine mouth electric generation offers the potential for the development of additional plants of this type. As of 1974, there were only two relatively small coal fired electric generating plants in the state, with two new plants with a combined generating capacity of about 700 megawatts now being constructed.

Coal Gasification

In March of 1973, the Northern Natural Gas Company and Cities Service Gas Company jointly announced that they were examining the possibilities of developing a coal gasification complex in the Powder River Basin area of southeastern Montana. The companies intended to jointly construct both the gasification plants and the proposed pipeline, which would be an estimated 700 miles in length. The gasification plant would utilize proven Lurgi technology for coal gasification. Each of the proposed gasification plants would have the capability of producing 250 million cubic feet daily of pipeline quality synthetic gas. This gas would be used to serve the Northern Natural customers located in the Midwest, and the Cities Service customers located in Kansas, Missouri, Oklahoma, Nebraska and Texas. Since the announcement, the coal leases of the Peabody Coal Company, the major supplier of coal for the proposed project, were revoked by the Secretary of the Interior. Several other companies have shown an interest in constructing gasification plants in Montana or fueled by Montana coal. In December of 1971, the HFC Oil Company of Casper, Wyoming submitted a request for 50,000 acre feet of water for future use in two or more gasification plants located near Bloomfield in Dawson County. Colorado Interstate Gas Company has also announced its interest in building a gasification plant at Sarpy Creek, near Hardin, Montana on the Crow Indian Reservation. This plant would be fueled by Westmoreland Coal Company coal.[19] The Burlington Northern, Inc., through its subsidiary Dreyer Brothers, Inc., has applied for 67,000 acre feet of water rights annually for the purpose of operating a synthetic fuels plant. This plant would be located northwest of Circle, Montana in McCone County. Its initial output would consist of ammonia, with methyl fuel and synthetic diesel fuel being produced in later years.

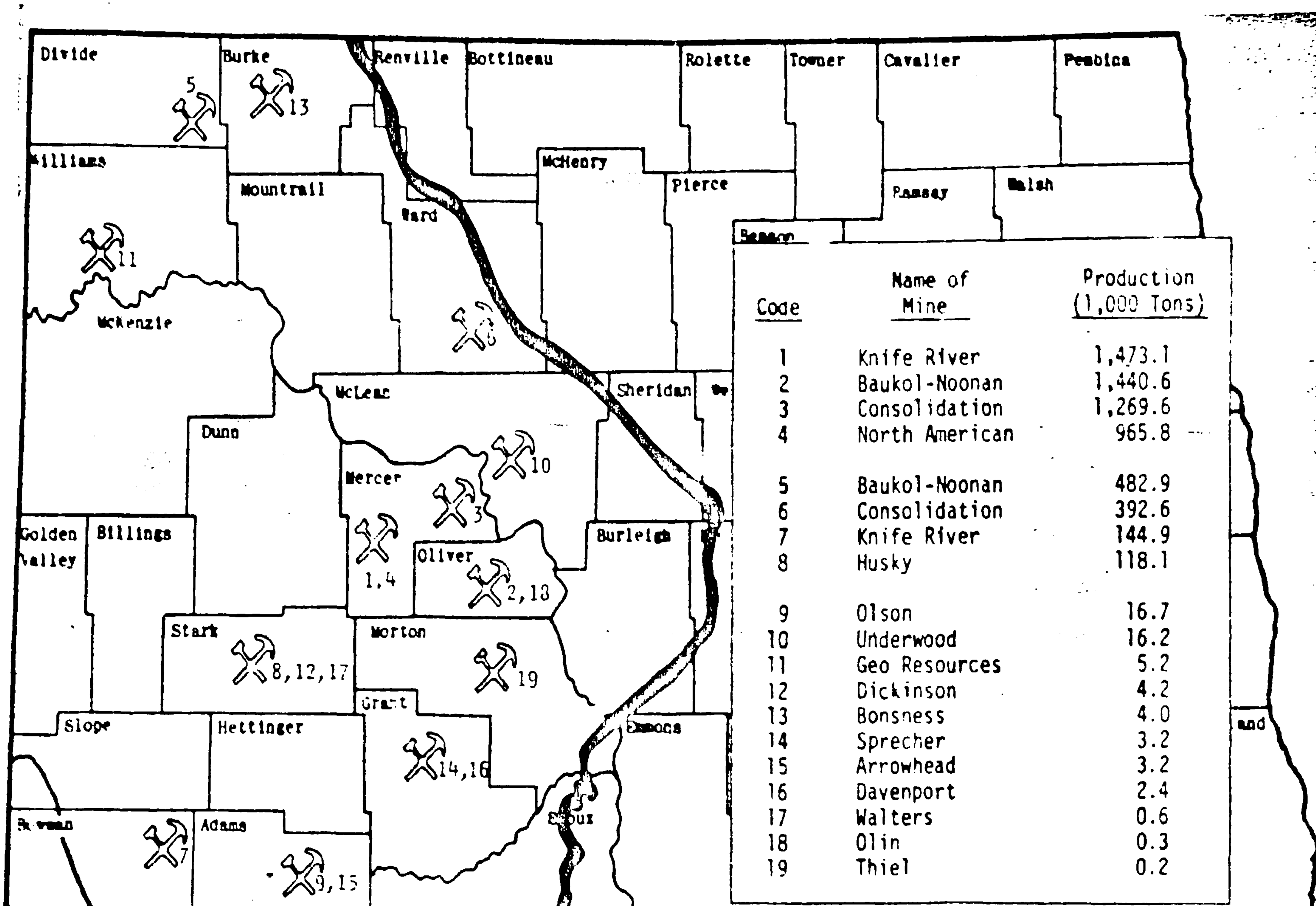
North Dakota

Current Situation

Mining of lignite coal in North Dakota first began in the 1870's.[20] The first recorded production of lignite coal was 35,000 tons in 1884.[21] By 1923, there were 259 lignite mines in North Dakota, which employed about 1,100 people and produced around 1.4 million tons. From 1923 until about the 1950's, coal production increased significantly, with greater use being made of strip mining techniques. This caused a significant decline in coal mining employment, a trend which has continued until recent times. Following the conversion from coal to diesel power on the railroads, and greater utilization of hydro-electric power from the Missouri River Dams, coal production declined during the late 1950's and early 1960's. The downward trend in coal production was reversed in 1963 when the R.N. Hesket Plant at Mandan began operation. Another electrical plant fueled by lignite coal was opened in 1963. The use of coal to generate electricity has caused a rapid expansion in annual coal production, which reached about 6.3 million tons in 1972.[22]

Since 1923, the number of coal mines has declined from 259 to about 20 in 1972. While 189 of the 259 were underground mines in 1923, underground mining has been discontinued in North Dakota and there were no underground lignite coal mines in 1972.[23] The 20 remaining strip mines were located throughout the western part of the state.[24] A list of these and their location is provided as Table 16. A list of the major North Dakota coal mining companies is provided as Appendix 9.

LOCATION OF NORTH DAKOTA SURFACE MINES 1972



Code	Name of Mine	Production (1,000 Tons)
1	Knife River	1,473.1
2	Baukol-Noonan	1,440.6
3	Consolidation	1,269.6
4	North American	965.8
5	Baukol-Noonan	482.9
6	Consolidation	392.6
7	Knife River	144.9
8	Husky	118.1
9	Olson	16.7
10	Underwood	16.2
11	Geo Resources	5.2
12	Dickinson	4.2
13	Bonsness	4.0
14	Sprecher	3.2
15	Arrowhead	3.2
16	Davenport	2.4
17	Walters	0.6
18	Olin	0.3
19	Thiel	0.2

SOURCE: F. Leistritz, "Coal Development in North Dakota: Effects on Agriculture and Rural Communities", Presentation to Fargo Optimists, February 11, 1974.

The major North Dakota mining companies are:

Mining Company	Parent
North American Coal Company	Independent
Consolidation Coal	Continental Oil
Knife River Coal	Montana Dakota Utilities
Baukol-Noonan Coal	Independent

In 1973, these four coal mining companies produced 97 per cent of North Dakota's lignite production.[25] The Knife River coal mining company has mining operations at Beulah and Gascoyne, North Dakota, and Savage, Montana. Its largest mines are located at Beulah and are called the "North" Beulah Mine and the "South" Beulah Mine. In 1973, these two mines produced 1,585,769 tons of lignite coal. The "North" Mine has been closed, and the "South" Mine production is expected to be expanded. The company's mine at Gascoyne produced 182,161 tons in 1973.

The Baukol-Noonan, Inc. coal mining company has mines at Noonan and Center, North Dakota. The largest operation is at Center, with production of 1,563,446 tons in 1973. The Noonan mine produced 482,229 tons in 1973, for a total production representing about two million tons, or slightly less than 30 per cent of North Dakota's 1973 lignite coal production.

The Consolidation coal company operates mines at Stanton and Velva, North Dakota. The Stanton mine produced 1,327,314 tons in fiscal 1973, and the Velva mine produced 417,732 tons during this same period. In total, Consolidation coal company production amounts to slightly more than 25 per cent of the North Dakota total.

The North American Coal Corporation has only one mine currently operating at Beulah, North Dakota. This produced 1,049,416 tons in fiscal 1973, representing slightly more than 15 per cent of North Dakota production.

Coal Use

The lignite coal mined in North Dakota in 1973 totaled about 6.8 million tons and at an average value of $2 per ton, had a total value of about $15.6 million, as is shown in the following table.

TABLE 17

NORTH DAKOTA LIGNITE PRODUCTION

	Production (Thousands of Tons)	Production Value ($ in 000's)
1969	4,590	8,245
1970	5,002	9,053
1971	5,821	10,844
1972	6,344	12,045
1973	6,798	13,567

SOURCE: North Dakota Annual Coal Mine Report, 1973, Iszler, Rudolph, State Coal Inspection Dept.

The primary use of North Dakota lignite production is in electric power generation, with 84 per cent of the state's 1971 coal production being used by electric utilities in North Dakota, South Dakota and Minnesota.[26] In 1971, 61 per cent of the electric power generated in North Dakota was produced by coal-fired plants. However, a significant proportion of North Dakota electric power is exported to other states, and in 1974 about half of the electricity produced was exported over high energy AC transmission lines.[27]

A number of the characteristics of North Dakota lignite make it either unsatisfactory or uneconomical for shipping over long distances. Among these are the relatively low energy content, about half that of bituminous coal, its extremely high moisture content, tendency to crumble on drying and to ignite by spontaneous combustion, the difficulty in properly pulverizing the coal for burning in electric furnaces, and its high ash content.[28] However, the low sulphur content has led to the development of a sizeable export market for North Dakota lignite coal. In 1960, about 547,000 tons or 21 per cent of annual production were exported. Since that time, exports have increased to 38 per cent of annual production and in 1971 totaled around 2.3 million tons. Lignite exports will increase even more in 1975 when a new Gascoyne mine begins to produce coal for shipment to a new 440 megawatt electric power plant located at Big Stone Lake, South Dakota.[29] The coal requirements of this plant will amount to 2.5 million tons per year and will double the amount of coal exported from North Dakota. This coal will be transferred by train over a distance of almost 400 miles.

Coal Development Outlook

Currently, there are seven coal-fired electric plants located in North Dakota, having a capacity of 100 or more megawatts. The four larger plants are located in three adjoining counties: Mercer, Oliver, and Morton, which lie around and to the immediate northwest of the Bismarck-Mandan area.[30]

With seven coal-fired electric plants now operating in North Dakota, the state's current electrical generation capacity totals approximately 1,300 megawatts per year. Already, the state has received a number of requests to construct additional coal-fired plants which would boost the annual electrical capacity to about 14,000 megawatts.[31] While most of the existing plants are in the 100 to 200 megawatt size category, the plants now being proposed run around 450 megawatts, and in some cases plants of this size are planned to be only one unit of a multi-plant complex with between 900 and 1,200 megawatts per year capabilities.

In July of 1974, the United Power Association-Cooperative Power Association of Elk River, Minnesota was granted 15,000 acre feet per year of water for an approximately 900 megawatt generating plant to be located six miles south of Underwood, North Dakota. This plant is estimated to cost around $537 million, $83 million of which will be financed by the REA, and $454 million financed by private lenders under a government guarantee.[32]

In February of 1974, the Minnkota Power Cooperative was granted a water permit for an approximately 440 megawatt plant to be constructed by a subsidiary of Minnkota, the Square Butte Power Cooperative. The entire output of this plant will be transported about 450 miles over high voltage direct current lines to Duluth, Minnesota.[33] It is expected that this new plant will be completed in 1977. The company eventually expects to develop a 6,400 megawatt generating complex in North Dakota.[34]

The Basin Electric Power Cooperative is building a plant near Stanton, North Dakota, with an electric generating capacity of about 440 megawatts. This is scheduled for completion in 1981, and will become part of an eventual 1,200 megawatt electric plant near Beulah, North Dakota to be in operation by 1981.[35]

The Minnesota-Dakota utilities which already operates one small coal-fired electric plant at Beulah and a 100 megawatt plant at Mandan, North Dakota, has proposed to build a 440 megawatt plant at Beulah, North Dakota for operation in 1981.[36]

In that most North Dakota coal is lignite in nature and therefore generally unsatisfactory for transportation over long distances, it will most likely be used in the general area where it is mined. Because the basic requirements for electrical power generation exist in North Dakota, these being a fuel source, a market, water supplies, and a high voltage power transmission grid, it is to be expected that the electric generating plants proposed will indeed become a reality, and that other similar plants will also be forthcoming in the future. While the North Central Power Study only identified four North Dakota locations for mine mouth electrical generating plants, in Bowman, Beulah, Dickinson and Center, North Dakota, it now appears that much more intensive and widespread use of North Dakota lignite for power generation is in the offing. While most of the existing and proposed plants lie within the Mercer, Oliver and Morton Counties, it is conceivable that the use of lignite for electric power generation could spread into the coal rich southwestern counties of North Dakota in the future. Already, Bowman county coal is being mined by the Knife River Coal Company for export out of state. In that the state's greatest concentration of strippable coal reserves lie in the southwestern counties, including Bowman, Golden Valley, Slope and Stark, it is to be expected that more extensive development of these reserves for electric power generation can be expected.[37]

Coal Gasification

A number of pipeline and utility companies have announced their interest in developing lignite fueled coal gasification plants in North Dakota. Only one company, the Michigan-Wisconsin Pipeline Company (a subsidiary of the American Natural Gas Company), has yet to obtain a water use permit for such a plant. In February of 1974, this company received a permit from the State of North Dakota to build a lignite gasification plant requiring 17,000 acre feet of water per year on the Missouri River west of Bismarck, North Dakota. This plant is not expected to be in production until 1980.[38] It is important to note that the company originally applied for water rights sufficient to operate a gasification complex with four times the capacity of the approved facility. Therefore, it is possible that the first facility may eventually be expanded substantially. The proposed gasification plant will be capable of producing 250 million cubic feet of synthetic gas per day. While the company received a water permit for 17,000 acre feet per year, enough for one gasification plant, it also has a priority on another 51,000 acre feet,[39] or enough for three additional gasification plants. One of the major attractions North Dakota provides for coal gasification is the relatively plentiful supply of water provided by the Missouri River. All four of the Michigan-Wisconsin proposed gasification plants would rely on the Missouri River as their water source. Three of the plants would rely specifically on the Lake Sakakawea portion of the Missouri River.

Two other companies have announced their intentions to construct gasification plants in North Dakota. The Natural Gas Pipeline Company of America has announced plans to build four gasification plants in Dunn County of North Dakota. In April of 1974, the company submitted a request for 70,000 acre feet of water annually for these plants. In addition, the company has entered into a twenty-year lease agreement with Star Drilling, Inc. for 2.1 billion tons of Dunn County lignite coal.[40] Another company, El Paso Natural Gas Company, has applied for 71,816 acre feet of water to fuel four gasification plants in Dunn, Stark and Bowman Counties. Other companies have also shown interest in the use of North Dakota lignite for the production of synthetic gas. Among these are Texaco and Panhandle Eastern.[41]

Besides the fact that North Dakota lignite coal is cheap, that water is relatively plentiful in North Dakota, and that lignite coal is unsatisfactory for long distance transportation, a number of other factors will have an important affect on the future use of lignite coal for the production of synthetic gas. One of these is coal gasification technology. Lignite is one of the types of coal well suited for use in coal gasification as performed by the carbon dioxide acceptor method developed by the U.S. Bureau of Mines.[42] This process, while one of the most refined of the second-generation gasification techniques, is still about fifteen years away from commercial use. Lignite is also well suited for use in gasification plants using the Lurgi process. This method has already been used commercially throughout the world to produce low BTU gas.[43] A methanation process for upgrading Lurgi gas to a high BTU level has recently been tested and proven in Scotland. While the carbon dioxide acceptor process is significantly more efficient than the Lurgi process, with three carbon dioxide acceptor gasifiers having the same capacity as 31 Lurgi gasifiers, the Lurgi process is the only method now available and proven for producing synthetic gas.[44] The fact that lignite coal is well suited for both existing and future gasification technology is of key importance to the favorable outlook for lignite-based coal gasification.

In that each coal gasification plant will require about 58 megawatts of electricity annually, it is important that such plants be located near electrical generating plants.[45] With the expected increase in North Dakota electrical generating capacity, a ready source of electricity for gasification plants would be available. This will serve to make the North Dakota area attractive to coal gasification operations.

It will be necessary that coal gasification companies have a means of transporting their synthetic gas products to eventual users in the Midwest and Eastern United States. This problem could be solved by the probable construction of the Northern Border Pipeline through Mercer County of North Dakota. This pipeline will originate in the Prudhoe Bay area of Alaska and will extend through North Dakota to the Upper Midwest and eastern parts of the United States.[46] The availability of this pipeline as a means of transporting synthetic gas produced in North Dakota is also important to the prospects for extensive coal gasification in the state.

Wyoming

Current Situation

Coal was first mined in Wyoming in the 1860's, when the Union Pacific tracks came through. The depression of the 1930's caused a decline in coal production and severe unemployment to the state, but during the war, coal production increased and peaked at 9.8 million tons in 1945. About 8 million tons of this came from underground mines and about 1.8 million tons from surface mines. In 1947 and 1948, the first diesel locomotives rolled through the state, and in 1954 the Union Pacific closed its Hanna mine due to dieselization of the railroad.[47] Thereafter, Wyoming coal production declined and amounted to only 1.6 million tons in 1958. By 1970, the potential of Wyoming coal had been recognized and production had increased to 7.4 million tons. In contrast with earlier coal production, most of the 1970 production, or 6.9 million tons, came from surface mines, with only .5 million tons from underground mines.[48]

At the end of 1972, there were eighteen coal mines in Wyoming, thirteen of which were strip mines and five of which were underground coal mines. In January of 1975, there continued to be eighteen mines in operation in Wyoming. Four of these were small mines with annual production of less than 100,000 tons. Three of these opened in 1974. Several of the Wyoming mines were among the top fifty largest coal mines in the United States. These include the

Pacific Power and Light Company, Dave Johnston Mine which produced 2.9 million tons in 1973, the Arch Minerals, Seminoe No. 1 which produced 2.9 million tons in 1973, and the Chemicals Company, Sorensen which produced 2.5 million tons in 1973. These three mines rank eighteenth, twentieth and twenty-sixth among the fifty largest U.S. coal mines.[49] A listing of these mines with certain relevant details is provided as Appendices 12 and 13. Also included in these appendices is a listing of the twelve proposed mines which could be opened anytime between 1975 and 1978.

From 1962 up until 1969, Wyoming coal production was less than 5 million tons per year. However, in 1970 production began to increase rapidly and by 1974 had increased to approximately 18.9 million tons. The Wyoming State Department of Economic Planning and Development, using the available contracts for coal sales from Wyoming mines and other relevant data, has produced a projection of future Wyoming coal production. This is summarized, with the history of annual coal production, in Table 18. This shows that Wyoming coal production could grow from 18.9 million tons in 1974 to 140 million tons in 1980, and thereafter to as much as 200 million tons in 1985. Of the projected production of 140 million tons in 1980, 96 million tons will be mined under contracts that have already been announced. It is expected that 78 per cent, or 110 million tons, will be shipped out of the state in unit trains. The remaining 30 million tons will be used in the state for electric power generation and to provide a coal feedstock to one coal gasification plant.[50]

TABLE 18

WYOMING COAL PRODUCTION

Actual Production [a]

Year	Production (000's of tons)
1962	2,569
1963	3,124
1964	3,101
1965	3,260
1966	3,670
1967	3,588
1968	3,829
1969	4,606
1970	7,222
1971	8,502
1972	10,928
1973	14,886(3)
1974	18,887(3)

Projected Production [b]

Year	High	Low
1975	25,410	29,912
1976	36,500	43,950
1977	57,550	65,050
1978	87,650	95,250
1980	96,000	140,000
1985	-	200,000

a. National Coal Association, Coal Facts, 1974-75, p. 79.
b. State Department of Economic Planning and Development, Wyoming Mineral Yearbook: 1974, pp. 59-80.

At the end of 1973, the private electric utilities in Wyoming were using coal to generate about 870 megawatts of electricity. The North Central Power Study[51] shows the potential in Wyoming for ten electric power plants in the Powder River Basin, one in the Buffalo/Sheridan area, and three in the southwestern portion of the state. These fourteen plants were all to be fired by strippable coal and could produce up to 121,000 megawatts of power. There are a number of additional coal conversion plants planned for Wyoming. Included among these are several electric plants and one coal gasification plant. Proposed electric plants include a 1,500 megawatt power plant near Wheatland, a 330 megawatt expansion of the Wyodak Plant at Gillette, an 860 megawatt expansion of the Naughton Power Plant at Kemmer. All of these plants could be in operation by 1980.

An interesting form of coal transportation system is that proposed by Energy Transmission Systems, Inc. This company has proposed a 38 inch pipeline to run from Wyoming to Arkansas, and to be used in transporting Wyoming coal through a coal-slurry pipeline. This company estimates that 96 per cent of the coal energy in its original form can be delivered using coal-slurry pipelines. In August of 1974, a report was prepared by the Senate Interior and Insular Affairs Committee which suggests that coal-slurry pipeline will play a major role in transporting western coal to consumer markets. This report was motivated by the Coal Pipeline Act of 1974 and shows five possible pipeline routes in the

Rocky Mountain States. Two of these affect Wyoming, the first and more likely of which is the energy transportation systems line from Campbell County, Wyoming to Arkansas. The estimated cost of this pipeline is $750 million, and the pipeline is estimated to be 1,036 miles in length.

Gasification

According to the Wyoming State Department of Economic Planning and Development, the Carter Mining Company is studying the feasibility of locating a coal gasification plant at Gillette. In addition, Texaco acquired the majority of the Reynolds Metals Company's interest in the Lake DeSmet area of the Powder River Basin, an area in which Reynolds had announced its intentions to construct a gasification facility. Both the Carter Mining and Texaco Company have adequate coal and water reserves for coal gasification, but neither company has announced plans for a plant. Texaco officials however admit plans to develop coal and water resources they control.[52] One company, Panhandle Eastern Pipeline Company, has announced its plans to construct a gasification plant in Wyoming. The company's request to transfer an irrigation water right for use in gasification, imperative to the future of the plant, was denied by the State Board of Control on May 7, 1974.

Summary

In reviewing the current status of western coal development, it is obvious that this development has already reached substantial proportions.

Over time, development has progressed through a number of stages: railroad mining, local consumption as a heat source, and electric power generation. From a historic standpoint, gasification may merely represent another evolutionary phase of coal use. In a way, the actual development which has occurred has laid the groundwork for further development. Importantly, a great deal of uncertainty exists over the outlook for gasification.

The existing and planned mines and plants will impact on gasification. The electric plants will provide needed electricity, the mines a supply of coal. In addition, the skilled construction work force assembled to build electric plants could also be used to construct gasification plants. On the other hand, rapid electric plant activity could mean work force shortages and unavailability of sufficient water for gasification.

Lastly, the large power plants already sited in Montana and North Dakota provide an indication of the economic and financial impact of such facilities. With the construction work forces needed to build gas plants of a similar composition and size, some of these impacts can be extended to gas plants.

Chapter II

Footnotes

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3. National Coal Association, Impact of Surface-Mined Bituminous Coal and Lignite on U.S. Energy Sector, Figure 11.

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33. "Lignite Has Its Drawbacks-But It's Cheap", Business Week, March 16, 1974, p. 102.

34. League of Women Voters, Coal Development, p. 2.

35. Ibid.

36. Ibid.

37. Dalsted and Leistritz, "North Dakota Coal Resources", Slide 27.

38. Minneapolis Tribune, February 20, 1974, p.7A.

39. Ben A. Franklin, "What Price Coal", p. 27.

40. League of Women Voters, Coal Development, p. 3.

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43. Dalsted and Leistritz, "North Dakota Coal Resources", p. 11.

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48. Burlington Northern Railroad, "The Energy Crisis".

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50. State Department of Economic Planning and Development, Wyoming Mineral Yearbook 1974, p. 4.

51. U. S. Bureau of Reclamation, North Central Power Study, p. 35.

52. State Department of Economic Planning and Development, Wyoming Mineral Yearbook 1974, p. 6.

CHAPTER III

COAL GASIFICATION OUTLOOK

It is necessary in an analysis of the economic and financial impact of coal gasification to perform a review of those factors which could have a significant impact on its future.

The outlook for gasification is extremely clouded, with development currently stalled by environmental lawsuits, the leasing moratorium and delays in obtaining requisite certificates from the Federal Power Commission. The long-range outlook is also unclear due to the uncertainties created by the lack of a national energy policy, escalating costs and questions over economic feasibility, capital shortages and other factors.

The focus of this chapter will be to develop a review and assessment of the key factors affecting the outlook for gasification. It will provide a summary of the positive considerations, a review of the economic feasibility of synthetic gas, and an assessment of the obstacles to future gasification development.

A statement made by the National Petroleum Council in 1972 serves as an appropriate lead-in to this portion of the paper:

> "The coal task group, in analyzing the future potential of coal-based synthetic pipeline gas, concluded that neither technological considerations nor the adequacy of supply of the stocks would be major factors affecting the growth of synthetic gas production. The buildup rate would, in fact, be primarily influenced by economic or other considerations." [1]

Gasification Projections

Several projections of future coal gasification plans and production have been produced. Several of these forecasts were done by the United States Federal Power Commission, two in earlier years and the last more recently, and then only in the preliminary draft stages. Another projection was made by the National Petroleum Council, an industry advisory council to the U.S. Department of the Interior. This was released in December of 1972. A brief summary of these projections follows.

National Petroleum Council

In early 1970, the National Petroleum Council was asked to perform a comprehensive study of the nation's energy outlook by the Assistant Secretary, Department of the Interior. In response to this request, the NPC Committee was established and the assistance of over 200 representatives from industry solicited. In December of 1972, the results of this group's efforts were published in a summary report, U.S. Energy Outlook. Projections were made for four case situations, two of which were combined. The projections made were of high BTU synthetic gas, and were made without regard to economic considerations.

The NPC made a number of projections according to the following case situations:

I. A maximum rate of buildup under special conditions and appropriate special policies.

II. A rapid but practical build-up rate.

IV. A minimum rate of buildup which can be foreseen on the basis of current economics.

An annual projection of installed synthetic gas from coal production is provided in the following table.

TABLE 19

FINAL APPRAISAL - NPC
INSTALLED CAPACITY OF
SYNTHETIC GAS FROM COAL

(TCF per year-90% operating factor)

Case	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
I	0.08	0.16	0.28	0.40	0.56	0.80	1.12	1.52	2.00	2.48
II/III	0.08	0.12	0.16	0.24	0.36	0.52	0.68	0.84	1.08	1.31
IV	–	–	–	–	0.18	–	–	–	–	0.54

SOURCE: E.H. Reichl, U.S. Energy Outlook: Coal Availability, Report by the Coal Task Group of the National Petroleum Council, 1973, p. 67.

According to Case I assumptions, there would be a total of thirty gasification plants having an individual capacity of 250 million cubic feet per day in operation by 1985. This would require the construction of about six plants per year towards the end of 1976-1985. Under Case II and III, there would be sixteen gasification plants in operation by 1985, requiring annual reconstruction of three plants per year. The Case IV projection was based on a significant reduction in the initial appraisal and would require around seven plants to be in operation by 1985.

Federal Power Commission - 1973

In 1971, the FPC established a Supply Technical Advisory Committee of the National Gas Survey for the purpose of achieving several objectives, one of which was to ascertain the supplemental and alternative fuel considerations for natural gas. A number of individual task forces were established to accomplish this and other objectives. Among these was the Synthetic Coal Task Force. This task force had the objective of evaluating the technical and economic aspects of coal to gas conversion technology, and of providing projections through 1990 of probable costs and commercial availability of gas from both coal and oil shale. Among the conclusions of this task force was that the supply of coal necessary and suitable for gasification is sufficient and readily available in quantities adequate to support synthetic gas production well into the next century. Identified coal reserves totaling 42 billion tons were projected to enable the production of 542 trillion cubic feet of gas, about twenty-five times current annual demand at that time.

It was the task force projection that the first commercial coal gasification plants based on Lurgi technology could be in operation by 1976 and that there could be five additional Lurgi plants in operation by the end of 1980. It is expected that second generation technology plants could be available after 1980, and that by 1990 there could be as many as thirty-six gasification plants of varying types producing about 3 trillion cubic feet of synthetic natural gas from coal annually. Given the proper incentive through government policies and actions, it was felt that greater production by 1990 would be possible.[2] According to the report, there was substantial agreement within the task force regarding the 1990 forecast, and there were no dissenting statements to the report by task force members. The projections made by the task force are provided in the following table.

TABLE 20

GASIFICATION PROJECTION
FEDERAL POWER COMMISSION BUREAU OF NATURAL GAS

Projections by Others for Pipeline Gas From Coal, Commercial Plant Capacity

Year	National Petroleum Council (Cases II and III)			FPC Bureau of Natural Gas		
	Number of plants	Capacity, trillion CF per year	Investment, million dollars[1]	Number of plants	Capacity, trillion CF per year	Investment, million dollars
1975	1	0.08	250	[2]1	[2]0.1	[2]220
1980	4	0.36	1,000	3	0.3	710
1985	16	1.31	4,000	15	1.4	3,440
1990	[3]n.e.	n.e.	n.e.	36	3.3	7,995

[1] Constant 1970 dollars. [2] 1976. [3] n.e. = not estimated.

Synthetic Gas-Coal Task Force Projections of Commercial Plant Capacity

Year	Member A		Member B		Member C		Average	
	Number of plants	Capacity, trillion CF per year	Number of plants	Capacity, trillion CF per year	Number of plants	Capacity, trillion CF per year	Number of plants	Capacity, trillion CF per year
1975	([1])	([1])	([1])	([1])	([1])	([1])	([1])	([1])
1980	8	0.7	2	0.2	5	0.4	5	0.4
1985	19	1.6	14	1.1	15	1.2	16	1.3
1990	32	2.7	40	3.2	35	2.9	36	2.9

[1] None.

SOURCE: Federal Power Commission, National Gas Survey, Volume II: Supply Task Force Reports, p. 501.

In more recent forecasts prepared by the staff of the FPC, and based on projections made by the Natural Gas Survey task forces, somewhat different forecasts of synthetic gas from coal production were developed. Using a scenario approach for varying levels of development, it was projected that synthetic gas from coal production could vary between 1.2 trillion cubic feet under Case I assumptions, to as much as 5.1 trillion cubic feet under Case IV assumptions. The scenarios, ranging from Case I to Case IV, assume varying levels of supply from natural, substitute, and imported gas sources. It is to be noted that under each of the scenarios as provided in the following table, gas from coal generally represents only about 10 per cent of total gas supplies in the year 1990. This indicates that synthetic gas produced from coal is not expected to provide a complete substitute for natural gas, nor to serve as even a primary gas source.[3] It is important to note that the relative contribution of gasification to national gas supplies is only expected to be a minor one, and that the primary source of gas is expected to remain natural gas.

TABLE 21

FEDERAL POWER COMMISSION
PRELIMINARY GAS SUPPLY FORECAST

	Future Available Gas Supply			
	Case I	Case II	Case III	Case IV
Total Supply*				
1970 Actual	22.8	22.8	22.8	22.8
1975	23.6	21.4	18.0	14.1
1980	24.3	24.7	25.3	25.2
1985	24.8	31.2	32.6	34.2
1990	25.0	35.8	41.0	49.2
Gas From Coal*				
1980	.2	.3	.4	.6
1985	.7	1.1	1.3	1.9
1990	1.2	2.2	3.0	5.1
Percent Gas From Coal				
1980	% .8	1.2	1.6	2.3
1985	% 2.8	3.5	4.0	5.6
1990	% 4.8	6.1	7.3	10.4

*Trillion Cubic Feet

SOURCE: Federal Power Commission, National Gas Survey, Volume I, Chapter 9: Future National Gas Supplies-Preliminary Draft, pp. 4-5.

Announced Coal Gasification Plants

To date, a number of companies have announced their intentions to construct a total of five pipeline quality gasification plants, two in Montana, two in North Dakota, and one in Wyoming. These announcements were discussed in some detail in the preceding chapter describing the current coal development situation in each of these three states. While each of these announcements, particularly those of the Michigan Wisconsin Pipeline Company for the Beulah area of North Dakota and of the Natural Gas Pipeline Company of America for the Dunn-Center area, represent significant expenditures already incurred in the form of research and analysis, it is fully possible that these plants will never be built. However, the developmental expenditures companies are making does indicate their continuing support. For example, Texaco had been constructing facilities to raise the water level in Lake DeSmet to increase water availability to coal conversion.[4] A summary of the various commercial coal gasification plants which have been announced to date is provided in the following exhibit. Ten gasification plants have also been announced for other parts of the United States. Two of the others, the New Mexico gasification plants of El Paso and of Texas Eastern are the furthest advanced in terms of design, and it is expected that construction will begin on the Texas Eastern project in 1976. The future of the El Paso project is uncertain at this time, with further action postponed indefinitely pending resolution of coal lease problems.

TABLE 22

Announced Commercial and Demonstration Coal Gasification Plants

Controlling Company(s)*	Process	Plant Output, million CF/day	Status
A. HIGH-Btu GAS PROJECTS			
El Paso Natural Gas Co., New Mexico	Lurgi gasification with methanation	288	El Paso Natural Gas Co. plans to construct and operate the Burnham Coal Gasification Complex on the Navajo Indian Reservation. Capital costs (1973 basis) will be $114 million for the mining operation and $491 million for the gasification plant. The average unit cost of the synthetic gas over a 25 year plant life is estimated at $1.17/1000 CF. Coal Feed: 28,250 ton/day.
Texas Eastern Transmission Corp. and Pacific Lighting Corp. (Utah International Corp.), New Mexico	Lurgi gasification with methanation	1000 (4 plants)	The firms plan to construct and operate four plants on the Navajo Indian Reservation near Farmington, N.M. Cost of the first plant is estimated at $447 million, with operation scheduled for early 1978. Coal Feed: 105,200 tons/day.
Panhandle Eastern Pipe Line Co. (Peabody Coal Co.), Wyoming	Lurgi gasification with methanation	250	Plant operation is anticipated in the 1978-1980 period. Plant investment will be about $500 million. Coal Feed: 25,000 tons/day.
Natural Gas Pipeline Co. of America, Dunn Co., North Dakota	Lurgi gasification with methanation	1000 (4 plants)	The company plans to build at least four and possibly eight gasification plants. Cost of the gasification plant will be $370 million. The first plant is scheduled to go on-line in 1982. Coal Feed: 108,500 tons/day (4 mines).
American Natural Gas Co. (North American Coal Corp.), Beulah-Hazen Area, North Dakota	—	1000 (4 plants)	Four plants are planned. Plant cost is estimated at $450 million each. The first plant is scheduled for operation in 1980.
Northern Natural Gas Co., Cities Service Gas Co., Powder River Basin, Montana	—	1000 (4 plants)	Northern Natural and Cities Service plan to construct four 250 million CF/day coal gasification plants. Through 1975, $10-$11 million will be spent for preliminary development. Construction of the first plant could start in 1976-1977 with operation in 1979-1980.
Texas Gas Transmission Corp. (Consolidation Coal Co.), Kentucky	—	80	Texas Gas Transmission and the State of Kentucky have signed an agreement to build a $200 million, 80 million CF/day gasification plant expandable to 250 million CF/day.
Colorado Interstate Gas Corp. (Westmoreland Coal Co.), Montana	—	250	Colorado Interstate has an option on 300 million tons of coal and 10,000 acre-feet per year of water to be suplied by Westmoreland for development of a coal gasification project. Coal Feed: 25,000 ton/day.
The Columbia Gas System, Inc., Illinois	—	300	Preliminary capital cost estimates are $635 million for the plant and $75 million for three associated mines.
Consolidated Natural Gas Co., Pennsylvania	—	—	Consolidated has 70% interest in southeastern Pennsylvania acreage containing over 300 million tons of coal and is negotiating for more reserves. The company expects to make a commitment on its first gasification plant in 18-24 months.
Pennsylvania Gas and Water Co., Pennsylvania	HYGAS or similar one	80	The company has proposed to the Office of Coal Research a plan for financing and operating a demonstration plant. Coal Feed: 5,000 tons/day.
Southern Natural Gas Co., Illinois	—	250	Southern Natural Gas Co. has acquired an option to purchase coal reserves in the Illinois Basin from Consolidation Coal Co.
Texas Eastern Transmission Corp. (Peabody Coal Co.), Southern Illinois	—	250	Texas Eastern has obtained tentative dedication of a large reserve of Peabody's southern Illinois coal while a feasibility study of a gasification plant is made.
Panhandle Eastern Pipe Line Co. (Peabody Coal Co.), Southern Illinois	Lurgi gasification with methanation	—	Feasibility studies underway.
Cameron Engineers and Marathon Oil Co., Colorado	—	250	The companies have filed plans with the U.S. Bureau of Land Management. Plant operations could begin in 1981. Coal Feed: 25,000 plus sewage sludge.

SOURCE: A.G.A. MONTHLY, March, 1975.

Siting of Coal Gasification Plants

A number of factors must be considered in selecting locations for coal gasification plants. Among these are the quantity of coal, quality, BTU content, deposit size and thickness, and overburden. Other considerations include the availability of adequate quantities of water necessary to gasify coal, and the availability of pipelines to be used in transporting such coal to consumer markets. An additional consideration which is taking on increasing importance is the attitude of local citizens towards having a coal gasification plant located in their area, as well as the attitude of state government towards such plants. For example, Montana in April of 1975 was in the process of considering and passing legislation which would place a moritorium on the location of additional coal conversion plants in the state.

The most referred to source of information on coal gasification sites is a yet secret study prepared by the American Gas Association. The purpose of this study was to determine the availability and location of coal and water resources in this country adequate to support a coal gasification industry. While specific locations are not revealed, this study did identify 176 potential coal gasification sites, 141 of which were west of the Mississippi River and 35 east of that river.[5]

The National Petroleum Council has provided a state-by-state breakdown of coal gasification plant locations for its Final Projections.

This breakdown is summarized in Table 23, and shows the bulk of these plants to be located in four states--Montana, North Dakota, Wyoming and New Mexico.

TABLE 23

NATIONAL PETROLEUM COUNCIL PROJECTION OF DISTRIBUTION OF COAL GASIFICATION PLANTS IN 1985

	Case I		Cases II/III		Case IV	
	No. of Plants	TCF	No. of Plants	TCF	No. of Plants	TCF
			Bituminous Coal			
New Mexico	4.0	0.33	4.0	0.33	2.0	0.16
			Subbituminous Coal			
Wyoming	7.0	0.58	3.4	0.28	2.1	0.18
Montana	6.4	.0.53	3.0	0.25	1.0	0.08
			Lignite			
Montana	8.0	0.66	3.6	0.29	0.0	0.00
North Dakota	4.6	0.38	2.0	0.16	1.5	0.12
Total	30.0	2.48	16.0	1.31	6.6	0.54

SOURCE: National Petroleum Council, Committee on U.S. Energy Outlook, J. McLean, Chairman, U.S. Energy Outlook, p. 168.

Another study which is more specific and therefore of perhaps greater use in determining the potential location of gasification sites within the three states of Montana, Wyoming and North Dakota, is the North Central Power Study, completed in 1971.[6] This study provides a summary of those sites with suitable and adequate supplies of strippable coal to fuel 1,000 megawatt mine mouth electrical generating plant. Another study, the Northern Great Plains Resource Program--draft report of September 1974, applied the same siting criteria to 1,000 to 1,250 megawatt power plants as it did to 250 MCFD gasification plants. It would therefore appear that those sites suitable for generating plants may also be suitable for coal gasification facilities. A list of the 42 potential generating plant locations and map of these locations is provided in the following Table 24. It is to be noted that 21 of these 42 locations, or half, lie within the boundaries of Montana, and that another 19 of these sites are located in North Dakota and Wyoming.

These three studies show that western coal is considered an attractive gasification siting alternative. Montana and Wyoming appear to offer the greatest number of feasible sites. However, the greater availability of water in North Dakota may play an important role in future plant sitings.

TABLE 24

STRIPPABLE COAL SITES FOR 1,000 MW OR MORE BASE LOAD MINE-MOUTH GENERATING PLANTS

Site Identification Number	State	Plant Size MW	Deposit Name	Location
1	North Dakota	5,000	Slope & Bowman Counties	Bowman, N.D.
2	" "	5,000	Knife River	Beulah, N.D.
3	" "	3,000	Heart River	Dickinson, N.D.
4	" "	1,000	Center	Center, N.D.
5	South Dakota	1,000	Cave Hills	Ludlow, S.D.
6	Montana	10,000	Pumpkin Creek	20 m. N.W. Broadus, Mont.
7	"	10,000	Hanging Woman Creek	10 m. S. Birney, Mont.
8	"	5,000	Beach-Wibaux	Wibaux, Mont.
9	"	5,000	Colstrip	Colstrip, Mont.
10	"	5,000	Foster Creek	Volborg, Mont.
11	"	5,000	Decker	Decker, Mont.
12	"	5,000	Otter Creek	10 m. S.E. Ashland, Mont.
13	"	5,000	"S" Bed	10 m. N.W. Brockway, Mont.
14	"	5,000	Moorhead	Moorhead, Mont.
15	"	3,000	Broadus	Broadus, Mont.
16	"	1,000	North Fork of 13 Mile Cr.	25 m. N.W. Savage, Mont.
17	"	1,000	Reserve	Reserve, Mont.
18	"	1,000	Fort Kipp	Fort Kipp, Mont.
19	"	1,000	Lane	Richey, Mont.
20	"	1,000	Carroll	Paxton, Mont.
21	"	1,000	Coalridge	Coalridge, Mont.
22	"	1,000	Poker Jim - Lookout	Birney, Mont.
23	"	1,000	Birney	Birney, Mont.
24	"	1,000	Kirby	Kirby, Mont.
25	"	1,000	Sonnette	Sonnette, Mont.
26	"	1,000	Sweeney Creek	10 m. N.W. Brandenberg, Mont
27	Wyoming	10,000	Lake De Smet	10 m. N. Buffalo, Wyo.
28 thru 37	"	10,000 ea. (100,000 mw total)	Gillette	15 miles N. of Gillette to Antelope Creek (55 miles S. of Gillette, Wyoming)
38	"	5,000	Red Desert-Cherokee	N. of Wamsutter, Wyo.
39	"	5,000	Adaville	6 m. W. of Kemmerer, Wyo.
40	"	3,000	Spotted Horse	Spotted Horse
41	"	1,000	Jim Bridger	25 m. N.E. Rock Springs, Wyo.
42	Colorado	1,000	Denver Basin	Watkins, Colorado
	Kansas, Iowa,		No sites	
	Nebraska, Missouri,		" "	
	Minnesota		" "	

SOURCE: North Central Power Study. Coordinating Committee, North Central Power Study, p. 37.

Coal Gasification Technology

History

The ability to produce a synthetic gas from coal is by no means a recent human achievement. Gas was first manufactured from coal as early as in the late 18th century. The first coal gas company was chartered in London in 1812 and the first U.S. company was formed in Baltimore in 1816. At that time, gas was produced by what was called "destructive distillation", which is the heating of coal to a temperature where it decomposes chemically. The production of synthetic gas spread throughout the eastern part of the U.S., and most large cities had what were called "gas houses" where synthetic gas was produced for local heating and lighting. Original coal gas had a heating value of between 475 to 560 BTU's per cubic foot.

A major drawback of the early gasification processes was that about 70 per cent of the original coal remained as solid waste. True gasification involves not only heating the coal to produce gas, as in the destructive distillation process, but also entails the subsequent reaction of the solid residue with air, oxygen, or steam. During the years, a number of methods were devised to more fully utilize the coal feedstock, therefore moving towards true coal gasification. These various processes produce "water gas", with a 300 BTU per cubic foot heat content, "carbureted blue gas" with a heat content similar to original coal gas, and "producer gas" with a heating value of between 110 and 160 BTU's per cubic foot.

Continuous refinements in these methods were made over the years from 1850 up until World War II. At that time the increased availability and low cost of natural gas caused a substantial decline in interest in manufactured gas products. Coal gasification, however, did continue to develop as the source of supply for town gas, as a chemical feedstock, and in the manufacture of ammonia.

Proven Technology

The most successful commercial gasification process that has been developed so far is the Lurgi Fixed Bed, Pressurized Gasification process. This process was developed by Lurgi Oil Techniques, Ltd. of Frankfurt, West Germany, about forty years ago. Since then, this process has been utilized in at least 58 units, located throughout the world. The largest such installation is the thirteen gasifiers at the Sasolburg plants in South Africa. Another process which has been utilized in some plants already in operation is the Koppers-Totzek Fully Entrained, Atmospheric gasification process. There are sixteen K-T plants operating around the world.[7]

The Lurgi process has been criticized for requiring too high of an investment cost per unit of capacity, not operating well with caking coals of the eastern United States nor with mine coals containing what are called "fines". In spite of this, the first commercial synthetic gas plants announced for the U.S. will be based on Lurgi technology. Those companies announcing Lurgi plants are:

El Paso Natural Gas Company, the Texas Eastern Transmission Corp., Commonwealth Edison, the Panhandle Eastern Pipe Line Company, Natural Gas Pipeline Co., and American Natural Gas Co.[8]

A major obstacle to the use of Lurgi gasification technology in the manufacture of "pipeline quality" synthetic gas was eliminated recently with the successful completion of a "Methanation Demonstration Program" in Scotland. Prior to this test, it was uncertain as to whether or not Lurgi technology, which had previously been used to produce only a low BTU gas, was suitable for pipeline quality gas production. The Continental Oil Company managed the program and it was funded by sixteen American companies. The test plant was brought on stream in September of 1973 and operated from May 1974 until October 1974. The methanation unit functioned very well, and the synthetic gas produced was used to satisfy about 60 per cent of the gas needs of the local market area.[9]

With the successful completion of the methanation program, the availability of technology for producing pipeline quality natural gas was attained. The availability of adequate gasification technology, then, is no longer a matter of concern nor a constraint on the development of coal gasification.

New Gasification Processes

A number of what are called "second and third generation" gasification technologies are currently under study. These are hoped to reduce initial investment costs, to improve operating efficiency, and to enable the use of a wider range of coal as the heat stocks to coal gasification. A list and description of these is provided in the following Table 25. In proving the feasibility of new gasification technology, each process undergoes a three stage investigation. The first of these is performed in what is called a pilot plant, the second in a demonstration plant, and eventually the technology is used in a commercial scale gasification operation. Currently only two pilot plants are in operation--the Hygas plant in Chicago, and the CO_2 Acceptor Plant in South Dakota. More than thirty experimental runs have been made at the Hygas plant, and twenty experimental runs have been made over a period of the last two years at the CO_2 Acceptor Plant. Two additional pilot plants are currently under construction, including the BCR Bi-Gas plant in Homer City, Pennsylvania, and the Battelle Agglomerated Ash plant in Ohio. Each of these test programs are joint industry and government projects involving the American Gas Association and the OCR (Office of Coal Research) coal gasification pilot plant program. In total, there are over thirty forms of coal gasification technology now under some form of study throughout the country.[10] The Hygas process is alleged to be the most advanced now under study. This process has operated successfully over a hundred hour period, producing 900 to 1,000 BTU gas from Montana coal. This process has several advantages in that it can accept any type of coal, does not require methanation, and operates at pipeline pressure, eliminating the need for additional compression.[11]

The future-generation gasification technologies will provide refined methods of producing synthetic gas from coal. This will provide a number of benefits, among which may be the ability to offset the impact of inflation on construction and operating expenses, and on the ultimate price paid by the consumer, with technological cost reductions. It is important to note, though, that these will only improve on an ability to produce synthetic gas from coal which exists today.

With the delays that have occurred in constructing the gas plants proposed as far back as 1972, it is very possible that gasification companies may decide to wait for second generation technology. The chairman of Northern Natural Gas, in a private conversation in September 1975, indicated this possible approach for his company. Such a decision could delay gasification by eight to ten years, the time needed to complete pilot plant tests, and to build and test demonstration-type gas plants for the most advanced new processes.

TABLE 25

PROCESSES FOR HIGH BTU PIPELINE GAS (SNG)

A: Processes Developed With Their Own Technology for Methanation

Developed or Offered by (and Process Name if any)	Process Comments	Status and Remarks
Bituminous Coal Research, Inc. (Bi-Gas)	Gasifier, at 1,000 to 1,500 psi., has 2 stages. Char is gasified with oxygen and steam in lower stage; the gas rises, picking up and entraining incoming coal; this stream goes to upper stage, which makes char and enriches the gas. Methanator has fluidized catalyst bed, with imbedded heat-transfer surfaces.	Gasification tested in 100-lb/h continuous unit; methanation likewise successfully tested. A 5-ton/h pilot plant for overall process being built at Homer City, Pa.
Columbia University	Coal's carbon reacts with steam in electric arc at about 10,000°C. Proper reaction and quench conditions enable production of SNG without additional methanation step.	See Sec. I.
Institute of Gas Technology (Hygas)	After pretreatment by air oxidation or by dilution with char, coal is oil-slurried and fed to top of 1,000-1,500-psi two-stage hydrogasifier, while mixture of steam and hydrogen (generated externally, from the char leaving hydrogasification) enters at the bottom. Heat in gasifier is supplied by carbon-hydrogen reaction. Methanator downstream uses multiple packed-catalyst-bed reactors.	3-ton/h pilot plant completed at Chicago in 1971 has operated on lignite, with hydrogen produced from char electrothermally. Now, IGT will run caking bituminous coal, and produce hydrogen via oxygen-combustion as source of heat.
Lurgi Gesellschaft für Wärme- und Chemotechnik mbH. (Lurgi Pressure Gasification)	In pipeline-gas projects, gasifier with lock hopper and grate (see Sec. I) employs oxygen for gasification, producing a raw gas of about 400 Btu/ft³. A heterogeneous nickel catalyst is used in the downstream methanation step.	Gasification well established (see Sec. I). Methanation being groomed in demonstration plants. First SNG-from-coal plants in U.S. will use Lurgi technology.
Stone & Webster Engineering Corp. (Solution/Gasification)	Coal is slurried in a solvent; then a two-step treatment with hydrogen solubilizes the coal and produces pipeline-quality gas without an explicit methanation step. Process does not entail oxygen or steam.	Tested on bench scale. Under new joint venture with General Atomic, nuclear reactors will provide heat for hydrogen generation. Demonstration plant planned.
U.S. Bureau of Mines (Synthane)	Coal is pretreated with steam and oxygen in fluidized bed reactor that is integral part of gasification system. The system operates at high pressures (e.g., 1,000 psi). Of methane contained in final gas, 60% is made during gasification step. Two variants of downstream methanation with Raney nickel catalyst are under study.	Tested in a continuous unit rated at 10 to 20 lb/h. A 75-ton/d pilot plant due completed at Bruceton, Pa., in August.

TABLE 25, continued

B: Processes That Will Be Combined With "Outside" Methanation Technology

Developed or Offered by (and Process Name if any)	Process Comments	Status and Remarks
Applied Technology Corp. (Atgas)	Coal is injected into 2,500°F molten-iron bath; reaction with steam and oxygen produces sulfur-free gas for shift conversion and methanation. Sulfur removed as slag by limestone addition.	Gasification step has been tested in 2 ft-dia. reactor, equivalent to 10 lb/min of coal. Company seeks funds to build 15-ton/h unit.
Babcock & Wilcox Co.	Entrained coal gasifier; char recycled. Methane content of gasifier output can be regulated by selecting pressure and temperature.	Technology commercial in 1950s for making synthesis gas. Now soliciting customers for fuel production (including SNG) as well.
Babcock & Wilcox Co.	Gasifier employs sulfur dioxide instead of oxygen for blowing.	Conceptual. Seeking funds for testing.
Cogas Development Co. (Cogas)	Multistage pyrolysis of coal yields gas, oil and char. More gas comes from reacting char with steam, at under 100 psi. Heat for gasification supplied by burning some char in air, in a combustor external to the gasifier. No oxygen needed.	Pyrolysis step demonstrated in COED-Process work of FMC Corp., one of the partners in Cogas Development Co. Two pilot plants will test char-gasification step.
Consolidation Coal Co. (CO_2 Acceptor)	Lignite is gasified with steam in presence of hot, calcined dolomite. This reacts exothermally with the gasification-generated carbon dioxide, removing it while providing heat for gasification. Dolomite regenerated by heating.	Runs have been made in a 30-ton/d pilot plant completed in South Dakota in 1972.
Davy Powergas Inc. (Winkler)	Oxygen-feeding version of process outlined in Sec. I serves as gasification step to precede shift conversion, purification, and methanation.	See Sec. I.
Exxon Corp.	Air burns char outside of gasifier, to provide heat for gasification reactions involving steam. System does not require oxygen.	Tested in ½-ton/d unit at Baytown, Tex. Design of proposed 500-ton/d plant nearly completed.
Garrett Research & Development Co. (GRD Coal Gasification Process)	A low-pressure (30 to 50 psi.) step pyrolyzes coal quickly in the presence of some steam and recycled gas. The pyrolyzer also receives partially burned char (produced externally by air combustion), which supplies the needed heat.	Tested in a 50-lb/h unit (a highly similar liquefaction process has been tested in a 300-lb unit). Now seeking support for a 250-ton/d pilot plant.
M. W. Kellogg Co.	Coal is contacted with oxygen and steam in a molten-sodium-carbonate bath at about 1,700°F. and 1,200 psi. The salt serves as catalyst and heat-transfer agent, all operations involving salt take place in the one vessel. Raw gas from gasification is tar-free. Of methane in the final gas, 55 to 60% is made during this gasification step.	Process development, underway for several years, has included studies in a 5¼-in-dia reactor. Next step will employ a 30 in reactor. Funding sought for building a large continuous pilot plant.
Koppers Co. (Koppers-Totzek)	Effluent from gasification described in Sec. I is suitable for shift conversion, and methanation.	See Sec. I.
Union Carbide/Battelle/Chemico	Two fluidized bed systems, a combustor and a gasifier, are linked by an agglomerated ash circuit that transfers heat. Gasifier, at 1,000°F and 250-350 psi, is fed coal and steam; the combustor is fed char and air. No oxygen required.	Components of process tested during 1960s by Union Carbide and Battelle. Chemico completing design, for Battelle, for 25-ton/d pilot unit.
U.S. Bureau of Mines (Hydrane)	In a first, "dilute" stage, coal particles are heated through their plastic-transition temperature range in a stream of hydrogen and methane from fluidized bed second stage. Devolatilized coal, meanwhile, falls into second stage, where it contacts hydrogen generated externally from char, steam and oxygen. Gas leaving dilute stage, at 2,000 psi., is 75% or more methane.	The two stages have been tested separately at Bruceton, Pa. A pilot unit to demonstrate them together has just been built but is not likely to start up during this fiscal year.

SOURCE: "Gas-From-Coal: An Update." Chemical Engineering, 3/74.

Gas Supply and Demand

The existence of adequate demand for gas is, of course, of critical importance in evaluating the outlook for future coal gasification. At the end of 1973, there were about 44 million natural gas customers consuming around 22.6 trillion cubic feet of natural gas per year. Natural gas sales in 1974 were down nearly 6 per cent from the prior year, and amounted to about 21.3 trillion cubic feet.[12] The reduction in annual gas consumption was due to depressed economic conditions, more moderate winter temperatures, to energy conservation measures instituted in reaction to the energy crisis of 1973. Due to artificial market constraints, such as rationing and refusal to make new gas hookups, it is likely that real demand was in excess of sales in 1974.

TABLE 26

U.S. NATURAL GAS RESERVES & PRODUCTION

		Trillion Cubic Feet	
Year	Customers	Annual Production	Remaining Reserves
1970	42.5 million	22.0	291
1971	42.2 "	22.1	279
1972	43.0 "	22.5	266
1973	43.7 "	22.6	250
1974	NA	21.3	237

About half, or 49 per cent, of annual natural gas production is consumed by industry, about 16 per cent is used in the generation of electric power, and most of the remaining 36 per cent is used in residential home heating. It is important to note that about 3.7

trillion cubic feet, or about 16 per cent of annual gas consumption, is used by what are called "interruptible" gas customers. In that these customers are sensitive to the cost of natural gas and alternative fuels as sources of energy, any escalation in natural gas prices, perhaps like that which would be caused by deregulation, could have a substantial effect on the volume of gas consumed by this segment. The fact that these customers are interruptible users indicates that they are able to utilize alternative fuels with some facility.[13] About 8.2 trillion cubic feet, or 52 per cent of total annual industrial consumption, is consumed by customers classified as "large volume" sales.[14] Because of the higher level of gas consumption of these customers, major changes in fuel sources can be more easily justified and recovered through cost disparities between alternative fuels. Therefore, while probably most interruptible customers with annual consumption of about 3.7 trillion cubic feet would fall in the "large volume" category, it is conceivable that this entire category, amounting to 35 per cent of annual consumption, could feasibly switch to an alternative fuel source to natural gas over the long range.

The decline in 1974 gas consumption, the effect of conservation, and the ability of a significant proportion of natural gas users being able to switch to an alternative fuel source, indicate that future natural gas or synthetic gas demand is by no means certain.

Gas Curtailments

The possibility of some industrial users switching to an alternative fuel source is compounded by the uncertainty created by the gas curtailments that have been experienced during the last four years. The following table shows the magnitude of these curtailments, which in 1974 approximated 12.7 per cent of total interstate pipeline gas sales in that year.

TABLE 27

INTERSTATE GAS SALES AND CURTAILMENTS 1970-1974

(Shortfall in Deliveries Under "Firm" Customer Contracts)

	Total Interstate Pipeline Gas Sales (TCF)	Net Interstate Firm Gas Curtailments (TCF)	Curtailments as a Percent of Total
1970	14.1	0.018	Neg. %
1971	14.2	0.286	2.01
1972	14.2	0.649	4.57
1973	13.7	1.131	8.25
1974	13.2	1.679	12.71

SOURCE: Federal Power Commission, Gas Supply Indicators, Monthly Curtailment Report, and Staff Gas Supply Report.

These curtailments will have the effect of eventually reducing gas demand.[15] The increasing unreliability of this fuel source is stated to be the major cause behind significant industrial fuel switching during 1972, and the first half of 1973. Price increases also motivated some switching.

Projected Gas Demand

The Federal Power Commission, in a preliminary draft of the chapter dealing with future gas demand of the national gas survey, provided a recent forecast of future gas demand. This forecast was developed by the Future Requirements Committee (FRC) of the University of Denver. This agency is composed of members from industry and government, and from the various industry associations such as the American Gas Association. The FRC forecast is alleged to be the most detailed and comprehensive forecast yet available. A summary of the results of this forecast is provided below, and shows gas consumption to increase from its present level of 21.3 trillion cubic feet in 1974 to as much as 45.3 trillion cubic feet by 1990. Major assumptions in this forecast were:

1. There will be an adequate supply of gas for all estimated requirements.

2. The 1970 price relationship of gas to competing fuels will remain about the same.

3. There will be no major war or depression, or that technological development will be of an evolutionary nature.[16]

TABLE 28

FUTURE REQUIREMENTS COMMITTEE FORECAST
OF U.S. FUTURE GAS REQUIREMENTS

(Trillion Cubic Feet)

	1975	1980	1985	1990
Residential	5.8	6.8	7.7	8.8
Commercial	2.6	3.2	3.9	4.8
Industrial	12.2	13.6	17.0	20.0
Electric utility	5.5	6.8	7.4	9.0
Other	1.9	2.1	2.3	2.6
Total	28.0	33.4	38.4	45.3

SOURCE: Federal Power Commission, National Gas Survey, Vol. I, Chapter 7: Future Gas Demand-Preliminary Draft, p. 5.

Projected Utility Gas Demand

Another interesting forecast of natural gas usage was provided by the National Electric Reliability Council. This forecast projects a substantial decline during the next ten years in the amount of natural gas used in the generation of electricity. In fact, it was one of the assumptions of the forecast that there would be continuing government pressure to require the abandonment of the use of natural gas as a boiler fuel.[17] This forecast shows a decline in the use of natural gas in electric generation from 2.9 trillion cubic feet in 1974 to 1.9 trillion cubic feet in 1983. Most of the reduction in usage would occur in the "interruptible" user category, a significant reduction could occur in the "subject to curtailment" category, and some reduction would occur in the large "firm and not curtailable" category. A copy of the NERC forecast is provided in the following Table 29.

Any significant variation in a natural gas market segment as important as electric power plants, accounting for 16 per cent of 1973 gas consumption, could have a meaningful impact on gas demand. A reduction in demand, as projected by the NERC for electricity, could defer gasification development.

TABLE 29

NERC FORECAST
NATURAL GAS DEMAND FOR ELECTRIC POWER GENERATION

NERC U.S. Only	Natural Gas -- Billion Cubic Feet
1974	2,910.1
1975	2,693.7
1976	2,626.3
1977	2,573.5
1978	2,506.4
1979	2,381.3
1980	2,220.0
1981	2,092.9
1982	1,929.4
1983	1,881.5

SOURCE: National Electric Reliability Council, Estimated Fossil Fuel Requirements for the Electric Utility Industry of the United States, Table III.

Price Elasticity of Gas

The price of gas that must be paid by the consumer would be increased quite substantially by the production and sale of higher cost synthetic gas. Economists believe that the demand for gas is price elastic, and that if prices rise high enough supply and demand for gas may balance. Various studies support this belief and indicate that this could occur before synthetic gas became economic.

The gas industry, on the other hand, does not feel that price has a significant impact on gas demand. A number of pragmatic considerations support the gas industry's position and are worthy of mention. Perhaps reality lies somewhere between these two opposing views, reflecting the unique expertise possessed by each source.

First, it is expected that the cost of higher priced synthetic gas will be "rolled-in" to the existing gas supply, similar to the way in which higher cost "new" gas (gas entering interstate commerce since January 1, 1973) is averaged throughout the gas base. In addition, a large proportion of the price paid by the consumer represents distribution and transportation expenses which will not be influenced by the increasing cost of the gas itself. These represent something over 80 per cent of the delivered cost of natural gas. Accounting for the mitigating impact of these two factors, the American Gas Association has estimated that on average synthetic gas costing $3.00 MMBtu's could be used to the extent of 20 per cent of total supply without increasing the cost of gas delivered to the consumer above $2.00 per MMBtu's. In contrast, the average cost of gas in 1974 was $1.42, indicating an increase of about 40 per cent. While this is a significant increase, it is much less than what one might expect when comparing $3-4 synthetic gas with the 23.5¢ price of interstate gas established by the FPC in early 1976.

The fundamental nature of gas consumption, unique uses of gas, difficulty and expense of converting existing consumption facilities, also create a dependence on gas that might not be easily altered. This, with the cost advantage gas has over some other energy forms, and the escalating costs of these alternatives, may sustain gas demand even in the face of possible 40 per cent price increases.

Chemical From Coal

The use of coal as a chemical feedstock could significantly impact the level of coal gasification development in the West.

The statement was made ten years ago by a member of the British Coal Utilization Research Association that "almost any organic chemical can be produced from coal".[18] This statement was qualified with a remark that this would not take place "unless a drastic change occurs in the availability and price of petroleum". It is fairly obvious that this change has occurred.

At this point in time, available technology exists to produce a wide range of organic chemical products, and this is already taking place on a large scale in the Republic of South Africa.

In June of 1974, a new company, Coalcon, was formed as a joint venture between Union Carbide Corporation and Chemical Construction Corporation to design, engineer and construct such coal processing plants in the United States. According to a spokesman for this company, it will be able to provide a plant for almost any situation where large quantities of organic chemicals are required. Examples of such products are methane and propane to be used as the feedstock for olefin, phenol, cresylic acids, neutral oils, and aeromatic chemicals including benzene, toluene and xylenes. This venture, and the Montana Power Company, have proposed that the Office of Coal Research join them in sponsoring a project to test one of these new processes in a plant to be located near Billings, Montana.

The synthetic gas produced by coal gasification plants can also be easily used as a feedstock for making methanol and ammonia. Methanol is an easily stored and easily transported, clean burning liquid with a number of important uses. Methanol's primary use today is as a petro chemical feedstock, a role in which it is expected to continue. Methanol can serve as a substitute for LPG, which serves many specialty markets and which is in short supply. Lastly, methanol does have the potential of serving as an automotive fuel.[19]

Technology already exists to produce ammonia through coal gasification. In a study released in August of 1974, it was noted that any three of the first-generation gasification processes could be used to produce ammonia. Also, the economics of coal gasification based ammonia production appear attractive. At a natural gas cost, $1.15/ MM BTU, the delivered cost of ammonia produced by coal gasification is comparable to that produced using natural gas as the feedstock.[20]

Western subbituminous coal provides an attractive source of coal, in that if gasified at the mine mouth, it is in relatively close proximity to the using markets located throughout the corn belt states of North Dakota, South Dakota, Nebraska and Kansas. The potential for producing ammonia from coal is supported by the June 1974 announcement of the Burlington Northern, of its intent to construct such an ammonia plant in McCone County of Montana. This plant would be used primarily in the manufacture of ammonia fertilizer and possibly liquid products such as methanol-methyl fuel and synthetic diesel fuel.

At the Sasolburg gasification plant in the Republic of South Africa, chemical by-products provided include road tars and pitch, benzene, nylon, nitrogenous fertilizers, synthetic rubber, polystyrene plastics, lubricating oils, detergents and various gasses. Within the last twenty years, an industrial complex and a community of 35,000 persons has evolved.

The ability to produce a wide range of chemicals from coal adds significantly to the potential for coal gasification. Shortages of chemicals, such as ammonia, will further advance the need for gasification. The development of a coal-based chemical industry could have a substantial impact on local developments.

A statement made by the coal purchasing agent for a large Midwestern utility, to the effect that some day we will realize that coal is too valuable to burn, adds creditility to the prospects for the use of coal as a chemical feedstock.

Natural Gas Supply

Probably the greatest threat to the future development of coal gasification is the availability of natural gas, particularly if available at artifically low prices. All of the projections for synthetic gas costs previously mentioned in this chapter were substantially above the current interstate rate of 43 cents per MCF. Higher allowable interstate prices are therefore necessary to achieve economic feasibility for synthetic gas from coal, but on the other hand may have a substantial negative impact on gasification prospects. If interstate gas prices are increased, it is to be expected that the increased economic stimulus provided will eventually serve to increase the availability of gas to this market. This could be achieved through a switching of interstate gas into the intrastate market, and through the additional exploration and discovery of gas reserve.

Natural Gas Reserves

The American Gas Association, or AGA, has estimated proved gas reserves and maintained a record of annual gas production data. According to the AGA, a total of 705 trillion cubic feet (Tcf) of recoverable natural gas has been discovered in the U.S. About 455 Tcf, or 65 per cent, has been produced, leaving about 250 Tcf of proved remaining recoverable reserves at the end of 1973. Proved reserves are potential suppplies of natural gas and gas liquids recoverable in the future from known gas reservoirs under current economic and operating conditions with reasonable certainty. United States proved natural gas reserves peaked at 292.9 Tcf in 1967 and have declined almost continually since that time. A table showing the history of proved reserves and the relationship between reserves and reserve additions to production is provided in the following Table 30. This shows that at the end of 1973, there were 250 Tcf of natural gas, about 11.1 years of supply.[21] In a more recent announcement, the AGA estimated natural gas reserves to have declined five per cent to 237.1 trillion cubic feet and remained at about 11.1 times annual production, which in 1974 was 21.3 Tcf.

TABLE 30

UNITED STATES NATURAL GAS SUPPLY *

(All Volumes in Trillions of Cubic Feet @ 14.73 Psia and 60°F.)

Year (1)	Production (2)	Reserve Additions (3)	Proved Reserves (4)	R/P Ratio (4) ÷ (2)** (5)	F/P Ratio (3) ÷ (2)** (6)
1946	4.9	17.6	159.7	32.5	3.6
1947	5.6	10.9	165.0	29.5	1.9
1948	6.0	13.8	172.9	28.9	2.3
1949	6.2	12.6	179.4	28.9	2.0
1950	6.9	12.0	184.6	26.9	1.7
1951	7.9	16.0	192.8	24.3	2.0
1952	8.6	14.3	198.6	23.1	1.7
1953	9.2	20.3	210.3	22.9	2.2
1954	9.4	9.6	210.6	22.5	1.0
1955	10.1	21.9	222.5	22.1	2.2
1956	10.9	24.7	236.5	21.8	2.3
1957	11.4	20.0	245.2	21.4	1.7
1958	11.4	18.9	252.8	22.1	1.7
1959	12.4	20.6	261.2	21.1	1.7
1960	13.0	13.9	262.3	20.1	1.1
1961	13.5	17.2	266.3	19.9	1.3
1962	13.6	19.5	272.3	20.0	1.4
1963	14.5	18.2	276.2	19.0	1.3
1964	15.3	20.3	281.3	18.3	1.3
1965	16.3	21.3	286.5	17.6	1.3
1966	17.5	20.2	289.3	16.5	1.2
1967	18.4	21.8	292.9	15.9	1.2
1968	19.4	13.7	287.4	14.8	0.7
1969	20.7	8.4	275.1	13.3	0.4
1970	22.0	37.2	290.7	13.2	1.7
1971	22.1	9.8	278.8	12.6	0.4
1972	22.5	9.6	266.1	11.8	0.4
1973	22.6	6.8	250.0	11.1	0.3

* Includes gas in underground storage.
** Computed prior to rounding.

SOURCE: Federal Power Commission, Natural Gas Survey, Vol. I, Chapter 9: Future Domestic Natural Gas Supplies - Preliminary Draft, p. 20.

The AGA estimates of natural gas reserves have been verified by another study of gas reserves performed by the Federal Power Commission. This program, conducted during 1972 and 1973, produced an estimate of proved natural gas reserves which was about 9.8% lower than that of the AGA at that time. This difference was considered relatively insignificant and the FPC continues to use the AGA estimates in its own work.

In addition to the proved reserves, it is expected that substantial quantities of gas called "Potential Supplies" exist. Projections of the quantity of potential gas are provided by a number of sources, the most quoted of which are those of the Potential Gas Committee (PGC) and the U.S. Geological Survey (USGS). A summary of these two projections is provided in the following Table 31, and shows that in addition to the 237.1 trillion cubic feet of proved reserves, there is as much as 1,146.0 to 2,100.0 trillion cubic feet of potential gas supplies.

(Trillion Cubic Feet)

Area Area Totals-48 States	PGC Probable	 Possible (12-31-72)	 Speculative	 Total	USGS Recoverable (12-30-70)
Onshore: 0 - 15,000 ft	121	153	139	413	-
below 15,000 ft	33	45	59	137	-
Total	154	198	198	550	1,000
Offshore: 0 - 600 ft	58	74	71	203	-
600-1,500 ft	0	18	9	27	-
Total	58	92	80	230	620
Total 48 States	212	290	278	780	1,620
Alaska	54	94	218	366	480
Grand Totals	266	384	496	1,146	2,100

SOURCE: Federal Power Commission, Natural Gas Survey, Vol. I, Chapter 9: Future Domestic Natural Gas Supplies - Preliminary Draft, p. 61.

The "Potential Supply" of gas is defined by the PGC as "the prospective quantity of gas yet to be found or to be added to existing fields exclusive of proved reserves." It is divided into three categories, including probable, possible and speculative. The PGC's breakdown of potential supplies to these three categories follows. These are important in evaluating the ability of synthetic gas to compete with natural gas from new discoveries. It must also be borne in mind that natural gas has become harder to find and more expensive to obtain, drilling depths have increased, and natural gas exploration has moved offshore.[22] The location and depth of potential natural gas reserves are shown in Table 32. The PGC projection does not account for the cost of finding and producing gas in estimating the potential supply. In a recent article, a number of sources stated that even at 75 cents per MCF, price was too low to sustain the current level of gas exploration.[23]

Recent econometric research indicates that gas supply and demand would balance by 1980 at a new contract field price of $1.00 Mcf and wholesale price of 88 cents Mcf. These are about double 1975 levels of 52 cents and 43 cents, respectively.[24] Both prices are significantly below the current cost projections for synthetic gas from Western coal.

TABLE 32

ESTIMATED POTENTIAL SUPPLY OF NATURAL GAS

(Trillions of Cubic Feet)

	Probable	Possible	Speculative	Total
Forty-Eight States	212	290	278	780
Alaska	54	94	218	366
	266	384	496	1,146
Forty-Eight States Breakdown				
On-Shore (Drilling Depth):				
0 - 15,000 feet	121	153	139	413
15 - 30,000 feet	33	45	59	137
	154	198	198	550
Off-Shore (Feet of Water):				
0 - 600	58	74	71	203
600 - 1,500	-	18	9	27
	58	92	80	230
Total Forty-Eight States	212	290	278	780

SOURCE: Potential Gas Committee, Potential Supply of Natural Gas in the United States (As of December 31, 1972), Colorado School of Mines Foundation, Inc., Golden, Colorado, November 1973, pp. 27-30.

Canadian Natural Gas Import Outlook

On November 22, 1974, the Energy Administer of Canada, Donald McDonald, announced that Canada would gradually reduce its oil exports to the United States on a schedule that would eventually eliminate exports completely by 1982.[25]

A statement made by Canadian Prime Minister Trudeau on December 5, 1974 noted that natural gas exports were then the subject of hearings similar in nature to those which preceded the announcement on the curtailment of crude oil exports.[26] It was further noted in this statement that the major natural gas discoveries in frontier areas, such as the McKenzie-Delta and the Arctic Islands will increase gas supplies sometime in the future. However, the government has only received one application regarding the construction of transportation systems to deliver this gas to Southern markets. No applications have been received for the Arctic Island natural gas, and it is expected that significant advances in current pipeline technology will be necessary before this gas can be feasibly transported.

It is the Canadians' conviction that natural gas prices have been unrealistically low in the past, and that these should be increased to a point reflecting their value in comparison to alternative energy supplies. In view of this, natural gas export prices will increase to $1.60 per 1,000 cubic feet by November 1975, from a mid-year level of $1.00. Canada's gas resources are estimated to be around 725 trillion cubic feet, only 55 trillion cubic feet of which have been proved.[27] In comparison, the remaining proved reserves of the U.S. are estimated to be about 237 trillion cubic feet. According to Northern Natural Gas, Canada has denied all new export applications since 1970 when it first became concerned over the adequacy of their own supplies. The uncertainty over continued Canadian exports was supported by a statement in the Montana Power Company 1974 annual report. This noted that 20 billion cubic feet of annual gas import authorizations expire in May of 1975, and that it was expected interim extensions would be granted pending Canada's final decision on export policy.[28]

Economics of Coal Gasification

For the immense investment required in coal gasification plants to be justifiable, there must be a guarantee that the product can be sold at a price yielding a satisfactory profit. This guarantee could be accomplished in a number of ways including governmental regulation, and competitive pricing with alternative sources of energy. To be economically viable, without governmental guarantee, synthetic gas must be competitively priced in relation to natural gas and to electricity. It is primarily in the area of space heating that synthetic gas must be cost competitive to electricity.

Natural Gas Prices

In 1950, the average interstate natural gas cost was 6.5 cents per MCF; in 1960, 14.0 cents per MCF; and in 1973, averaged 21.6 cents per MCF. The trend in natural gas consumption and average price is shown in the following table.

TABLE 33

MARKETED PRODUCTION OF NATURAL GAS AND AVERAGE WELLHEAD PRICE 1963 - 1973

Year	Marketed Production: Millions of Cubic Feet	Marketed Production: Trillions of BTU	Average Wellhead Price (cents per MCF)
1963	14,746,663	15,852.7	15.8
1964	15,462,143	16,621.8	15.4
1965	16,039,753	17,242.7	15.6
1966	17,206,628	18,497.1	15.7
1967	18,171,325	19,534.2	16.0
1968	19,322,400	20,771.6	16.4
1969	20,698,240	22,250.6	16.7
1970	21,920,642	23,564.7	17.1
1971	22,493,012	24,180.0	18.2
1972	22,531,698	24,221.6	18.6
1973	22,647,549	24,346.1	21.6

Note: Marketed production as reported by the Bureau of Mines is equivalent to natural gas production usefully consumed. It includes natural gas sold by producers and other non-utilities to industrial consumers and includes natural gas mixed with manufactured gas for consumption.

SOURCE: U.S. Bureau of Mines, Natural Gas Annual, 1973.

Recently the FPC set a field price ceiling of 52 cents per MCF for new gas sold throughout the interstate market. While it is planned that this price increase in the future, the intrastate gas price of natural gas has recently run in excess of $2.00. This diverted gas from the interstate market and has created a shortage of gas availability to the interstate buyer.

Synthetic gas from coal will have to compete with the marginal cost of natural gas including the new contract interstate natural gas price of 52 cents per MCF, and the much higher intrastate rate of $2.00 per MCF.

Based on current cost projections, it is clear that synthetic gas is not competitive. Increases in natural gas prices are necessary, and it is expected significant increases will occur as the artificial and unrealistic regulated prices are removed through some form of deregulation. Higher drilling costs and declining finding rates may also force such increases.

While economic feasibility is an important factor, it is conceivable that dwindling supplies and the lack of pipelines from alternative sources, or failure to achieve an equitable reallocation of supply through timely deregulation of natural gas prices, could cause a movement for gas availability at any price in certain areas. The State of Montana may find itself in such a position.

Synthetic Gas Cost

There are a variety of forecasts of costs of synthetic coal gas available. Some of these are relatively old and reflect obsolete assumptions regarding the cost of coal and the investment required to construct a coal gasification plant. Key assumptions in each of these include the cost of coal, cost of the plant, operating expenses, interest level, return on capital objectives, and coal to gas conversion efficiency.

In March of 1974, a projection of the cost of synthetic gas from Lurgi and "New" process technologies was provided by Mr. Barnett of the Arthur G. McKee & Company. The results of this projection are summarized in the following Table 34, and show that "New" process technology including Hygas and Molten Carbonate processes are expected to produce significantly cheaper synthetic gas. In evaluating the significance of these differences, it must be remembered that the "New" process technology has yet to be proven. The Lurgi technology, however, has been proven and could be used immediately. It is conceivable that by the time the "New" process technology is proven and the first commercial scale plant built, the cost associated with these processes will be similar to those incurred by a Lurgi plant constructed in prior years.

TABLE 34

ESTIMATED CLEAN FUEL COST
SELECTED COAL CONVERSION PROCESSES

	Cents per Million BTU's		
	Lurgi	Hygas	Molten Carbonate
Coal cost @ 30¢/MM BTU's	44.0	51.6	35.2
Other operating costs	67.0	39.5	36.1
By-product credits	(8.0)	(8.3)	(0.5)
Capital charges (depreciation, ROI, etc.)	52.0	25.2	41.8
Total cost	145.0	108.0	111.0

SOURCE: F.M. Barnett, "Synthetic Fuels From Coal", Presentation at American Institute of Chemical Engineers, Tulsa, Oklahoma, March 10-13, 1974.

In February of 1975, Mr. Landers of the Conoco Coal Development Company, a leader in coal gasification, projected that synthetic gas would cost $2.90 per million cubic feet (MCF) or $2.95 per million BTU's. He further noted that at these levels, synthetic natural gas produced from western coal was far more expensive than interstate regulated natural gas, and was also higher than short-term intrastate gas prices.[29]

Three gasification plant announcements have been accompanied by projections of the ultimate cost of the synthetic gas produced. In February of 1973, the Pacific Lighting Company and the Transwestern Pipeline Company filed an application with the FPC to approve a Lurgi coal gasification complex in New Mexico. The joint venture formed by these two companies was named Western Gasification Company, or Wesco. It was projected that the cost of the synthetic gas produced would be $1.32 (in 1973 dollars) per MCF, but that the cost could go up to $1.60 or $1.70 by the time the plant opened in the winter of 1977-78. The planned gasification complex would produce 250,000 MCF/D, and cost $500 million.

Shortly after the Wesco application, the El Paso Natural Gas Company filed an application for a similar Lurgi based gasification plant. This plant was estimated to cost in excess of $400 million, and with supporting mining operations, to have a total cost of around $600 million. El Paso projected that its first coal gas would cost $1.51 per MCF (in 1973 dollars), and over the twenty-five year life of the plant would average $1.17 per MCF. It was in connection with the El Paso application that the FPC determined that it did not have jurisdiction over the gasification plant and delivery line, only over the gas itself once it is co-mingled in the distribution pipeline.[30] Also, an FPC administrative law judge ruled that El Paso can average coal gas cost among all its customers. This will mean that El Paso's customers will pay an additional nine cents per thousand cubic feet regardless of whether or not they are buying coal gas or natural gas.[31]

While the Wesco and El Paso applications projected a gas cost three to four times higher than the current 43 cent interstate rate, but somewhat below the current intrastate rate of over $2.00, the Michigan Wisconsin Pipeline Company has filed an application with the FPC for a proposed gasification plant with a significantly higher synthetic gas cost. In March of 1975, the company projected that the "tailgate price", a price similar to the wellhead price for natural gas and the plant price noted for other gasification plants, would be $4 per MCF. This price is significantly higher than any provided in prior projections, and far exceeds the current interstate and intrastate gas prices.[32]

Space Heating--Gas Versus Electricity

One of the major markets in which synthetic gas will compete with electricity is in the space heating of residential and commercial properties. In a presentation in December of 1974, Mr. Linden, president of the Institute of Gas Technology, described the comparative advantage that synthetic gas would have over electricity in space heating. This comparison, a resume of which is provided in the following Table 35, shows synthetic gas to cost $5.85 per million BTU's, about half the cost of electric heat at $11.52 per million BTU's. In making this analysis, a synthetic gas cost at the plant of $2.16 per million BTU's was assumed, with transportation costs of 30 cents and distribution costs of $1.05, bringing the total synthetic gas cost to the customer of $3.51. The cost of synthetic gas of $2.16 used in the analysis is midway in an expected cost range estimated by Linden of between $1.50 and $2.50 per million BTU's. [33]

The advantage of using coal to produce synthetic gas instead of electrical energy lies in the comparative efficiencies of the two alternative uses. The El Paso Lurgi plant was expected to achieve a conversion efficiency of about 56 per cent. Recent research indicates that the "New" process conversion technology may enable conversion efficiencies in the area of 70 per cent. This is about twice as high a level of efficiency as is achievable in the production of electricity from coal. [34]

On a comparative basis, then, synthetic pipeline gas appears economically feasible and cost competitive with electricity as a source of energy to satisfy space heating requirements. What is more, there is a substantial price buffer between these alternatives which will allow further increases in synthetic gas prices without jeopardizing the feasibility of synthetic gas. This relationship, showing synthetic gas a cheaper heat source, could become an important factor supporting gasification, if natural gas were unavailable.

TABLE 35

ESTIMATED INCREMENTAL COST OF HEATING USING GAS AND ELECTRICITY FROM COAL

Estimated Cost of Electric Heat From Coal	
Capital Cost	$456/kW
Annual Capital Cost at 20%	$91.2/kW
Fixed Charge Rate at 65% Load Factor	1.602 cents/kWhr
Fuel Cost at $1.00/Million Btu	0.90 cents/kWhr
Operation and Administration Cost	0.15 cents/kWhr
Generation Cost at Bus Bar	2.65 cents/kWhr
Cost of Service to Residential Customers	1.28 cents/kWhr
Total Cost of Electric Heat	3.93 cents/kWhr
Total Cost of Electric Heat	$11.52/million Btu
Estimated Cost of Gas Heat From Coal	
Capital Cost (288 Million CF/Day)	$540 million
Annual Capital Cost at 20%	$108 million
Fixed Costs	$1.197/million Btu
Fuel Cost (at 56% Efficiency)	$0.89/million Btu
Operating Cost	$0.075/million Btu
Total Production Cost	$2.16/million Btu
Transmission Cost	$0.30/million Btu
City Gate Price	$2.46/million Btu
Distribution Cost to Residential User	$1.05/million Btu
Residential Gas Cost	$3.51/million Btu
Cost of Residential Heating at 60% Efficiency	$5.85/million Btu

Source: *Gas Supply Review 3, 9* (1974) November 15.

SOURCE: H.R. Linden, Testimony at Public Seminar, President's Energy Resources Council, Washington, D.C., December 10, 1974, p. 5.

Water Availability

In assessing the availability of sufficient water to satisfy coal gasification plant requirements, a review of several water use projections was made. One of these was concerned with Wyoming alone, and two covered the entire Montana, North Dakota and South Dakota area. Basically, these forecasts show that there are adequate water supplies in the areas containing large coal reserves, or located in areas from which the water can be transported to coal reserves and gasification plant sites.

The North Central Power Study of October 1971, in selecting suitable electric power generating plant sites, studied the availability of adequate water supplies. This study concentrated on the Gillette, Colstrip geographic area, and estimated that there was about 2.8 million acre feet of water available for industrial development of coal in this area. Around one million acre feet was estimated to be immediately available from the Wind Big Horn system, and another million acre feet from the Fort Peck or Garrison reservoirs. The construction of new reservoirs was projected to enable the availability of an additional 800,000 acre feet per year. In summary, the study stated that about 1.8 million acre feet are potentially available for the Colstrip-Gillette coal development.[35] The Wyoming Department of Economic Planning and Development has also assessed the demand of water for coal conversion in Wyoming. In a report to a legislative subcommittee, the Department stated that the coal industry already consumed about 24,000 acre feet of water annually, about 24 per cent of the current total industrial consumption in the state. The Department projected that coal related water consumption in Wyoming would amount to 132,000 acre feet in 1980, 208,000 in 1985, 284,000 in 1990, and 434,000 in the year 2000.

The most useful water forecast available is that provided by the Northern Great Plains Resource Program draft report of September 1974. This report divides the coal region into three areas and provides separate water forecasts for each. In summary, this report shows that the Yellowstone River Basin is an area where available stored water is scarce. However, the adjoining Upper Missouri River Basin is estimated to contain up to three million acre feet of water which could be made available for coal development without conflict with existing and developing uses. Possibly two million acre feet of this water could be stored and transferred to the water scarce Yellowstone Basin. The three major reservoirs on the Main Stem of the Missouri River at Fort Peck, Sakajawea and Oahe, have a total capacity of 66 million acre feet. Even at the dam furthest downstream, it is estimated that three million acre feet could be made available for coal development.[36]

The Department of the Interior has also produced a "water for energy" forecast for the northern Great Plains area. This forecast is largely based on the work done in the northern Great Plains resource program. This report does provide some interesting facts regarding the current contracts which energy companies already have for water rights in the Upper Missouri River Basin. Options have already been exercised on approximately 712,000 acre feet of water per year, primarily from the Boysen Reservoir and Big Horn Lake. At the present time, none of these options have been activated and no water is being used. Applications are also pending for another 2.2 million acre feet of water in this area.[37] The report also identifies potential water delivery system routes throughout the region. The results of the study are summarized in the following Table 36 and show that the Upper Missouri River Basin appears to contain ample water to meet all projected needs and uses including a high level of energy development through the year 2000. This determination, showing adequate water for gasification plant operation, is in accord with the results of the Northern Great Plains Resource Program and of the North Central Power Study of 1971.

TABLE 36

WATER AVAILABILITY-YEAR 2000
DEPARTMENT OF INTERIOR PROJECTION--JANUARY 1975
YEAR 2000

	UMR Basin (Acre-Feet)	Yellowstone Subbasin*
Water Supply		
Estimated undepleted flow	28,353,000	11,235,000
Total Depletions (1970)	6,532,000	2,435,000
Water Available 1970	21,821,000	8,800,000
Projected Needs		
Energy (including revegetation)	614,000 to 1,107,000	267,000 to 616,000
M&I	315,000	130,000
Irrigation	1,910,000	540,000
Fish and Wildlife	630,000	53,000
BLM Lands	52,000	9,000
Totals (Maximum)	4,014,000	1,348,000

*Included in UMR Basin

SOURCE: U.S. Department of the Interior, Report on Water for Energy in the Northern Great Plains Area with Emphasis on the Yellowstone River Basin, p. VII-4.

Energy Alternatives

It has already been noted that a number of gas users have switched to alternative energy sources, including oil, electricity and coal, due to the increasing unreliability of an assured supply of natural gas. Additional switches have been motivated by the recent escalation in national natural gas cost. These factors could continue to cause additional and more substantial switches into existing alternative energy sources, as could the numerous research projects dedicated to developing practical alternative energy sources. However, within the near future almost all switching will be into existing alternatives.

There are numerous Geothermal areas located throughout the western United States. Unfortunately, Geothermal energy technology is still in its infancy and developments in this area continue to be disappointing. To date there is only one Geothermal resource in commercial use, this being the Geysers Steam Field north of San Francisco. One source has estimated that substantial Geothermal electric power generating capacity could be developed by the year 2000. [38] The Pacific Gas and Electric Company now operates a Geothermal steam-driven electric generating plant having about 400 megawatts of capacity in California. Initially, this company utilized this geyser field in 1960 to produce only 12.5 megawatts. By 1975, it is expected that this field will be used to generate sufficient electricity to serve a city the size of San Francisco.[39] Development of the Geothermal resource areas of the United States is based on a Department of the Interior leasing program, the first bids of which were announced in March of 1974.

The National Science Foundation and National Aeronautics and Space Administration believe that in less than thirty years, wind power can be used to generate 1.5 trillion kilowatt hours of electricity. This approximates U.S. electrical production in 1970. Currently, there is a five year federal program underway to study and build windmills to be used as electric power plants.[40] Another industry source noted that the power potential of wind in the U.S. exceeds by a factor of ten the U.S. projected needs of electricity in the year 2000.[41] In the past, a number of windmill based electrical generating tests have been performed in Denmark, the United States, Britain and Germany. None of the large-scale projects have been particularly successful.

The prospects for obtaining energy from solar power appear much better than for other alternative energy sources. Already, solar power is being used extensively in various parts of the world. For example, there are twelve million solar heaters which warm the water in houses in Japan, South America, Australia and elsewhere. In fact, an Australian company successfully sells such solar water heaters in the U.S.[42] Extensive research is now being conducted in this country and thirty U.S. homes now take a major portion of their energy needs from the sun. The National Audubon Society headquarters in Boston is partially heated by solar power. Further technological developments are expected and it is projected that the use of solar energy in space heating could come into widespread use within the next five to ten years.[43] It is also anticipated that the use of solar power to produce electricity will be technologically feasible around the turn of the century. The ability to use solar power in heating homes and buildings would, if competitive on an economic basis, serve as an important alternative to the use of natural or synthetic gas.

Fuel cells, which convert natural gas to electricity in a very efficient manner, could be commercially viable within ten years. While such equipment would consume gas, the efficiency of the process could enable a reduction in total demand.

Government and Judicial Impact

As of October 1975, western coal gasification was being stalled by policies of various federal agencies, legal attacks, and by the lack of a national energy policy. Before gasification can be developed, a number of these man-made obstacles must be removed.

The moratorium on leasing of federal lands, in effect since February of 1973, makes it nearly impossible to economically mine many coal areas. In conjunction with this moratorium, the Department of the Interior has refused to approve mining plans covering federal land, blocking coal mining on federal lands already under lease. Federal legislation establishing national strip mining guidelines is the key to eliminating these two obstacles. During 1975, the Administration twice vetoed such legislation passed by Congress. All forms of coal development are effectively deferred until federal strip mining legislation is passed.

The Federal Power Commission, in reviewing the El Paso and Wesco gasification applications, determined that it had jurisdiction over the sale of synthetic gas once it is co-mingled with interstate national gas. Its approval is therefore required before synthetic gas can be transported and sold, and it can set the rates to be charged for synthetic gas. Obtaining a favorable certificate from the FPC, including an acceptable price, is therefore a prerequisite to gasification development and financing. As of October

1975, no FPC gasification certificates had been awarded.

Because of the immense cost and commesurate risk associated with gasification, it is the vendors' view that the certificate for a gas plant should arrange for some sharing of risk. This could take the form of customer surcharges, market guarantees, and product purchase guarantees. In contrast, the chairman of Northern Natural Gas has stated that the FPC is taking the position that the vendor must bear all risks. Without the ability to distribute risk, it is possible that gasification will have to wait for the day when synthetic gas could compete on a direct basis with the "New Contract" cost of natural gas.

There are a number of ways in which the federal government could assist gasification development. These include, but are not limited to:

1. low interest loans
2. government guarantees or insurance for private loans, covering technical and commercial risk
3. government construction subsidies
4. government price supports, or product purchases to protect against foreign price reductions
5. authorization of roll-in substitute gas prices [44]

The only assistance concept to receive strong Administration support is the Energy Independence Authority, a $100 billion source of loans, loan guarantees and equity capital for energy development. One interesting fact about this plan is that the Administration has a separate plan for synthetic fuel development alone, should the comprehensive plan fail to take the form of legislation.

One of the concerns about the feasibility of the Energy Authority is the fear that local public utility commissions will not approve high enough energy prices to generate an adequate return. Hostile rate commissions are a major problem of the utility industry already, and seriously jeopardize the ability of industry to raise equity funds to support new capital expenditures. This, and its immense cost, could cause coal gasification to suffer from a major capital shortage. Government price supports or loan guarantees could eliminate the risk associated with this problem.

Indian moves to void their coal leases with four major mining companies could also delay coal mining on Indian lands and related gasification projects in Southeastern Montana. In September of 1975, the Crow Indians sued to void their leases, alleging mis-handling by the Bureau of Indian Affairs. The Cheyenne are considering similar action. If successful in their suit, the Indians may decide not to allow coal development of any kind on their land.

The Sierra Club versus Mortin suit, requiring an environmental impact statement for the entire Northern Great Plains before coal development could continue, represents one of the major obstacles to coal gasification. The uncertainties and risk caused by this suit have already caused two major companies to discontinue operations and expenditures in Montana and Wyoming areas. If the Sierra Club prevails, coal development could be delayed four years or more while the proposed research and hearings were conducted. Suits of this kind are an important development obstacle. In the case of the Alaskan Oil pipeline, Congress provided immunity by passing legislation which prevented such suits from being heard in federal courts. The same thing may be required to expedite Western coal development. However, such legislation is very rare.

The uncertainty created by the lack of a clear, stable and long-term national energy policy in the areas of air quality standards, strip mining standards, import controls, and energy pricing has caused private enterprise to temporarily defer most large-scale development efforts. As long as this uncertainty exists, in the absence of legislation which establishes an environment conducive to long-range large-scale capital planning, no significant level of gasification development can occur. New mines will be opened only if it is apparent that a market will exist for the coal, and not be eliminated by legislation over mining or air quality standards. New power plants will be constructed only when the long-term outlook for capital recovery and profit seem secure through satisfactory energy prices. Gasification will only be feasible if the government allows high enough gas prices to enable project economic and financing feasibility. As well, the venders must be assured that a surplus natural gas situation caused by additional exploration or by a change in foreign import policy will not impair their products marketability. New legislation or reaffirmation of existing legislation must occur before uncertainty can be removed as an obstacle to gasification development.

Summary

The outlook for coal gasification can best be summarized as uncertain. A number of arguments support gasification development, yet important unresolved issues are prohibiting this from taking place. Importantly, this country can develop gasification if it wants to. Adequate coal is available and proven technology already exists.

High priced synthetic gas has been estimated to be a more economical source of space heating than electricity, assuring a continuing demand for gas as a heat source. Gasification can be used to produce chemical feedstocks, providing yet another important market for synthetic gas. The supplies of Canadian gas used in certain parts of the country are in jeopardy, requiring the development of alternative sources on a timely basis.

Various companies have announced their intentions to develop gas plants, and are investing substantial amounts of money in research and developmental efforts. Studies by such groups as the NPC and FPC show that as many as thirty to thirty-six gasification plants could be in operation by 1990. Most of these are expected to be located in the West.

But serious obstacles exist to coal gasification becoming a reality. The cost of synthetic gas, about double the current intrastate rate for natural gas, is one of these obstacles. As long as natural gas is available at prices below synthetic gas, gasification will not be economically feasible. However, natural gas prices must increase, perhaps dramatically, as exploration and drilling efforts become more risky and expensive. While natural gas costs go up, new gasification technology may be able to stabilize gasification costs. Over time, parity could result.

It is also conceivable that adequate supplies of natural gas will not be available even with increased exploration. If this happens, resulting in continuing and worsening regional shortages, it is to be expected that availability rather than price could become of primary concern. As the only alternative besides imports, gasification would likely be called on to fill the demand gap.

Environmental delays, typified by the Sierra Club versus Morton suit, pose another problem. If the Sierra Club wins, western development could be delayed five years. The availability of water, once considered a problem, has been shown to provide no serious obstacle.

State regulatory attitudes towards gasification are another barrier. However, North Dakota has approved the development of one gas plant on a test basis, and Montana has changed its view and is actively pursuing a gasification facility to replace the reduction in natural gas availability in the state due to cutbacks in Canadian exports.

Uncertainty over FPC pricing and saleability of gas due to an inability to compete with low cost natural gas or imports, are major gasification risks created by the lack of a national energy policy. These problems can be removed only through federal legislation, requiring popular and political support. It is possible that this support will be forthcoming only when the energy runs out. The gas shortages that are expected to occur during the next few winters could begin to generate this support. The unions in Montana (an influential political force) have already expressed their support of gasification in view of potential job impact associated with a gas shortage. The proposed synthetic fuel Energy Authority serves to show that federal assistance could be forthcoming within the next year or so. With governmental controls or regulation in some form over almost every aspect of development, governmental support is critical to gasification's future.

Chapter III

Footnotes

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CHAPTER IV

ECONOMIC IMPACT OF COAL GASIFICATION

A coal gasification plant has been projected to have a substantial impact on the local economies of the areas in which sited. Mine-mouth gasification of Western coal may generate a significantly larger impact because of the need to create a supportive private and public infrastructure in relatively remote and unsettled locale. The economic effect of a gasification plant may be augmented by other forms of nearby mining or coal conversion. With coal deposits concentrated in relatively few locations, a concentration of development activities could naturally be expected.

The purpose of this chapter is to assess the economic impact of a coal gasification plant on the local area in which sited. It will focus on employment, including direct and indirect gasification employment, salary levels; total payroll, population and population characteristics; on local retail sales volumes; and on trade areas. The results of this analysis will then be used in the following chapter as a basis for performing a determination of such a plant's effect on local financial needs.

For the purposes of this paper, a coal gasification plant capable of producing 250 million cubic feet per day of pipeline quality synthetic gas will be used as the example. Such a facility approximates those already proposed for Western areas.

Gasification Employment

The personnel requirements and payroll associated with constructing and operating both the coal gasification plant and related coal strip mine represent the single most important factor determining the local economic impact of coal gasification. An analysis of the employment impact requires consideration of the number of jobs directly created by coal gasification plant and mine construction and operation, the variation in the size of the construction workforce during the approximately three and one-half year period required to build a gasification plant, the kinds of jobs which will be created, the source and nature of the workforce, and the derivative or secondary employment, such as new commercial, municipal and professional jobs.

Direct Employment

A summarization of the estimated personnel requirements associated with construction and operation of a gasification plant and its accompanying strip mine is provided in Table 37. This shows two of the four companies which have announced plans to construct gasification plants, projecting the plant construction force to peak at about 3,000. Combining this requirement with the 200 person mine workforce projected by one company brings the total peak construction workforce to about 3,200. The company estimates of the number of personnel required to operate the mine and plant fall in a relatively narrow range between 925 to 1,234 workers. On average, it could be stated that a gasification plant and mine will require about 1,000 persons in its operation. Each of the gasification plants announced by companies are to be based on Lurgi technology.

The fifth estimate of employment requirements provides a breakdown according to type of coal gasification technology. It is to be noted that the Lurgi process, projected to require 1,000 persons in its operation, shows the highest workforce requirement. This estimate, which is comparable to those made by the companies planning gasification plants, exceeds two of the second-generation technology processes by meaningful margins, and is more than double the amount estimated for the CO_2 acceptor process. If second generation technology enables smaller operating staffs, the economic impact of coal gasification in the employment area could diminish in the future as new technologies are implemented.

TABLE 37

DIRECT GASIFICATION EMPLOYMENT

Projection Source	Construction			Operation		
	Plant	Mine	Total	Plant	Mine	Total
1. Michigan-Wisconsin Pipe Line Co. [a]	NA	NA	NA	746	305	1,051
2. Natural Gas Pipeline Co. [b]	3,000	200	3,200	525	300	925
3. Panhandle Eastern Pipeline Company [c]	3,000		3,000+	800	290	1,090
4. El Paso [d]	NA	NA	NA	883	351	1,234
5. West River [e]						
CO_2 Acceptor Process	NA	NA	NA	274	170	440
Sythene Process	NA	NA	NA	697	170	860
By-Gas Process	NA	NA	NA	726	160	880
Lurgi	NA	NA	NA	790	210	1,000

[a] Michigan Wisconsin Pipe Line Company, "Coal and Water for Gasification", Water Permit Application to the North Dakota State Water Commission, February 21, 1973, p. 5.

[b] Natural Gas Pipeline Co. of America, "Environmental and Socioeconomic Considerations", Water Permit Application to the North Dakota State Water Commission, December 17, 1974, p. 11.

[c] Wyoming Department of Economic Planning and Development, Coal Development Alternatives, Appendix C, pp. 1-2.

[d] Montana Energy Advisory Council, Coal Development Information Packet, p. 51.

[e] The University of North Dakota, Extensive Utilization of Lignite in the West River Diversion Area, p. 52.

Construction Schedule

According to one company, it will take about three and one-half years to construct a coal gasification plant. The construction workforce was projected by this same company to peak at about the end of the second year at 3,000 workers. An illustration of this company's projected construction manpower requirements throughout the construction period is provided as Table 38. The variation in jobs and payroll, such as an employment curve illustrates, could have a dramatic impact on local economic stability. The boom-bust economy indicated by such an employment schedule would impact the stability of the demand for financial services, liquidity needs, and possibly credit losses.

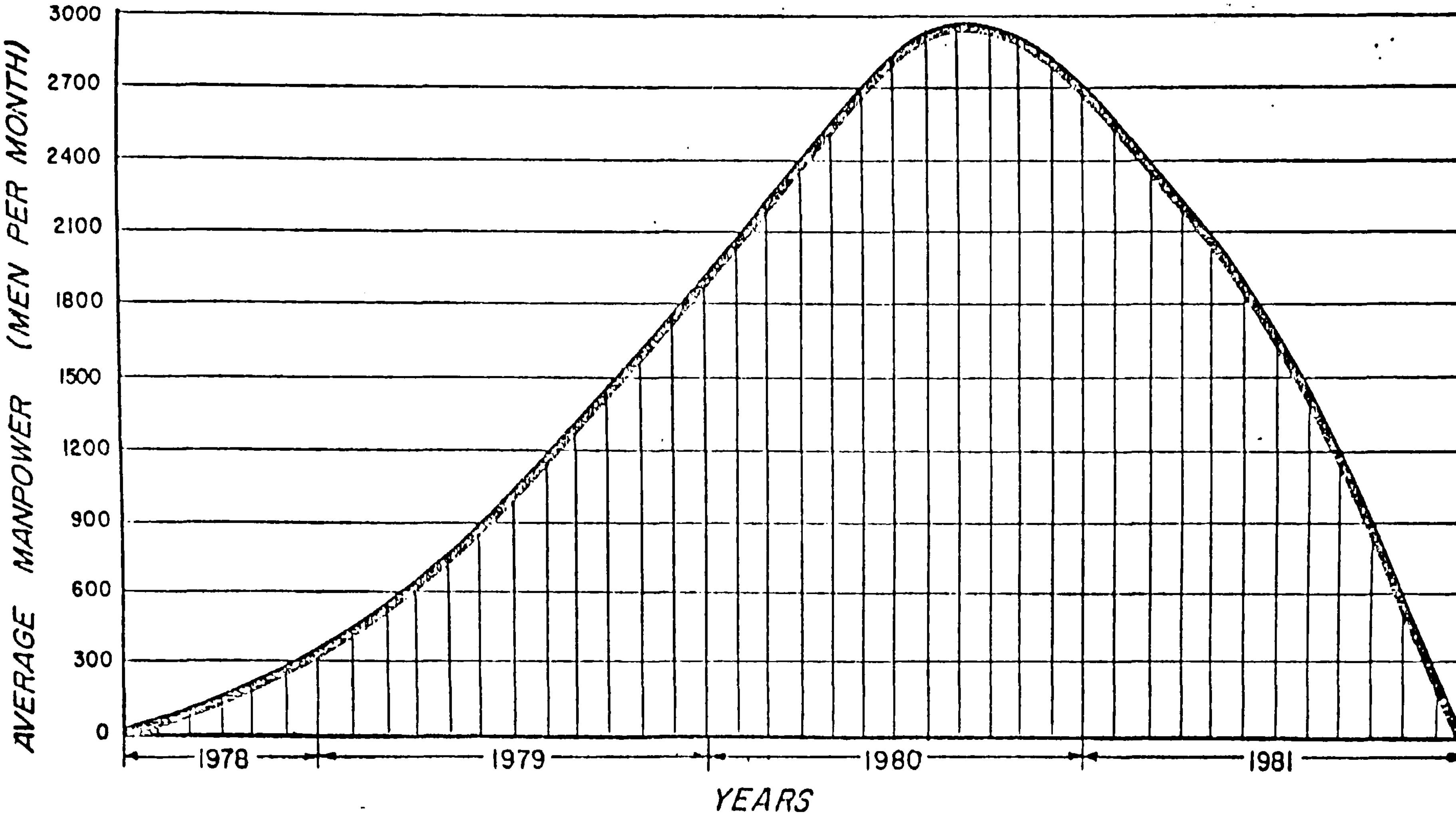


TABLE 38

FIELD MANPOWER REQUIREMENTS

SOURCE: Natural Gas Pipeline Co. of America, "Environmental and Socioeconomic Considerations", Water Permit Application to the North Dakota State Water Commission, December 17, 1974, p. 127.

Secondary Employment

In addition to direct plant and mine employment, gasification will also produce substantial secondary or derivative employment in other segments of the local economy. Areas affected would be retail trade, construction, finance, services, government, communications, utilities, transportation and agriculture.[1] One North Dakota economist has estimated a one to one ratio between direct and secondary employment.[2] The various companies that have announced gasification plants have estimated a relatively wide range of multiples for secondary employment. A review of these estimates is provided in Table 39. This shows that secondary employment is projected to amount to between 85 and 200 per cent of direct gasification employment. Based on the Michigan Wisconsin and West River Diversion Report forecast, combined direct and secondary employment attributable to a gasification plant would approximate 2,000 persons for a plant based on Lurgi technology.

TABLE 39

SECONDARY EMPLOYMENT

	Operating Work Force Plant and Mine	Secondary Employment	Secondary Employment	Secondary/ Operating
Michigan [a]	1,051	910	1,961	.85
NGPCC of A [b]	925	1,500	2,425	1.52
El Paso [c]	1,234	2,468	3,702	2.0
West River [d]				
CO_2 Acceptor	440	330	770	.75
Synthane	860	750	1,610	.87
Bi-Gas	880	780	1,660	.89
Lurgi	1,000	860	1,860	.86

a Michigan Wisconsin Pipe Line Co., "Coal and Water", p. 6.

b Natural Gas Pipeline Co. of America, "Environmental and Socioeconomic Considerations", p. 12.

c Montana Energy Advisory Council, Coal Development, p. 50.

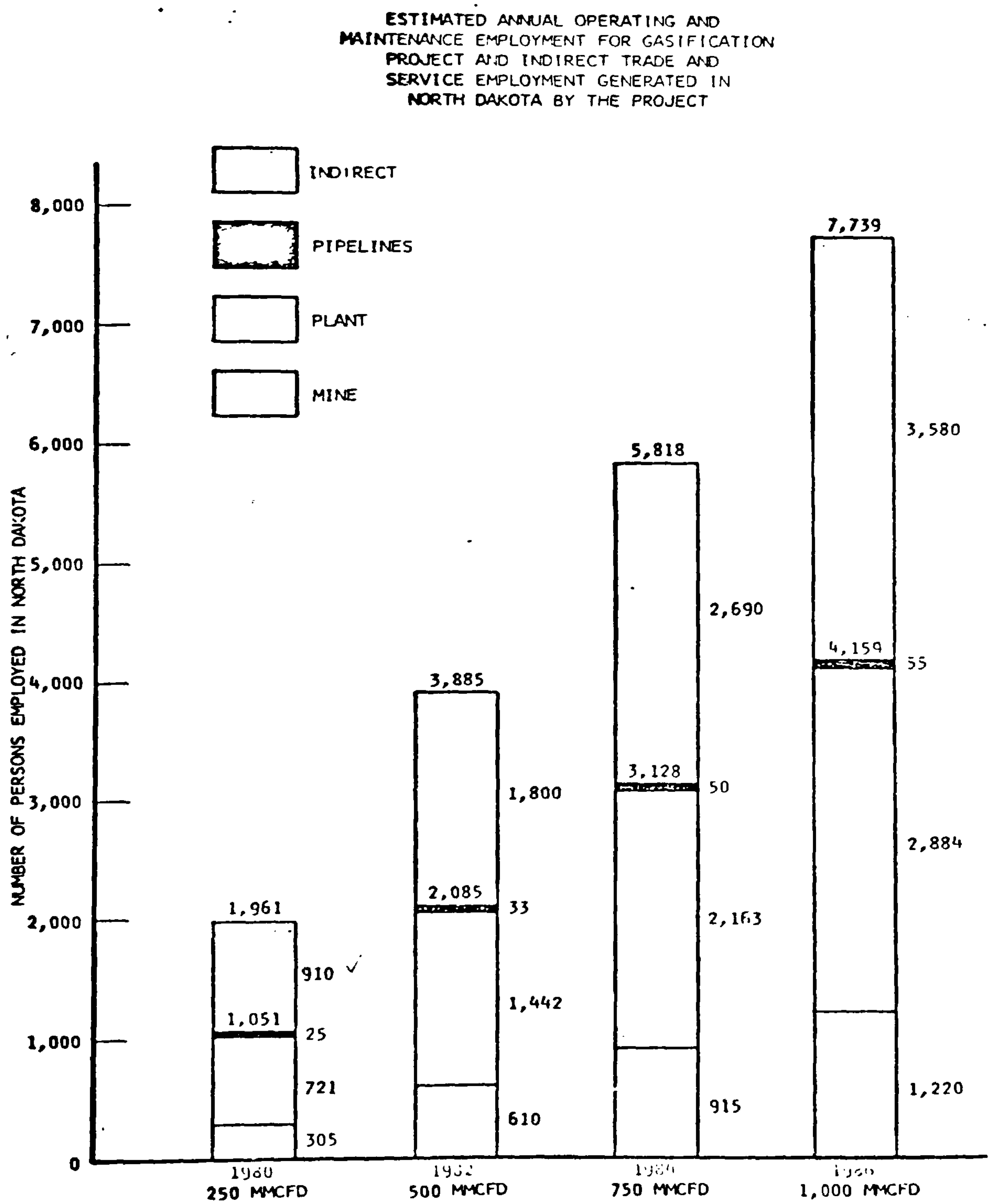
d The University of North Dakota, Extensive Utilization of Lignite in the West River Diversion Area, p. 52.

Multi-Plant Concept

However, it is important to note that most of the announced gasification plants are intended to be only the first of what would ultimately become a three or four plant complex. The increase in employment opportunities associated with the development of the three additional plants in such a complex is illustrated in Table 40. This shows the total direct and secondary employment associated with such a complex to be 7,739 jobs. Assuming two or three year periods between the completion of plants, the multi-plant concept greatly expands the total time period during which construction of coal gasification plants in a given locality would occur. At four year intervals, it would take sixteen years to complete all four gasification plants. A sixteen year construction period represents a meaningful expansion of the length of time which a financial service firm would have to recover its investment and generate a fair return.

TABLE 40

MICHIGAN-WISCONSIN GASIFICATION EMPLOYMENT



SOURCE: Michigan Wisconsin Pipeline Company, "Coal and Water", p. 8

Types of Jobs

The kinds of jobs available in the construction and operation of gasification plants, the source of personnel and the characteristics of the workforce, will all have a bearing on the nature of financial customers and financial needs precipitated by coal gasification. While no information was readily available on the kinds of jobs associated with construction of coal gasification plants, a listing of the types and numbers of workers required to construct the Colstrip electrical power units #1 and #2 is available. A listing of the kinds and numbers of workers employed in October of 1974 on the construction force building the Colstrip units is provided as Table 41. As is indicated, only 157 or about 13 per cent of the total workforce consists of superintendents, engineers, and other professional individuals. The remainder is composed of primarily laborers, carpenters, iron workers, boiler makers, pipe-fitters, electricians, operating engineers, and painters. A recent survey of coal related employment in North Dakota provides a breakdown of job types. This shows 22 per cent of the workers hold white-collar or foreman positions.[3] Of the remaining 78 per cent, about 19 per cent are general laborers, 12 per cent are mechanics, welders and carpenters, 17 per cent are equipment operators, and the other 30 percent are composed of electricians, dragline operators and miscellaneous jobs. A preponderance of labor type jobs is also evident in the projection of operating manpower provided for several of the various gasification technology in the West River Diversion Report.[4]

TABLE 41

TOTAL CONSTRUCTION EMPLOYMENT BY TRADE ON THE COLSTRIP PROJECT (OCTOBER 1974)

Craft	Total Number Employed in October 1974
Laborers	117
Carpenters	90
Millwrights	18
Ironworkers	81
Foremen	24
Boilermakers	113
Pipefitters	253
Electricians	116
Operating Engineers	34
Truck Drivers	11
Painters	22
Others	25
Subtotal Manual	980
Superintendents	35
Engineers	49
Survey	13
Office	48
Warehouse & Safety, First Aid	12
Subtotal Non-Manual	157
Total	1,137

SOURCE: Montana Energy Advisory Council, Coal Development Information Packet, p. 59.

Worker Characteristics

Some indication of the characteristics of the workforce associated with coal development is available from a survey performed in 1973 of the population of Hanna, Wyoming. Hanna, located in Carbon County, has been a coal town since 1868. The employment, population and fortune of this town are tied very closely to the level of coal development. In 1970, there were only 460 people in the town, with 53 in a neighboring town two miles away. Following rapid coal development, the population of this town expanded significantly and by the end of 1972 totaled 1,085 people in the two towns. A survey of the population, in which 78 per cent of the households in Hanna responded, showed that most of the newcomers were young, with the median age for heads of household being 25 years old. In comparison, the survey of North Dakota coal employment referred to earlier showed 82 per cent of the employees were 47 years of age or younger. About 87 per cent of the newcomers were married, and 60 per cent had at least one child. The newcomers to the area appeared to be quite mobile, as is evident in the following Table 42. Of the individuals over 30 years of age, only 41 per cent had been at their last residence for six years or more. More importantly, only between 25 to 34 per cent of the newcomers plan to remain in the town indefinitely. This level of mobility is an important characteristic of the workforce associated with coal development. The survey also determined that about 10 to 15 per cent of the newcomer workforce had a college degree, which is approximately the same as the Wyoming state average.[5]

TABLE 42

WORK FORCE MOBILITY CHARACTERISTICS
HANNA, WYOMING

	Years at Last Place of Residence	
Age	Six or More	One or Less
30 years or less	33.3%	25.0
Over 30	41.0	10.2

A potential customer base composed of young persons, who are generally in a period of life requiring credit but having little savings, will impact the kind and level of financial services needed. The mobility and temporary nature of a portion of this workforce could also have a bearing on types of services demanded, credit standards, and loan terms.

Salary Levels

Not only will the construction and operation of coal gasification and support facilities create a substantial number of new jobs, in general these workers will be paid almost twice the average annual salary of the surrounding areas. It has been estimated by one company that nearly 95,000 man months of effort will be required to construct a single coal gasification facility.[6] If the disposable income of each worker was $1,000 per month, this would amount to total payroll available for expenditure in the local area of $95 million over the construction period of the gasification plant.

In Hanna, Wyoming, the gross income of most newcomers is between $10,000 and $15,000 per year, with a significant portion of those over 30 years of age earning between $15,000 and $25,000. A distribution of incomes in Hanna is provided below.

TABLE 43

INCOMES OF NEWCOMERS TO HANNA

	30 or Under	Over 30
$3,999 or less	1.1%	0.0%
$4,000 - $6,999	1.1	1.1
$7,000 - $9,999	25.0	11.1
$10,000 - $14,999	55.5	52.7
$15,000 - $24,999	11.1	30.5
$25,000 or more	1.1	1.1

SOURCE: University of Wyoming, What Does Energy Development Mean for Wyoming?, p. 13.

Interviews in October 1975 with two major Montana mining companies determined that miners were then earning on the average about $20,000 per year. An annual income of this magnitude could provide a number of workers with a substantial saving, as well as borrowing capacity.

An estimate of gasification and coal mine salary levels has been provided by a North Dakota economist. This is summarized in the following table and shows that relatively few of the operating staff of a coal gasification plant or mine will earn less than $8,000 per year. It also shows that the average gasification plant employee will earn between $8,000 to $12,000, while most coal mine personnel earn $12,000 or more per year. In contrast, more than half of the Mercer County workers, a potential coal gasification area in North Dakota, earned less than $6,000 per year in 1969.

TABLE 44

EARNINGS DISTRIBUTION OF
SELECTED ENERGY FACILITIES
(1972 DOLLARS)

Earnings	Gasification Plant	Power Plant	Coal Mine
	(percent of total employment)		
Less than $6,000	-	-	-
$6,000 to $7,999	3.8%	-	3.4
$8,000 to $9,999	48.7	9.0	1.7
$10,000 to $11,999	34.3	31.0	1.7
$12,000 and over	12.8	60.0	93.1
Average annual Earnings	$12,630	$13,250	$13,400

SOURCE: Leistritz, Dalsted, Hertsgaard, "The Economic Impact of Energy Development in Western North Dakota", April 26, 1974, p. 11.

Gasification Payroll

In its application for water permits, the Michigan Wisconsin Pipeline Company has stated average gasification plant operator salaries to be $11,905. Total annual payroll in terms of 1972 dollars was forecast to be about $12.5 million. A further breakdown of these estimates is provided in the following Table 45.

TABLE 45

ANNUAL PAYROLL FOR ONE
250 MILLION CUBIC FOOT PER DAY
GASIFICATION COMPLEX
(1972 COST BASIS)

	Personnel Required	Average Salary	Total Payroll
Mine	305	$ 10,731	$ 3,273,000
Plant	721	12,411	8,948,000
Pipelines	25	11,647	291,180
	1,051	11,905	$12,512,180

SOURCE: Michigan Wisconsin Pipe Line Company, "Coal and Water for Gasification", Water Permit Application to the North Dakota State Water Commission, February 21, 1973, p. 5.

With the initial gasification plant representing only the first facility in a complex composed of as many as four such plants, the total annual operating payroll of a coal gasification plant complex could total $49.4 million.[7] This level of payroll in conjunction with the very substantial construction payroll which could occur at the same time as second, third and fourth facilities are built, represents probably the most important economic stimulus in those localities where gasification facilities will be sited. It is the local expenditure of these salaries which will spur local commercial, municipal, other economic development, and sales.

Support and Secondary Employment

The direct payroll associated with the construction and operation of a coal gasification facility, and the indirect or secondary payroll caused by the multiplier effect, are not the only sources of salary income caused by coal gasification. In addition, it is expected that substantial additional salary dollars and other coal expenditures could be made to construct and operate support systems such as railroad tracks and facilities, reservoirs and water pipelines, electric power lines, gas pipelines, housing, hospitals, and municipal facilities.

With the influx of a 1,000 man operating staff, or a 3,000 man construction force, housing is expected to be in short supply in anticipated gasification plant areas. The construction of adequate housing, whether single or multi-family, will itself require a large labor force. For example, at Colstrip, about 164 workers were employed in October of 1974 in the construction of housing facilities. This is in addition to the 1,137 working on the two new electrical plants.[8] However, it is conceivable that all workers will not live in the plant area, but rather will commute from nearby trade centers or wherever housing development takes place. Also, a large portion of housing needs could be handled by mobile homes. In 1973, about 35 per cent of Gillette, Wyoming's housing was accounted for by mobile homes. As coal development increases, this is expected to grow to 70 per cent.[9]

An expansion in population will require an increase in municipal and health facilities. This will take the form of city and county capital outlays for water, sewer, waste, roads, schools, libraries, hospitals, municipal buildings, and larger budgets and payrolls.[10] Based on assumption that each mineral industry job will result in 6.5 person population increase, Wyoming projected that each new mineral job would create a need to expend $12,400 in local public outlays. With a gasification plant requiring about a 1,000 person workforce, this indicates public capital outlays of around $12 million per plant.[11]

Gasification plants could require a variety of support systems, themselves involving substantial construction and operating expenditures. Included among these would be water reservoirs and pipelines, electric power lines, and synthetic gas pipelines. These facilities, particularly during construction, could provide another important source of salary income and economic stimulus to the area. The availability of both electricity and gas could provide the basis for large scale industrial development in proximity to gasification areas. In Sasolburg, South Africa, the thirteen Lurgi-based gasifiers provide the chemical feedstock for a chemical complex which has evolved a 35,000 person community.[12] Already energy sensitive United States industries such as aluminum and taconite industries have displayed interest in synthetic gas. If local use of synthetic gas as an energy source or feedstock were to occur, the accompanying industrial development could greatly expand the economic significance of gasification alone.

Population

The size and characteristics of the increase in population in the area surrounding gasification plants will impact the nature and volume of demand for financial services. A number of factors could have an impact on the magnitude of the population change, including the population multiplier, source of employees, and types of jobs.

In 1970, households in North Dakota averaged 3.2 members[13] and in Montana the relationship between jobs and population averaged 3.1.[14] While these are not exact indicators of the job/population relationship in coal development areas, they do show that the local population could be about three times as large as the number of direct, indirect and support system jobs created by gasification. The number of new residents in an area could be affected by the extent to which workers are hired from the existing population. One company estimated that the population increase generated by its proposed gas plant operating staff could vary between 6,500 and 1,000, depending on where workers came from.[15] However, unless widespread unemployment exists in an area, it is questionable if local residents will provide much of a manpower source. Any local workers hired away to work for the gas industry will probably be replaced by another individual, possibly from outside the area. In addition, most plants have been proposed for relatively unsettled areas. These observations indicate that the population change will not be greatly affected by whether or not workers are hired from the immediate area. Instead, it is expected that gasification will result in an influx of workers, approximating the actual number of direct, indirect and supportive new jobs.

The population increase will be affected by the age and marital status of workers. It is expected that the construction force may not generate proportionately as large a population change as the operating staff, with one study indicating that about 30 per cent of the construction workforce would be single.[16]

Several other estimates of population multipliers are available. According to one Wyoming source, a permanent mineral industry job generally translates into 6.5 total people, two families averaging 3.25 persons each. This estimate assumes direct and indirect employment on about a one-for-one basis, and an average household of about 3.2 persons. Temporary construction workers, on the other hand, result in only 4 to 4.5 people.[17]

Another Wyoming study projected that permanent employees would cause a population increase of 2.5 persons, while construction workers would cause an increase of 2.0. In this study, indirect employment was estimated to generate a similar population increase as permanent jobs.[18] A combined permanent and indirect population multiplier would be about 5 persons, assuming a one-to-one direct/ indirect job relationship.

In addition to Wyoming studies indicating population/permanent jobs multipliers of 3.2, one North Dakota study displayed a multiplier of 3.2, [19] and a Montana study assumed a multiplier of 2.9.[20] Based on an average projected plant and mine workforce associated with one gas plant of 1,000, the population increase would be about 3,000 persons. For a four plant complex, the increase would be about 12,000 persons. These estimates exclude the population impact of indirect jobs, which based on a one-to-one direct/indirect relationship, could easily double these projections. Any support system employment or additional jobs generated by local industrialization could add further to population growth.

A Wyoming study provides an informative illustration of the population associated with various aspects of coal development over a five year period.[21] This projection assumes a peak gas plant construction force of 2,900, an 850 man operating staff, a construction worker population multiplier of 2.6, and a permanent worker multiplier of 6.25. As is shown in the following tables, permanent gasification plant and mine population (tenth year) would be about 7,000 persons, more than twice that of an electric power plant and mine at about 2,900 persons.

The substantial decline in gasification related population after the fourth year, from a peak of 9,600 to about 7,000, is a potential adverse occurrence that must be taken into account in assessing the tenure of the new financial markets accompanying gasification.

TABLE 46

TOTAL DIRECT AND INDIRECT RELATED POPULATION FOR EACH PROCESS[a]

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10
Thermal Electric Generation*	1908	3817	5341	5466	4178	1125
Gasification*	2625	5250	7088	9063	7281	5312
Liquifaction*	4725	9450	10500	15188	12788	9375
Slurry Pipelines*	3019	1575	469	469	469	469
Unit Trains*	788	788	1544	1613	1613	1831
Strip Mines*	315	591	591	1788	1788	1788

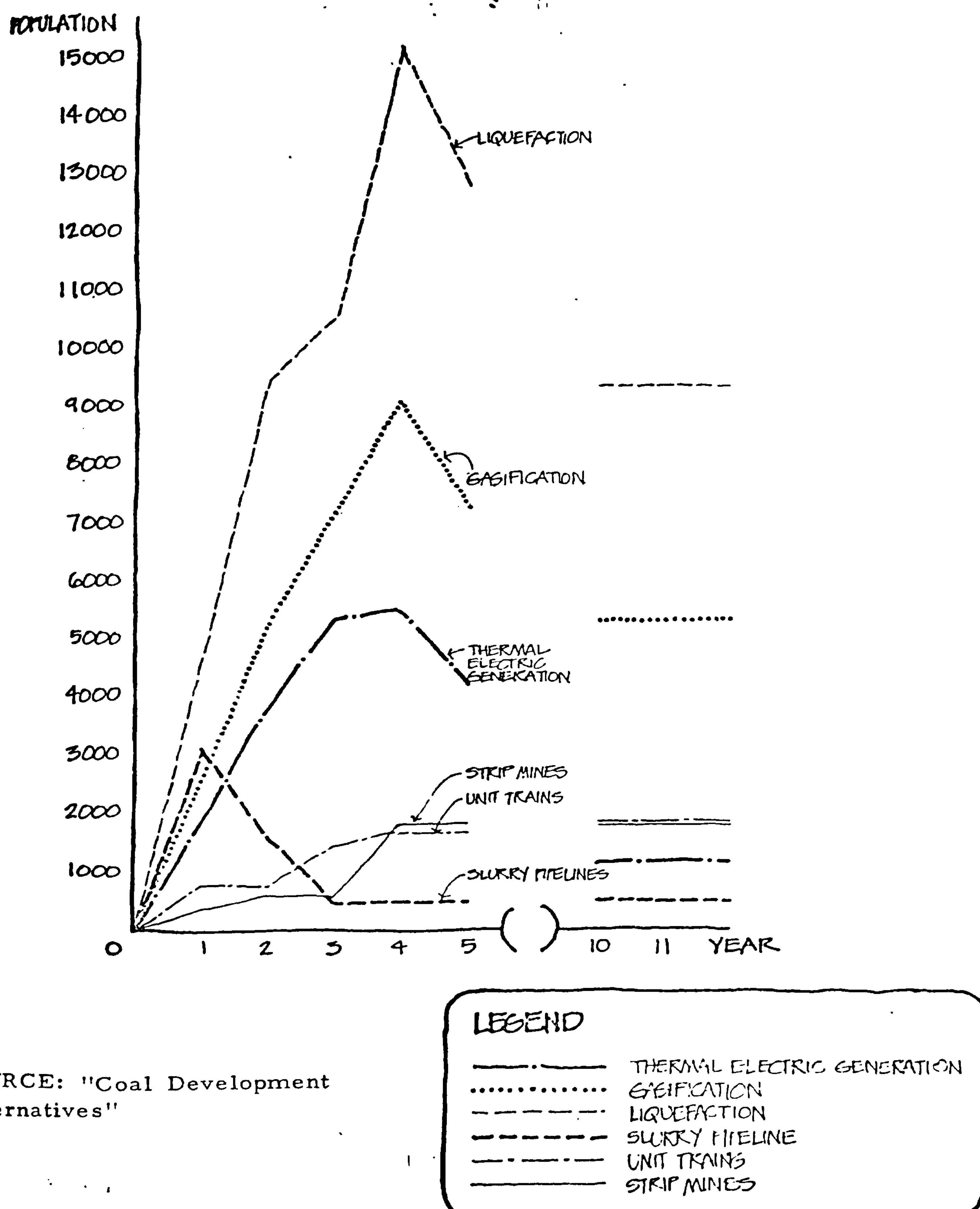
* Facility Sizes assumed as follows:
Thermal Electric Generation: 1000 megawatts
Gasification: 250 million standard cubic feet per day (Lurgi process)
Liquefaction: 100,000 barrels per day (Solvent Refined Coal Process)
Slurry Pipelines: 25 million tons per year
Unit Trains: 61 million tons per year
Strip Mines: 10 million tons per year

[a]The methodology used in deriving service, or indirect, employment and for deriving total population is that contained in Coal and Uranium Development of the Powder River Basin-An Impact Analysis, pp. 51-59. Briefly, the methodology assumes that each construction worker and his family create an additional .25 jobs. The average size of construction workers' families is assumed to be 2. Service workers and permanent workers have an average family size of 2.5. Each permanent worker is assumed to create an additional 1.5 jobs. In summary, this means that the total population associated with a construction worker is 2.625 and the total population associated with a permanent worker is 6.25.

SOURCE: David Freudenthal, Peter Riccradelli, and Michael York, Coal Development Alternatives, p. 76.

TABLE 47

DIRECT AND INDIRECT RELATED POPULATION PATTERNS OVER TIME-PER PROCESS



SOURCE: "Coal Development Alternatives"

Impact Areas

The dimensions of the geographic area which will be impacted by a gas plant will depend on a variety of factors. Among these will be the actions of state and local governments, of private businessmen and developers, of the coal development companies, and the preferences of the workforce itself. The nature and scope of services and products available in nearby trade centers and the distance of these from the gas plant could also play a major role in locating the impact area. The proximity of a large trade center may well cause a transfer of the economic impact from the gas plant site to the more developed trade center.

Commuting

The distances gas plant workers commute may affect where workforce residences are located. A survey performed in 1974 on a portion of the coal workforce in North Dakota showed that over 71 per cent of the coal industry employees commuted to work in their own car, and 24 per cent went in a car pool. A large proportion, 50 per cent, of the power plant workforce commuted to work in car pools. In contrast, only 8 per cent of coal mine employees used car pools. About 72 per cent traveled ten miles or less to work, and only 7.8 per cent commuted over twenty-one miles. Commuting distances for existing industry employees are, then, relatively short. However, employees with shorter duration jobs, such as the construction workforce, generally prefer to live in a larger city and commute greater distances.[22]

The housing shortage in the Hanna, Wyoming coal area caused a substantial level of commuting. This same phenomena could occur in other development areas. Workers at some mines commuted forty miles from Rawlins, 19 miles from Medicine Bow and 14 miles from Elk Mountain.[23]

In Colstrip, Montana, most of the workforce live at the mine and plant site. Only a relatively few commute from the nearby towns. This experience correlates with the short commuting distances noted for North Dakota mine workers. However, Colstrip is more representative of a gas plant in that a large construction force is involved with many of the workers coming from far-off areas.

Availability of Services

The availability of adequate educational facilities, services and products could also influence workers' location decisions. In a survey made in Hanna, between 82 and 86 per cent of the respondents stated a need for retail shopping; 75 to 78 per cent a need for good streets; 92 to 95 per cent a need for schools and sanitary facilities; and 52 to 79 per cent the availability of recreational facilities. If these were not available in the gas plant area, the desire to obtain them could cause workers to locate in nearby towns and commute to work.

Recently a projection of the economic impact of gasification on three and seven county areas of Montana was performed. This forecast showed that the impact of coal development in Rosebud, Big Horn and

Powder River counties would go beyond the immediate three county area, and significantly affect a total area including seven counties. The primary explanation of this is that Billings and Miles City, Montana-relatively large trade centers near coal areas-would receive a large share of the derivative impact of development.

The Northern Great Plains Resource Program coal development report of September 1974[24] pointed out that towns from 100 people to large cities could be impacted by coal development. Typical towns in coal areas range between 500 to 3,000. Towns such as those the size of Gillette, Forsyth and Stanton have proved able to provide most services needed. Larger areas such as Billings, Rapid City and Bismarck, serve as a source of a wide range of goods and services, and act as wholesale suppliers to coal area towns.

North Dakota Trade Areas

A November 1973 study of the trade areas of North Dakota provides a definition of the Trade Center Types, a mapping of trade areas, and of greater trade areas. This report broke trade areas down into four classifications, as shown below and defined in Tables 48 and 49.

TABLE 48

TRADE CENTER TYPES

Trade Center Type	Population	
	Trade Center	Main Trade Area
Local convenience	Under 500	Under 1,000
Minimum convenience	400 - 1,500	1,000 - 3,500
Partial shopping	1,400 - 3,000	2,500 - 7,500
Complete shopping	Over 5,900	Over 12,000

SOURCE: North Dakota State University Cooperative Extension Service, "Trade Areas in North Dakota", Extension Bulletin No. [illegible]0, November, 1973.

TABLE 49

TRADE CENTER CLASSIFICATIONS

Trade centers in North Dakota were classified according to the types and number of goods and services offered, by the population of the trade center and its main trade area population. Determination of the area served by a trade center was made by tabulating the respondents' answers to the question, "What town do you consider to be your main trade center?" Further determination was made by tabulating where most respondents of an area purchased 50 percent or more of most items listed on the survey form. The data were plotted on a map and served as a basis for determining the trade area boundaries. Estimation of the population within the trade area boundaries was made to determine the trade area's population. The trade centers were then classified into four groups as follows: local convenience, minimum convenience, partial shopping and complete shopping. The range in population for each type of trade center and their main trade areas is shown in Table 1.

Most **local convenience centers** have populations of under 500 and a trade area population of under 1,000. These trade centers generally offer few goods and services. The goods and services are largely limited to convenience items; however, a few of them offer some specialized services. The local convenience centers usually contain a small grocery store, a small restaurant, gas station, a bulk fuel oil dealer and often a grain elevator.

The **minimum convenience centers** range in population from 400 to 1,500 with most having a population of over 750 and a trade area population of over 2,000 but less than 3,500. The minimum convenience centers offer the same goods and services available in the smaller center plus some additional items. It offers more selection in the grocery stores, a more complete restaurant, a hardware store, generally an implement dealer, drugstore, a limited selection of appliances, and some farm chemicals. Some of the larger centers in this group offer dental, medical doctor and hospital services. The centers in this group with populations of under 750 are usually located at least 40 miles from a larger shopping center.

The **partial shopping centers** range in population from about 1,400 to 3,000 with trade area populations in excess of 3,500 but less than 7,500. These centers offer most goods and services necessary for family living and farm business operation. In addition to the goods and services offered in the smaller centers most of them have complete grocery stores offering fresh meat, frozen food and fresh vegetables; more complete restaurant services; service stations with tire, battery and maintenance service; two or more machinery dealers; at least one new car dealer; dental; medical doctor and hospital services; family clothing; and complete farm chemical supplies.

The **complete shopping centers** have populations in excess of 5,900 and trade area populations in excess of 12,000. These centers offer all retail trade services and supplies necessary for family living and farm business operation. They offer specialized goods and services not available in the smaller centers, especially in the health care services. The larger of these centers provide wholesale supplies to the other trade centers.

SOURCE: "Trade Areas in North Dakota".

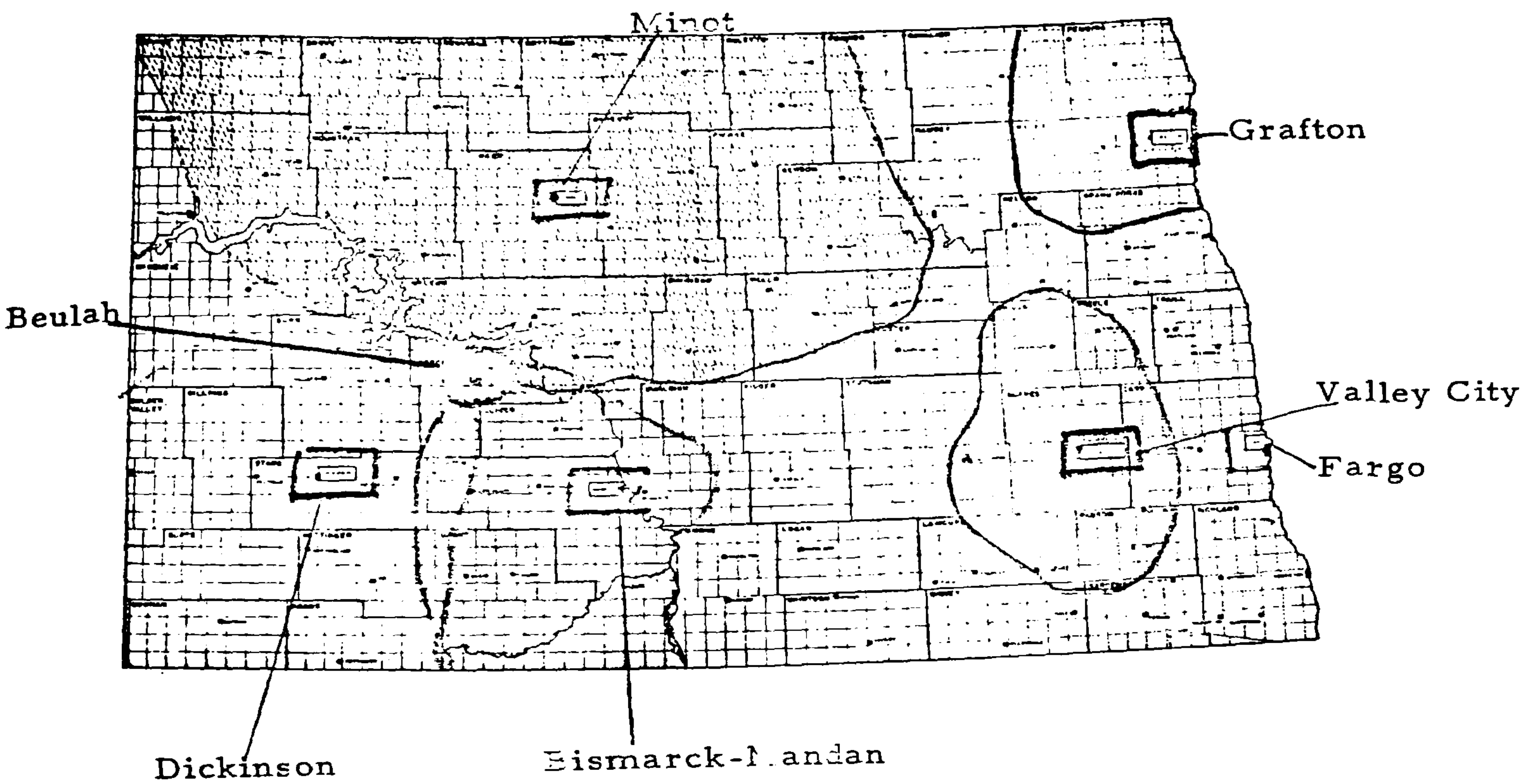
At that time there were 57 minimum convenience centers, 26 partial shopping centers, and 12 complete shopping centers in the state. The complete shopping centers are generally about 100 miles apart and on major highways. The partial shopping centers average 40 miles apart in western North Dakota, while minimum convenience centers average 20 miles apart.[25] The wider range of products and services available in partial and complete shopping centers could attract a substantial share of the gas plant payroll and perhaps population influx away from local convenience trade centers where plants would be located.

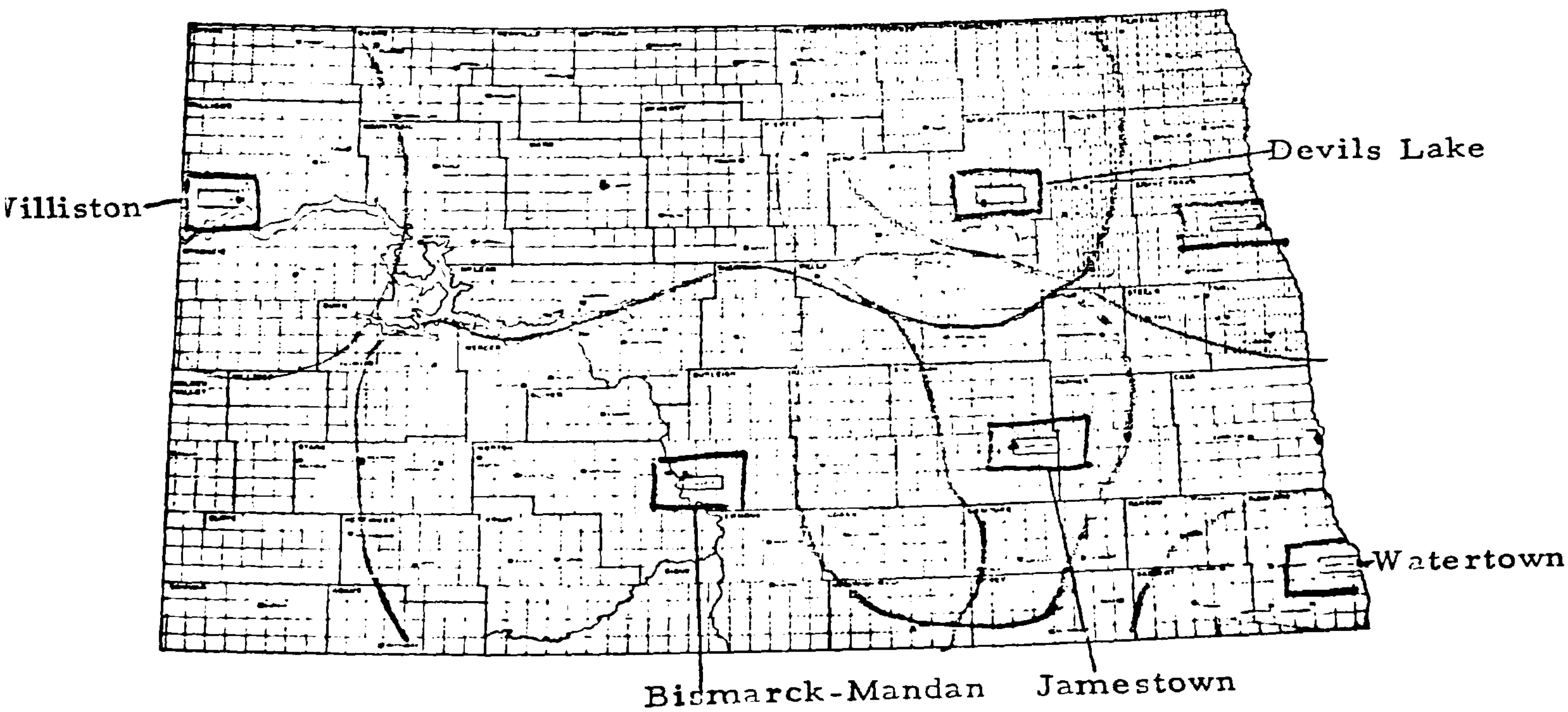
Because shopping in more than one trade area takes place, each of the 12 complete shopping centers has a larger trade area than its "Main Trade Area." This is called the "Greater Trade Area." The availability of health care services, furniture and clothes can impact the dimensions of this area. These areas are illustrated in the following Table 50. This shows that Minot, Dickinson, Bismarck-Mandan and Williston could participate in the economic impact of coal development throughout western North Dakota.

TABLE 50

GREATER TRADE AREAS OF COMPLETE SHOPPING CENTERS - NORTH DAKOTA

NOTE: Separate maps are for ease of understanding. All towns noted, except Beulah, are complete shopping centers.





SOURCE: "Trade Areas in North Dakota".

Beulah, North Dakota

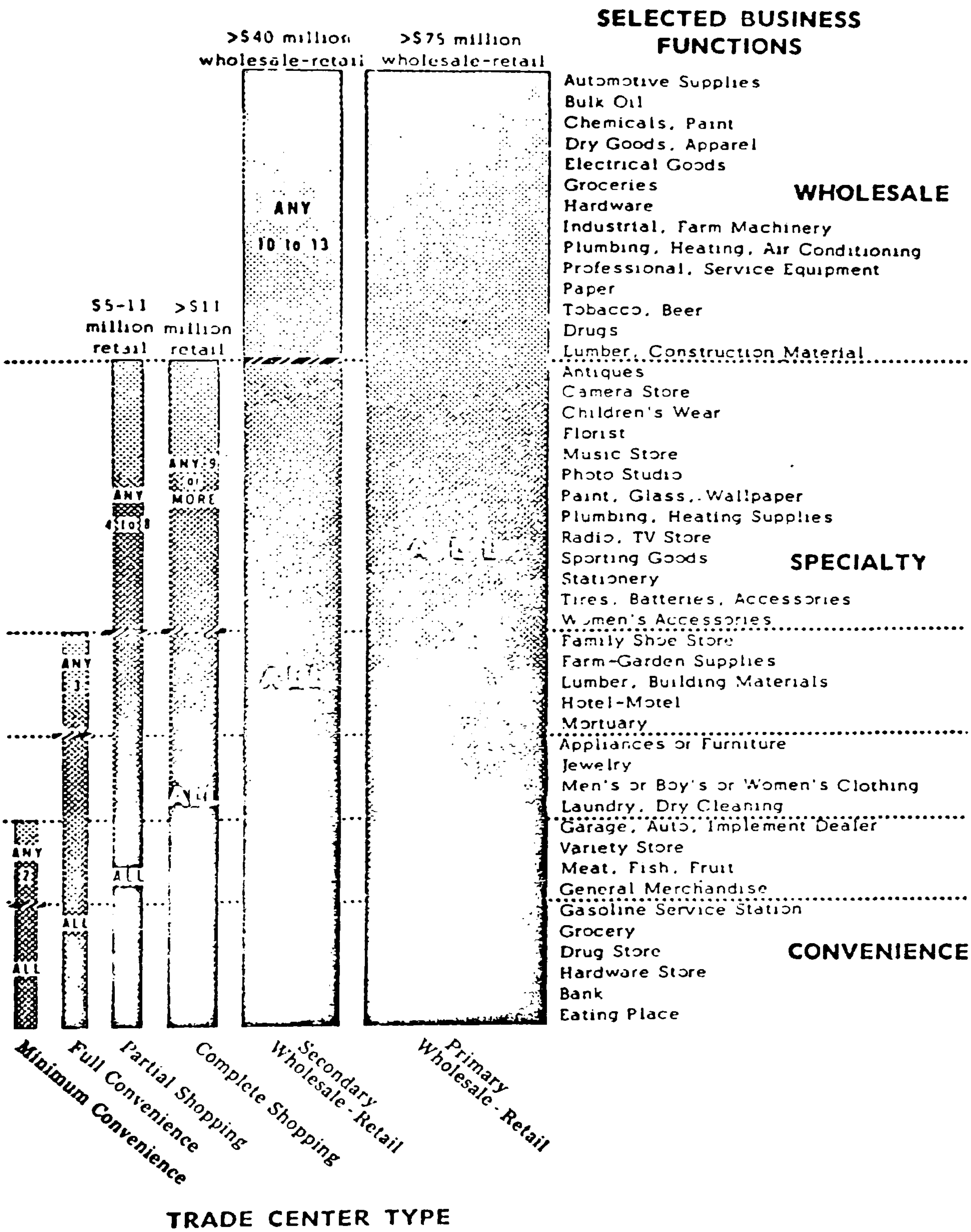
In 1972 a study was made of the trade area of Beulah, a town that is heavily affected in coal development. Beulah is the largest town in Mercer County, and its trade area includes Mercer, McLean, Oliver and Dunn counties. This area has a radius of about 30 miles and a population of 3,400 people.

The 1972 study classified towns into six possible trade center types, based on the kinds and numbers of businesses available. Beulah was termed a "hamlet", which is one step below the least developed trade center type.

The chart used to classify towns is shown as Table 51. This gives an idea of the kinds of business services required by coal development area populations, as well as the kinds of new businesses that could be needed as a coal town develops.

TABLE 51

Trade Center Types Defined by Business Functions



Source: Borchert, John R. and Adams, Russel B., Trade Centers and Trade Areas of the Upper Midwest, Urban Report No. 3, Upper Midwest Economic Study, University of Minnesota, Minneapolis, Minn. 1963

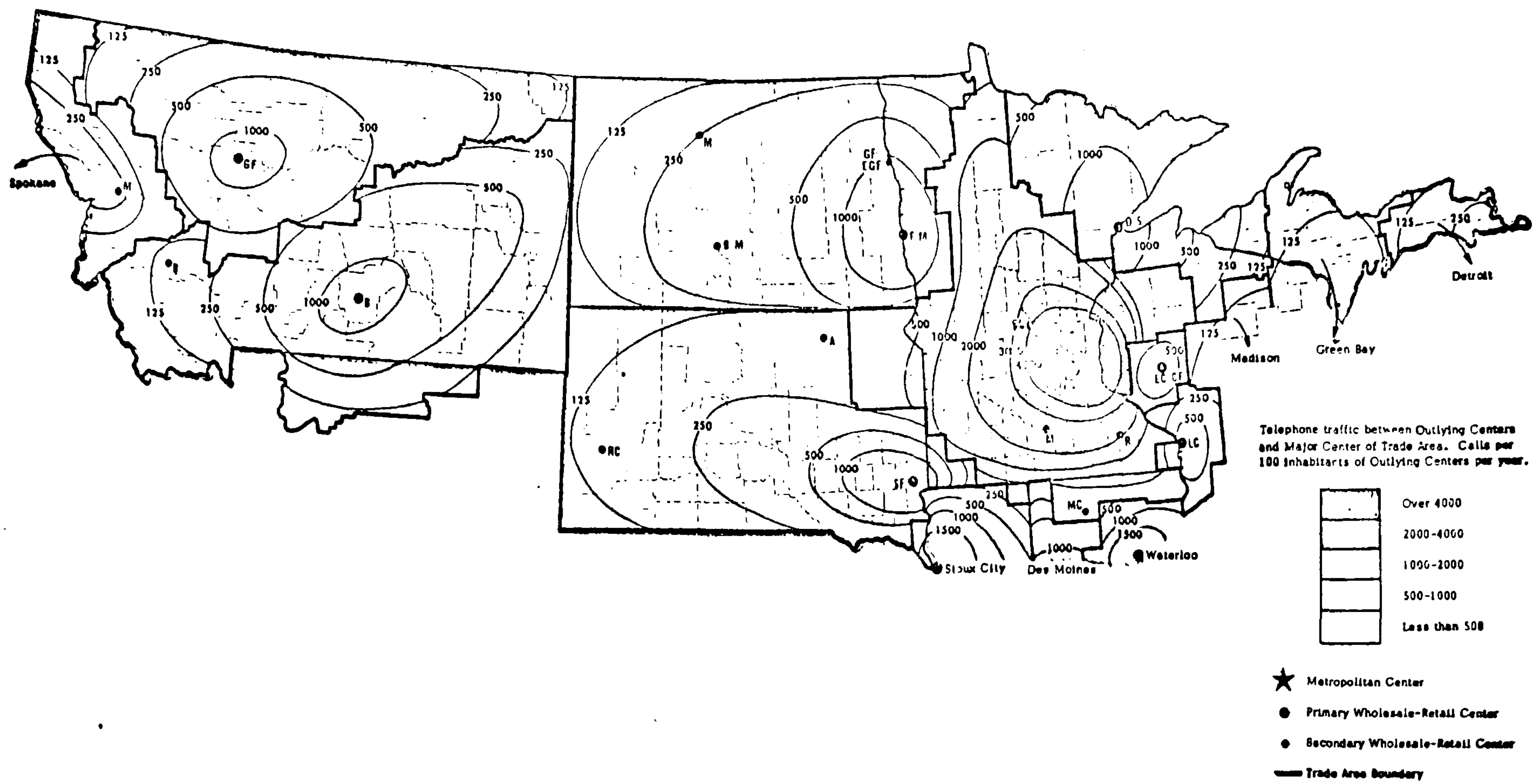
The study showed that about half of the hamlet's sales came from persons living within 5 miles, and 70 per cent from within a ten mile area. For specialty items like furniture, clothing and medical assistance, Beulah competes for sales with Bismarck. It was determined that half of the Beulah patrons shop for specialty items outside the Beulah area. In fact, the complete shopping centers such as Bismarck-Mandan, Dickinson and Williston sold 75 per cent of the specialty items in the 21 western North Dakota counties. Many of the purchasers of these items came from more than 40 miles away.

Montana Trade Areas

There are two major trade areas in southeastern Montana. One of these is Billings, classified as a "primary wholesale-retail" center, and Miles City, a "complete shopping" center.[26] This classification is based on the trade center ranking already defined in the Beulah trade area discussion. Accordingly, the types of trade centers, in increasing level of size and service availability are: minimum convenience, full convenience, partial shopping, complete shopping, secondary wholesale-retail and primary wholesale-retail. The Billings area is the most dominant, being of a highest order. The geographic coverage of the Billings trade area is illustrated in Table 52. This clearly encompasses the Montana coal fields, which lie about halfway between Billings and the eastern border of Montana.

TABLE 52

TRADE AREAS AT THE PRIMARY WHOLESALE-RETAIL LEVEL



SOURCE: Upper Midwest Economic Study, "Trade Centers and Trade Areas of the Upper Midwest", Urban Report Number 3, September, 1963, p. 27.

Retail Sales

Gasification would generate other kinds of expenditures besides the annual operating payroll, which could also have a significant impact on a local economy.

Construction outlays within the local area, for both the plant and mine, and the support infrastructure represent such additional stimulii. The construction of the gas plant itself will have the greatest impact, with an estimated 60% of the plant cost of $500 million being expended locally. The initial development of the support infrastructure including housing, business structures and public facilities, has been estimated to cost $52.1 million; and to alone generate local business retail sales volume of $116.7 million.[27] While these outlays would extend over a number of years, they would have only a one-time impact on the local area.

On a more permanent basis, annual recurring local purchases of goods and services by the gasification facility would add to the economic impact generated by the annual gasification payroll. It has been estimated that these purchases could amount to around $8.1 million (1972 dollars), which when combined with a projected annual payroll of $12.0 million (1972 dollars) would have an aggregate continuing effect of about $20 million per year. Such a stimulus has been estimated to generate local retail business volume of $53.0 million per year.[28]

Summary

The magnitude of local employment, population, payroll and local expenditures generated by a coal gasification complex indicate that such a facility could have an unprecedent economic impact on the remote coal areas of the West.

Before focusing on the financial needs accompanying this development, it is necessary to summarize the various observation regarding impacts made in this chapter. This is intended to provide a basis of assumptions about economic impact from which further analysis into financial needs can be performed.

First, it is expected that it will require about four years to construct a gasification plant, and that the construction force would peak at about 3,000 workers. If a four-plant complex is constructed, it is conceivable that a high level of construction employment could extend over a period as long as 16 years. Additional construction employment should accompany the building of the gasification complex, and include the construction of housing, business structures, support and municipal facilities. Assuming that the 3,000 construction workers will generate secondary employment of around 1,000 workers, the total number of jobs during the construction phase of a gas plant would be 4,000. If the number of persons per household during the construction phase would average 3, slightly less than the area average, the total population during construction would amount to about 12,000 persons. It has been estimated that construction workers would have a population multiplier of about 4 times the number of direct jobs available. It is assumed for the purposes of this paper that all gasification jobs will be filled by individuals from outside the immediate area.

General consensus is that it will require about 1,000 workers to operate a gas plant and mine. At a direct/secondary employment relationship of one-to-one, these jobs would generate another 1,000 secondary employment positions. Again assuming that the average household consists of 3 persons, this would indicate a permanent gasification population of 6,000.

For the purposes of this paper, it will be assumed that the annual gasification payroll will amount to $12 million (1972 dollars). This is being done to faciliate the use of various studies, but it must be remembered that wages have escalated substantially since that time. In recent interviews with southeastern Montana mining and power plant companies, comparable worker positions were determined to now be earning about $20,000 per year. At this level, the 1,000 direct operating jobs would generate a payroll of $20 million per year. Local purchases of products, supplies and services by the gasification facility are estimated to be $8.1 million per year (1972 dollars). This excludes the direct payroll expenditures. Again, it must be remembered that such expenses would have escalated in cost since that time. Certain subsequent analysis of gasification's impact on financial require an estimate of average gasification worker earnings in current dollars. Such analysis will be done on the assumption that the average construction and permanent operating employee would earn $20,000 per year. This equates to a salary of about $15,000 per year in terms of 1972 dollars, and is based on the increase in the consumer price index for services between 1972 and September 1975 of about 33 per cent.

Total gas plant construction costs will amount to about $500 million. About 60 per cent of the cost, or $300 million, is expected to be spent in the local area for products, supplies, services and personnel salaries, over the four years of construction. It is assumed that construction will require 95,000 man-months of time, for a total payroll of $95.0 million.

Recently, Panhandle Eastern estimated the cost of its proposed gas plant in Wyoming at $1.3 billion, and American Natural Gas projected its North Dakota plant to cost $1.6 billion. These include the cost of pipelines, interim construction interest and working capital, items which would not impact the local economy.

Local trade areas could benefit substantially from gas plant payroll, as could regional complete shopping centers, through the sale of specialty and wholesale goods. The ten regional shopping centers which could benefit include: Billings, Miles City, Rapid City, Williston, Dickinson, Minot, Bismarck, Mandan, Gillette and Sheridan. The potentially immense population gains associated with gas plants could project small towns from "full convenience" to "wholesale" trade center classification. This could be accompanied by commercial development, new business, and possibly change the existing trade area patterns significantly.

It is expected that the economy of a gas plant area could be not only booming, but highly volatile. Contributing to this would be the wide variance in the number of construction workers required in each of the four years of plant construction, the high concentration of a unionized workforce, uncertainties due to governmental or judicial action, and coal demand uncertainties. What's more, the coal reserves are finite in size and will at some time run out. When that might happen is unknown, due to the lack of knowledge about the size of the coal reserves themselves. One study has projected that the surface coal reserves of the areas including Montana, North Dakota and Wyoming could last between sixty to eighty years at a 5 per cent annual growth rate in production.[29] Conceivably, additional reserves will be found. On the other hand, the growth rate in western production could be much faster than 5 per cent.

Chapter IV

Footnotes

1. Michigan Wisconsin Pipe Line Company, Coal and Water for Gasification, p. 7.

2. F. Larry Leistritz, "Coal Development in North Dakota: Effects on Agriculture and Rural Communities", (presentation to Fargo Optimists, February 11, 1974, p. 10.

3. Wyoming Department of Economic Planning and Development, Coal Development Alternatives, p. A-7.

4. The University of North Dakota, Extensive Utilization of Lignite in the West River Diversion Area, p. 21.

5. University of Wyoming, What Does Energy Development Mean for Wyoming?, p. 8.

6. Wyoming Department of Economic Planning and Development, Coal Development Alternatives, Appendix C-2.

7. Michigan Wisconsin Pipe Line Company, Coal and Water, p. 8.

8. Montana Energy Advisory Council, Coal Development p. 56.

9. Northern Great Plains Resource Program, p. V-16.

10. Wyoming Select Committee, Economic Impact on Local Areas, p. 1.

11. Ibid., p. 3.

12. Wyoming Department of Economic Planning and Development, Coal Development Alternatives, p. 99.

13. The University of North Dakota, Extensive Utilization, p. 55.

14. Montana Coal Task Force, Coal Development in Eastern Montana, p. 62.

15. Natural Gas Pipeline Co. of America, "Environmental and Socioeconomic Considerations", p. 12.

16. Montana Energy Advisory Council, Coal Development Information Packet, p. 59.

17. Wyoming Select Committee, Economic Impact, p. 1.

18. Wyoming Department of Economic Planning and Development, Coal and Uranium Development of the Powder River Basin, p. 58.

19. The University of North Dakota, Extensive Utilization, p. 58.

20. Montana Coal Task Force, Coal Development; p. 59.

21. Ibid., p. 76.

22. Arlen Leholm and F. Larry Leistritz, Profile of North Dakota's Coal Mine and Electric Power Plant Operation Work Force, pp. 14, 18.

23. University of Wyoming, What Does Energy Development, p. 19.

24. Northern Great Plains Resource Program, p. V-9.

25. North Dakota State University Cooperative Extension Service, Trade Centers of North Dakota, Extension Bulletin No. 20, pp. 4, 5.

26. Upper Midwest Economic Study, "Trade Centers and Trade Areas of the Upper Midwest, Urban Report Number 3, September, 1963, p. 27.

27. Ibid., p. 73.

28. Arlen G. Leholm, F. Larry Leistritz, and Thor A. Hertsgaard, Local Impacts of Energy Resources Development in the Northern Great Plains, p. 77.

29. National Petroleum Council, U.S. Energy Outlook, p. 143.

CHAPTER V

LOCAL FINANCIAL NEEDS CREATED BY COAL GASIFICATION

Introduction

The western coal reserves account for 51 per cent of the strippable coal in the United States, with coal representing 69 per cent of the country's fossil fuel energy resource. During recent years these areas have experienced rapid and substantial development in the form of strip mines and electric power plants. Though uncertain, it is possible that coal gasification may emerge as the next form of western energy conversion facility. As was described in Chapter IV, the local economic impacts of a gasification plant would be substantial.

The availability of adequate capital has been identified as a potential obstacle to the large-scale energy development proposed for the future. A different type of capital shortage could also occur in the areas surrounding gas plants, due to the substantial financing needed to develop the supporting commercial, housing and municipal infrastructure. It is the purpose of this chapter to identify and quantify where possible the new and expanded local financial needs, including capital requirements and financial services, accompanying gasification. Hopefully this will serve to facilitate planning to meet these needs and assure the timely availability of responsive, quality financial services.

Experiences of Other Areas

The experiences of resource-related boom areas such as Alaska, Kentucky and northern Minnesota provide an indication of the impact of such development on financial needs. These situations show that a great deal of local economic expansion can occur even before the actual resource development occurs, as business prepares for the boom.

In Alaska, the state's twelve banks' deposits exceeded $1 billion for the first time in 1974. As a result of the coming boom, three new banks have applied for charters. In 1974, total deposits in the state increased $200 million to $1.1 billion, an impressive gain of 24.2 per cent. In individual banks, the increase has been as high as 48 per cent during 1974. What is more, loan demand is keeping pace with deposit growth. Demand deposits increased 42.5 per cent in 1974, following only a 9.7 per cent gain in the prior year. During the first half of 1975, demand deposit growth was running about 40 per cent on an annual basis. Importantly, this growth has been profitable due to higher volumes and the substantial spreads available in the high-loan demand, boom environment.

Housing is in short supply and costs are high. Transportation facilities are jammed, as are telephone circuits. Banking expenses have increased considerably in the inflationary environment, and the banks have difficulty retaining competent or even adequate staffing in the face of $900 per month construction jobs. In the past, the area's banks have relied heavily on public deposits and correspondents for funds. This is expected to continue, with some mitigation as the banks become large enough to handle their own business.[1]

Experiences in Kentucky also show dramatic financial growth. In the nine major coal mining counties, the deposits of the twenty commercial banks increased $300 million in 1974, a gain of 68 per cent. In Pike County alone, bank deposits almost doubled. Commercial loans were up 72% over the prior year.[2]

The northern Minnesota towns of Virginia and Grand Rapids show the degree of economic development which can occur in the early phases of large-scale development. In early 1975, about 2,700 workers were employed in the planned $900 million taconite expansion. It is expected that as many as 8,000 will be so employed by 1976.[3] The impact of this development is illustrated in the following table. This shows deposit growth of about 15 per cent in 1974, while loans increased around 20 per cent. This table also shows that loan growth has exceeded deposit growth by substantial margins during the last three years in these towns. This same shortfall in funds availability is expected for western coal areas. Business is reported to be up, with 16 new businesses locating in the nearby town of Hibbing during 1974. Minimum construction wages, indicated by laborer earnings, are $7.15 per hour, or $14,800 per year excluding overtime. A number of migrants have not found work. Because of this, the counties experienced a substantial increase of 100 per cent in welfare requirements in early 1975.

TABLE 53

NORTHERN MINNESOTA TACONITE DEVELOPMENT IMPACT

	Grand Rapids	Virginia
Deposit Growth		
1970	5.9%	9.5%
1971	14.9	12.2
1972	12.1	7.5
1973	12.2	10.9
1974	14.6	16.9
Loan Growth		
1970	13.0%	7.7%
1971	9.2	6.9
1972	16.4	13.4
1973	18.1	12.2
1974	17.6	23.2

SOURCE: Northwest Bancorporation, Minneapolis, Minnesota.

Gasification--How Big of a Boom?

The degree of local population growth will have a substantial and important effect on the degree of gasification impact on local financial needs. For the purposes of this paper, it is assumed that all new gasification jobs will be filled by immigrating workers. It is felt that this will better illustrate the impact of plants located in remote areas, in areas with an already high level of employment due to development, and in areas where a number of plants would be built simultaneously.

However, it is important to realize that the construction and operation of the first plant or of single plants at a time, is not expected to create large population increases. For example, it has been estimated that as many as 3,415 workers are available in the Beulah and Dunn Center gasification areas of North Dakota.[4] These represent 20% of the working age population and 40% of those currently employed. Availability such as this could be characteristic of other agrarian areas as well.

However, with or without a major increase in population, the impact of gas plant payroll and sales on existing people and businesses would alone be very substantial.

Due to a number of factors, it will take time for the full impact of gasification to be felt in the surrounding area. For one thing, the construction project extends over four years and is not expected to peak until the second year. Also, because of the small size of the gas town and unavailability of commercial facilities, most of the retail sales to gasification workers may be made in larger trade centers. As the gas towns develop commercial facilities, this would change. Sales of products, supplies and services to the gas companies will probably be initially made from larger trade centers and may continue to for a relatively long time. It is expected that a large portion of these sales will always be made outside of the immediate area, reducing the impact on the gas town.

The level of excess capacity in the existing community facilities will influence the level of new building needed to provide an adequate infrastructure around a gas plant. Possibly the existing roads, city hall, water and sewage plants may be able to handle the boom created by a single plant, either with the systems already in place or through minor expansion. The same may hold for local commercial facilities and housing. This would be particularly so in those counties which have been losing population. As an example, Dunn and McLean Counties of North Dakota experienced about a 20 per cent net reduction in their populations from 1960 to 1970, amounting to about 4,200 persons. [5] Assuming adequate facilities existed in 1960, it would therefore be possible to replace those lost with 4,200 new residents without requiring any new local constriction. Excess capacity, then, could have a significant impact on the amount of financial needs relating to local constriction. This would be particularly so for the first or for single gas plants, but would probably be immaterial in the case of multiple simultaneous sitings.

Boom Environment

Experiences in Gillette and Rock Springs, Wyoming show that rapid development can create an undesirable living, as well as a undesirable business environment. About half of the Rock Springs construction workers are classified as "transients" from out of state, and account for most of the town's social and criminal problems. In contrast, the Wyoming residents or the employees of major contractors have not been major sources of problems. Police calls in Rock Springs have increased from only 200 in 1970 to 40,000 in 1974. Living costs have also skyrocketed, similar to northern Minnesota experiences. Labor is in very short supply, and high in cost. In the opinion of the mayor, the town has experienced a general reduction in the quality of life.

The "Gillette Syndrome" is a term coined by a Wyoming clinical psychologist to describe the "deviant" behaviors observed in persons located in boom towns. It refers to the drunkenness, depression, delinquency and divorce attributable to crowded and unsanitary living conditions, lack of community and recreational facilities, lack of permanence and long hours at an unrewarding task. These problems have been accompanied by high school drop-out rates, delinquency and crime. [6]

The Rock Springs and Gillette experiences substantiate some of the expected impacts provided in a hypothetical forecast of a boom town "resource city". [7] These provide some indication of the potential business environment facing financial institutions in coal boom areas, if some of the problems are not avoided or solved:

1. critical housing and public service shortages
2. inadequate transportation systems
3. high job turnover
4. increase in welfare recipients
5. rapid increase in crime, vandalism, drunkenness
6. high wages for employees
7. high rate of absenteeism
8. high prices and costs of doing business
9. high priced real estate
10. high school students dropout to work in mines
11. residents do shopping in other towns to avoid traffic congestion, lack of parking, and to obtain services unavailable locally
12. difficult to attract qualified medical, educational and other professionals
13. air and water pollution worsened

14. recreational facilities and outdoor recreation areas deteriorate from overuse
15. high divorce rate

The occurrence of even a limited number of these problems could make satisfaction of the financial needs of a boom area difficult or unprofitable. Based on the hypothetical and actual experiences, it would appear that a financial institution will be faced with high expenses, personnel problems, high cost land and buildings, and a high incidence of credit quality problems due to worker backgrounds, layoffs, absenteeism, drunkenness, family disputes, and general unrest.

Financial Needs of Individuals

The construction and operation of a gasification plant and mine will require a large and diverse workforce with differing kinds and levels of financial needs. The new jobs will mean higher salaries and employment for local residents, and jobs for new residents immigrating into an area. At one time or other, it is expected that gasification employees would use most of the variety of retail services available through financial institutions. A list of the retail services available through banks is available in Appendix 14.

Gasification employees and beneficiaries could be segregated into several groupings: construction (major contractor personnel); construction (local); construction (transient); permanent workforce (skilled); permanent workforce (unskilled); permanent workforce (administrative); secondary employment; municipal workers; executives and professionals; and royalty recipients such as ranchers and Indians. Individual groups may have substantially different earning, borrowing, savings capacities, and financial needs, as well as levels of credit worthiness and potential local tenure.

Construction workers, because of their sheer number and population impact (12,000 persons at peak employment levels) are expected to create a substantial demand for all kinds of banking services, including loans. Those workers who move into the area with most of the necessary consumer durables, such as a mobile home, car and appliances, may not be users of funds, but instead may serve as important sources of funds for the area. Other workers may not already own the needed durables. It is expected that all workers could develop the need for any or all of these assets during their stay in the area. If within a given area multi-plant complexes are developed over a long period of time, it could be expected that the financial needs of the construction workforce would become similar to those of the also permanent operating workforce. While the construction workforce is projected to require four years or less to complete a plant, it is important to acknowledge that construction activities on a single multi-plant complex may extend over as much as sixteen years. With coal reserves concentrated in relatively few locations, it is conceivable that a number of multi-plant gasification facilities as well as electric power plants could be located in rather close proximity. Such an expansion in the level of mine-mouth coal conversion development could cause a significant extension in the length of the construction period.

The permanent operating staffs will require a full range of financial services, and at some time would require financing for a single family home. The permanent secondary workforces and municipal employees would have similar needs. Income levels for permanent employees will run around $20,000 per year, which should provide a strong saving as well as borrowing capacity. Probably a large proportion of permanent employment will represent construction workers who decide to stay in the area. Permanent workforces would not be needed until the plant was operating, following four years of construction.

Executives and professionals will have unique needs because of their probable higher level of earnings, financial sophistication and older ages. This kind of person would have larger savings and borrowing needs, would require investment services, have more life insurance, and utilize trust services. In early stages, there would only be a very few such persons. Unless the town can be made a sufficiently attractive place to live, few professionals may ever locate permanently.

A limited number of individuals or groups could benefit substantially from land sales, royalties and business opportunities associated with the development of gasification. These include ranchers, farmers, other landowners, Indian tribes, and local business men. The higher income groups such as the top 5 per cent of the working population that makes over $25,000 per year, represents a group with special needs. It is to be noted that 72 per cent of the families in this group have more than one working person, a situation that could occur frequently in a high-pay, labor-short boom environment. About 40 per cent of those in the upper 5 per cent achieve this status because of a working wife. Many of them are craftsmen and firemen, 21.3 per cent of the total.[8] The availability of competent financial counseling and fiduciary services will be very important to this more affluent group.

INDIVIDUALS CREDIT NEEDS

Individuals borrow money for a wide number of reasons, ranging from financing the acquisition of a home, to the actual financing of financings (debt consolidation or bill paying loans). Generally, loans to individuals are made on an installment basis and of an intermediate to long term nature.

In a boom town, the requirement for longer term loans may pose a meaningful problem to funds availability because of the less permanent nature of construction workers and other deposits. Also, the almost immediate need for housing financing could precede the local availability of deposit funds by a wide margin. In some boom areas the magnitude of loan demand has simply exceeded deposit availability. This too could happen in the West. These problems could create a funds shortage for individual lending, particularly in the area home loans. Without adequate financial services, the already marginal quality of life of a boom area could decline to undesirable levels. A listing of the kinds of individual borrowing needs is provided in Appendix 14.

Personal Loans

Surveys performed by the University of Michigan indicate that almost 50% of all families will borrow on an installment basis. For those families with debt, such borrowings averaged around $1,000, in the last three years the survey was performed. Application of these experience factors to the 2,000 new direct and secondary jobs created by the operation of a gasification facility provides an estimate of local installment loan demand at about $1.0 million. This assumes each worker to have a family, a fairly realistic assumption. The larger construction force of 3,000 employees, with secondary employment of 1,000, could have installment credit needs of $2.0 million based on these same assumptions. [9]

An analysis of the per capita loans in a number of Western towns was made for additional insights into possible installment borrowing in a gas plant town. This showed average per capita loans of $600. Unfortunately, the figures for certain of the Wyoming localities included in the analysis are probably misleading due to rapid population growth since 1970. Loan amounts were measured as of December 31, 1975 and population as of 1970. Because of this, a $500 per capita average loan would probably be more representative. At this level the installment borrowing associated with the permanent population of 6,000 would be $3.0 million, while borrowing by the 12,000 population construction force could be $6.0 million. Average per capital personal loans in major western coal areas are provided in the following table. This also shows auto loans to be about 30% of the total, single-payment loans of about 60%, and other installment and consumer goods loans of only minor proportions.

TABLE 54

Loans Per Capita in Western Coal Areas (Year-end 1974)
(Personal Loans)

Town (Bank)		1970 Population	Auto Loans $1,000	Auto Loans Per Capita	Consumer Goods $1,000	Consumer Goods Per Capita	Other Installment $1,000	Other Installment Per Capita	Single Payment $1,000	Single Payment Per Capita	Total $1,000	Total Per Capita
Montana												
Forsyth		2,156	$ 713	$ 330	$ 107	$ 50	$ 259	$ 120	$ 295	$ 137	$1,374	$ 637
Hardin		3,732	710	190	39	10	352	94	618	165	1,719	460
North Dakota												
Beulah		1,344	219	162	3	2	43	32	158	117	423	315
Hazen		1,240	396	320	64	51	118	95	234	189	812	654
Wyoming												
Rock Springs	1		1,524		55		97		118			
	2		989		541		567		496			
	3		2,240		621		82		785			
		11,657	4,753	408	1,217	104	746	64	1,399	120	8,115	696
Gillette	1		463		101		382		53			
	2		2,305		1,820		433		1,652			
	3		12		0		9		63			
		12,957	2,780	214	1,921	148	824	63	1,768	136	7,293	562
Sheridan	1		1,467		420		113		3,229			
	2		54		13		19		0			
	3		1,245		47		528		2,448			
	4		4		2		25		7			
		10,856	2,770	255	482	44	685	63	5,684	523	9,621	886
Average				$268		$58		$75		$198		$601

Source: Census of Population, 1970, and FDIC Magnetic Tapes of Bank Call Reports as of December 31, 1974.

(Continued)
Loans Per Capita in Western Coal Areas (Year-End 1974)
(Home Loans)

Area Bank		1970 Population	1-4 Family Property $1,000	1-4 Family Property Per Capita	Multi-Family $1,000	Multi-Family Per Capita	Mobile Homes $1,000	Mobile Homes Per Capita	Home Improvement $1,000	Home Improvement Per Capita	Total $1,000	Total Per Capita
Montana												
Forsyth		2,156	$2,608	1,210	88	40	1,020	473	126	58	3,842	1,782
Hardin		3,732	1,071	287	0	-	199	53	115	31	1,385	371
North Dakota												
Beulah		1,344	377	280	571	424	109	81	0	-	1,057	786
Hazen		1,240	1,351	1,090	600	484	299	241	50	40	2,300	1,855
Wyoming												
Rock Springs	1		4,106		0		3,010		117			
	2		1,618		0		379		141			
	3		4,401		0		5,096		0			
		11,657	10,125	869	-	-	8,485	727	258	22	18,868	1,619
Gillette	1		726		0		449		76			
	2		3,973		0		222		40			
	3		0		0		0		0			
		12,957	4,699	362	-	-	671	684	116	9	5,486	423
Sheridan	1		2,378		0		1,071		97			
	2		0		0		30		7			
	3		1,895		0		611		123			
	4		0		0		0		0			
		10,856	4,273	393	0	-	1,712	157	227	20	6,212	572

Several factors, including income, age, marital status and ages of children, can normally have a substantial impact on the frequency and magnitude of borrowing needs. In boom areas, other factors like lack of recreational facilities, transient nature of workers, and lack of shopping facilities could also affect borrowing behavior.

Income has proved to affect borrowing needs, with the proportion of families who borrow increasing directly with the level of income. In 1971, the percentage of families borrowing money peaked at 60% in the $10-14,999 annual income group, declining somewhat for higher incomes. Because of inflation, the average gasification worker making $20,000 today would have been earning about $15,000 in 1971. This would have placed them in this group assuming much higher income levels inapplicable for such workers. This assumes wage increases similar to the inflation in the prices of services of about 33% since 1971.[10]

It is the view of professional marketing people that escalation into higher income groups since 1971 will not have materially changed borrowing behavior because of the neutralizing impact of price inflation.

Age can also significantly affect borrowing needs, with about 65 per cent of those families whose head is under age 25 borrowing, in comparison to 51 per cent for those between 45-54 years of age. In that most of the workers are expected to be under 45 years of age, a higher borrowing incidence is to be expected. As is shown in the following table, older workers borrow larger amounts of over $2,000, while younger workers' loan needs are varied evenly as an amount between $200 to $2,000.

Marriage increases the probability of borrowing, to as high as 70 per cent for those families with older children. Unmarried persons, expected to compose about 30 per cent of the construction workforce, have a significantly lower borrowing incidence of between 34 to 41 per cent of all such individuals. Only between 5% to 9% of this group would borrow over $1,000.

In summary, a high proportion of gasification families, ranging from 50 to 70 percent, are expected to require installment credit services. Based on income, such workers would fall in the wage group having the highest incidence of installment borrowing needs. A much lower proportion of unmarried construction workers are expected to borrow. Installment loans to families that borrow could average around $1,000. If 50 per cent of the 2,000 permanent families borrow, $1.0 million in installment loan funds will be required. If 70 per cent borrow, $1.4 million would be needed. Construction and related employment of 4,000 jobs during the construction phase would require around twice this amount. Actual per capital borrowing in Western areas indicates that installment loans could run about double to triple these amounts.

TABLE 55

AMOUNT OF INSTALLMENT DEBT OUTSTANDING

(Percentage distribution of families)

	Amount of installment debt							
	Early 1971						Early 1970	
	Any debt	$1-199	$200-499	$500-999	$1,000-1,999	$2,000 or more	Any debt	$2,000 or more
All families	48	9	8	8	10	13	49	13
Annual family income								
Less than $3,000	29	16	7	3	1	2	19	1
$3,000-4,999	39	12	11	5	6	5	31	5
$5,000-7,499	51	12	8	10	13	8	52	9
$7,500-9,999	53	9	9	10	8	17	61	15
$10,000-14,999	60	6	11	8	16	19	65	19
$15,000 or more	46	6	5	9	7	19	49	20
Age of family head								
Under age 25	66	13	10	12	19	12	59	21
25-34	67	8	10	15	15	19	67	22
35-44	62	11	13	9	14	15	63	13
45-54	51	8	8	6	9	20	56	14
55-64	36	11	8	5	4	8	36	7
65-74	18	7	4	3	3	1	14	1
75 or older	8	6	*	*	*	2	6	*
Life cycle stage of family head								
Under age 45								
Unmarried, no children	41	16	3	8	9	5	41	11
Married, no children	66	6	8	9	18	25	63	17
Married, youngest child under age 6	68	10	12	12	17	17	71	21
Married, youngest child age 6 or older	70	8	16	18	14	14	71	22
Age 45 or older								
Married, has children	60	11	12	6	8	23	57	16
Married, no children, head in labor force	34	8	4	5	7	10	43	10
Married, no children, head retired	16	8	6	1	1	*	15	3
Unmarried, no children, head in labor force	34	10	3	7	5	9	29	2
Unmarried, no children, head retired	12	6	2	2	*	2	14	*
Any age								
Unmarried, has children	63	13	18	9	10	13	56	9

Note: The term no children, appearing frequently in this chapter, means no children under age 18 living at home. Unemployed people and housewives age 55 or older are considered retired; unemployed people and housewives under age 55 are considered to be in the labor force.

SOURCE: Institute for Social Research, Surveys of Consumers: 1971-72, pp. 8-9.

Housing Loans

Availability of housing would undoubtedly be one of the major problems posed by rapid coal development, and a source of one of the most substantial financial needs. Unfortunately, the funds needed to finance the development of adequate facilities will be needed at the front end of the project before local banks can grow to large enough levels to handle the expected demand. This, with the long-term nature of housing funds, and the other demands for bank funds, will most likely necessitate that a large portion of this capital be imported from outside the area. Because of the number of jobs, payroll and local retail sales associated with housing construction, housing would itself be a substantial economic stimulus.

Housing can take a number of forms, including single family homes, four-plexes, eight-plexes, apartments, motels, mobile homes, and modular homes. In late 1975, Colstrip living units totaled 362, excluding a large but unknown number of trailers used to house the temporary construction workforce. About 45 per cent of the residences were trailers, and excluding the motel, trailers would have accounted for almost 50 per cent. In comparison, trailers represented 35 per cent of Gillette's 2,000 housing units in 1974, and were then expected to increase to 70 per cent.

TABLE 56

COMPOSITION OF HOUSING - 1975
COLSTRIP, MONTANA

	Number of Units	Number of Household Residences	Percent of Total
Houses	108	108	30
Trailers	166	166	45
4-plex units	11	44	12
8-plex units	3	24	7
Motel	1	20	6
		362	100%

SOURCE: Martin White, Colstrip Project Manager, Western Energy Company, Personal Interview in Colstrip, October 1975.

The work of several North Dakota economists done in September of 1974 provides a fairly current estimate of the financial requirements associated with developing adequate housing. This posed two situations--one assuming the influx of all 2,466 gasification and secondary workers (Situation I), and the other assuming local hiring with immigration of only 413 workers (Situation II). Total capital outlays for the 2,056 new housing units under Situation I, which corresponds to the basic assumption of this paper--that all workers will immigrate into the gasification area--amounted to between $57.0 and $14.6 million, depending on the form of housing. Assuming a housing composition of one-third from each type of unit, the total cost of housing would be $32.3 million, a staggering financial demand upon local financial institutions. The breakdown of this cost would be: housing-$19.0 million; apartments-$8.4 million; and trailers-$4.9 million. Even if the trailers were already owned by immigrating workers, $27.4 million in houses and apartments would still have to be built and financed. Other nearby mining, power plant or gasification projects could increase the demand for housing even more dramatically. Also, even if mobile homes supply 70% of the projected 2,056 units needed, a capital expenditure and financing of $12.3 million in housing and apartments would still be needed, assuming equal division of the remainder. Mobile homes would then require $10.3 million in financing, for a total of $22.6 million. Apparently housing will pose a substantial financing need almost any way it is provided. What is more, the need is almost certain, while various other financial needs may be subject to mitigating factors.

TABLE 57

ESTIMATED COST OF HOUSING FOR A COAL GASIFICATION PLANT

(In 1972 Dollars)

		($ 000's)	
	Unit Cost	Situation I (2,056 Units)	Situation II (344 Units)
Houses	$ 27,751	$ 57,056	$ 9,546
Apartments	12,290	25,268	4,228
Trailers	7,125	14,649	2,451

SOURCE: A. Leholm, F. Leistritz, and T. Hertsgaard, Local Impacts of Energy Resources Development in the Northern Great Plains, p. 77.

Bank Lending Capacity

It is questionable whether or not the existing commercial banks in operation in the coal areas can handle a substantial increase in permanent real estate loans. A review of coal area banks, shown in the following table, showed that home loans already accounted for as much as 45 per cent of all loans, and 23 per cent of deposits in those areas which have recently experienced some of the most rapid growth--namely, Hazen, Forsyth and Rock Springs. Mobile home loans alone represent 20 per cent of aggregate Rock Springs loans, and 27 per cent of one of the banks individually.

The loan to deposit ratios in about half of the seven localities are already near or in excess of 60 per cent. Higher loan levels may not be prudent in view of these banks' vulnerability to seasonal loan demand, employee moves, layoffs, strikes, and other disruption of the bank's deposit levels.

TABLE 58

Positions of Coal Area Banks (Year-End 1974)
($ in thousands)

		Total Home Loans	Total Loans	Total Deposits	Home Loans as % of Loans	Home Loans as % of Deposits	Total Installment Loans	Installment as % of Loans	Installment as % of Deposits	Loans as % of Deposits
Montana										
Forsyth		$3,842	$12,043	$18,108	31.9%	21.2%	1,374	11.4%	7.6%	66.5%
Hardin		1,385	11,704	20,447	11.8	6.8	1,719	14.7	8.4	57.2
North Dakota										
Beulah		1,057	4,264	10,072	24.8	10.5	423	9.9	4.2	42.3
Hazen		2,300	5,631	12,462	40.8	18.5	812	14.4	6.5	45.2
Wyoming										
Rock Springs	1		10,977	19,038						
	2		8,835	23,494						
	3		22,325	38,069						
		$18,868	$42,137	$80,601	44.8	23.4	8,115	19.2	10.1	52.3
Gillette	1		7,291	15,770						
	2		33,238	52,957						
	3		777	1,607						
		5,486	$41,306	$70,334	13.3	7.8	7,293	17.6	10.4	58.7
Sheridan	1		23,373	39,954						
	2		1,527	2,865						
	3		18,049	25,187						
	4		299	418						
Totals		6,212	$43,248	68,424	14.4	9.0	9,621	22.2	14.1	63.2
Averages					26.0%	13.9%		15.6%	8.7%	55.0%

Source: Census of Population, 1970, and FDIC Magnetic Tapes of Bank Call Reports as of December 31, 1974.

Individual Deposits

The 4,000 construction-related workers and permanent gasification and secondary workforce of 2,000 will require financial services enabling the payment and storing of funds or financial assets. At a remote gasification site, the most likely source of these services would be the checking and savings accounts available through the commercial bank, savings bank, or perhaps credit union located in the gasification area. A number of workers may obtain these services by continuing the banking relationships in their home town or wherever their families reside while they work at the gasification project.

Individual checking, savings and time deposits will be of critical importance to the gasification economy, representing almost the only local source of personal loan and housing funds. The careful cash control normally exercised by large companies, the small number of these companies, and the few business at the outset would indicate that commercial deposits would not be a large funds source.

Financial Assets

The financial assets of families include checking and savings accounts, certificates of deposit, stocks, bonds and mutual funds. These vary considerably as to kind, amount and as to the proportion of families holding such assets. Providing, transferring, storing and safekeeping these assets gives rise to local financial needs.

As is shown in Table 59, the most demanded financial services, checking and savings accounts, were held by between 66-74 per cent of the families in 1971. These proportions for checking have been increasing, and professional marketing personnel indicate that 80 per cent of the families now have checking accounts. Around 8 per cent of the families have over one account.[11] The absence of alternative savings sources such as stocks, bonds and credit unions, could increase these proportions even more. In fact, the remoteness of gas plant sites and unsophisticated financial capabilities of most gasification and related workers indicate that most financial assets could be held in the form of bank deposits.

TABLE 59

PROPORTION OF FAMILIES HOLDING SELECTED FINANCIAL ASSETS, IN PER CENT

	Early in						
	1951	1960	1963	1968	1969	1970	1971
Savings accounts	47	55	56	64	62	65	66
Certificates of deposit	a	a	a	4.5	4.9	7.7	13.0
Checking accounts	44	60	62	71	72	75	74
Bonds[b]	43	32	26	26	26	28	28
Stocks[c]	9	17	20	23	25	26	27
Number of family units (in millions)	46.3	53.5	36.2	61.2	62.5	64.0	65.1

[a]Not available.

[b]In 1968, and in years before 1968, only government savings bonds. The ownership of other bonds was so uncommon in earlier years that these data are reasonably comparable to those for later years. In 1971, 4 per cent of families owned nongovernment bonds.

[c]Includes mutual funds.

SOURCE: Institute for Social Research, Surveys of Consumers: 1971-72, p. 61.

Assuming that 66 per cent of the workers will need a savings account, that 80 per cent of them will need checking accounts, and that about multiple accounts per family will add another 10 per cent to the number of checking accounts needed, an estimate of the numbers of these accounts can be made. On these assumptions, the 2,000 permanent workers will need about 1,300 savings accounts and about 1,750 checking accounts. The 3,000 construction workers and 1,000 related secondary workers would need twice these amounts, or 2,600 savings accounts and 3,500 checking accounts.

Age and income can have a significant effect on the level of financial assets, with higher incomes and older persons having a larger value of financial assets. The following table shows the relationship between income and assets in 1971.

TABLE 60

OWNERSHIP OF FINANCIAL ASSETS[a] BY INCOME AND AGE - EARLY 1971

(Percentage distribution of families)

	Value of Financial Assets								
	None	$1 -499	$500 -999	$1,000 -4,999	$5,000 -9,999	$10,000 -14,999	$15,000 -24,999	$25,000 or more	Total
All families[b]	19	22	10	23	9	5	5	7	100
Total family income									
Less than $3,000	48	19	6	19	4	2	1	1	100
$3,000-4,999	34	27	8	12	6	6	6	1	100
$5,000-7,499	24	27	6	21	9	3	5	5	100
$7,500-9,999	18	32	10	22	6	2	4	6	100
$10,000-14,999	5	23	16	33	11	7	2	3	100
$15,000-19,999	4	11	16	31	20	3	9	6	100
$20,000-24,999	3	3	10	27	12	8	19	18	100
$25,000 or more	*	*	2	9	15	13	7	54	100
Age of family head									
Under age 25	20	43	15	20	2	*	*	*	100
25-34	18	35	11	25	7	2	2	*	100
35-44	16	24	11	31	8	3	3	4	100
45-54	14	19	12	21	10	8	7	9	100
55-64	25	9	9	16	16	3	7	15	100
65-74	19	12	4	25	12	11	10	7	100
75 and over	27	4	7	16	12	6	13	15	100

*Less than 0.5 percent.

[a]Financial assets include checking accounts, savings accounts, certificates of deposit, stocks, bonds and mutual funds.

[b]A substantial proportion of families unable to give the amount of financial assets has been omitted. This explains the discrepancy between Tables 5-7 and 5-2.

SOURCE: Institute for Social Research, Surveys of Consumers: 1971-72, p. 67

Adjusting for inflation, gasification workers would have earned about $15,000 per year in 1971. The income categories bordering this earnings level show only 4-5 per cent of the families with no assets, about one-third of the families with assets of less than $1,000, one-third with assets between $1,000-$4,999, and one-third with assets over $5,000.

The relationship between age and asset holdings is also shown in this table. In that most construction and gasification workers are expected to be young (under 45 years of age), it is important to note that only between 2-11 per cent of the families whose head is under 35 years of age had assets valued at over $5,000. Only in higher age groups does the level of financial assets increase much over $5,000.

Demand for Checking Accounts

The incidence and dollar amount of checking accounts can be expected to vary with income, age and marital status. Table 61 shows the relationship between these factors and accounts. This shows that of families with 1968 incomes of $10-14,999, typical for gasification workers taking inflation into account, 94 per cent would have checking accounts. About 40 per cent of these would maintain a balance of between $200-1,000. Only a minor 14 per cent would have a balance in excess of $1,000. Somewhat lower proportions of young families would be expected to have checking accounts,

TABLE 61

AMOUNTS HELD IN CHECKING ACCOUNTS - EARLY 1968
(Percentage distribution of families)

	None and N.A.[a]	$1 -99	$100 -199	$200 -499	$500 -999	$1,000 -1,999	$2,000 -4,999	$5,000 -9,999	$10,000 or more	Total
All families	32	15	11	19	11	6	4	1	1	100
Total family income										
Less than $3,000	59	8	8'	11	8	3	3	*	*	100
$3,000-4,999	46	17	7	10	10	6	3	1	*	100
$5,000-7,499	35	20	12	18	7	4	3	1	*	100
$7,500-9,999	23	18	14	26	10	6	3	*	*	100
$10,000-14,999	16	16	15	26	14	7	4	1	1	100
$15,000 or more	5	8	8	24	22	12	11	7	3	100
Age of family head										
Under age 25	27	35	18	14	5	*	1	*	*	100
25-34	27	27	14	20	7	2	3	*	*	100
35-44	29	17	11	24	10	5	3	1	*	100
45-54	31	10	12	21	15	7	3	1	*	100
55-64	34	7	7	18	13	10	7	3	1	100
65-74	40	8	7	17	11	10	6	*	1	100
Age 75 or older	38	5	9	15	18	5	5	3	2	100
Education of family head										
0-5 grades	78	6	3	5	4	2	1	*	1	100
6-8 grades	43	11	7	16	12	6	3	1	1	100
9-11 grades	38	15	14	15	8	7	3	*	*	100
12 grades	27	20	11	20	13	5	4	*	*	100
High school plus noncollege	20	18	15	27	11	3	5	1	*	100
College, no degree	13	21	16	26	13	4	4	2	1	100
College, bachelor's degree	4	16	13	26	18	11	8	3	1	100
College, advanced degree	9	11	9	26	18	14	10	1	2	100
Life cycle stage of family head										
Under age 45										
Unmarried, no children	29	25	15	20	8	2	1	*	*	100
Married, no children	20	21	14	29	7	5	3	1	*	100
Married, youngest child under age 6	29	26	14	18	8	2	2	1	*	100
Married, youngest child age 6 or older	22	19	13	26	11	5	4	*	*	100
Age 45 or older										
Married, has children	32	12	11	21	13	4	5	2	*	100
Married, no children, head in labor force	23	6	11	22	17	10	6	4	1	100
Married, no children, head retired	32	6	5	15	18	15	5	2	2	100
Unmarried, no children, head in labor force	40	14	9	15	10	7	3	1	1	100
Unmarried, no children, head retired	52	4	8	14	10	5	7	*	*	100
Any age										
Unmarried, has children	48	23	9	10	5	2	2	*	1	100

*Less than 0.5 percent.
[a]The data in this column are somewhat higher than in Table 6-5 because information given in broad brackets is considered as not ascertained here while it was allocated in Table 6-5.

SOURCE: Institute for Social Research, Survey of Consumer Finances: 1968, pp. 116-17.

and the balances would normally fall under $500. In addition, fewer unmarrieds would have checking accounts.

Overall, the earlier estimate that 80 per cent of the workers would have an account is probably a reasonable approximation of the demand for payments services.

Assuming that this would generate the need for 1,750 permanent checking accounts and 3,500 construction-related accounts, checking accounts would represent a meaningful source of funds. According to marketing professionals, retail checking accounts maintain average balances of $900. Offsetting the generally lower balances maintained by young workers, with the higher balances of high income workers, it would seem realistic to expect about the same level of account balance among gasification workers. Permanent workers would therefore represent a $1.6 million source of funds, and construction-related workers a $3.2 million source, though perhaps temporary in nature.

Demand for Savings Accounts

The incidence and balance held in savings accounts also varies with income, age and marital status. The financial sophistication of the gasification-related depositor and availability of higher rate investments such as savings and loan association deposits in nearby trade centers, could also affect savings behavior.

The following table shows the relationship between savings and income level.

TABLE 62

SAVINGS ACCOUNTS[a] BY INCOME, AGE, EDUCATION AND LIFE CYCLE - EARLY 1971
(Percentage distribution of families)

	Savings Accounts					
	None	$1 -499	$500 -1,999	$2,000 -4,999	$5,000 or more	Total
All families	38	15	18	11	18	100
Total family income						
Less than $3,000	68	5	9	12	6	100
$3,000-4,999	54	11	14	4	17	100
$5,000-7,499	46	15	14	9	16	100
$7,500-9,999	43	17	18	9	13	100
$10,000-14,999	26	21	27	12	14	100
$15,000-19,999	13	19	29	15	24	100
$20,000-24,999	15	14	17	18	36	100
$25,000 or more	10	2	6	23	59	100
Age of family head						
Under age 25	44	30	20	5	1	100
25-34	44	19	20	11	6	100
35-44	38	19	26	10	7	100
45-54	35	16	14	12	23	100
55-64	34	7	14	14	31	100
65-74	35	2	14	15	34	100
75 or older	36	*	12	10	42	100
Life cycle stage of family head						
Under age 45						
Unmarried, no children	38	29	16	7	10	100
Married, no children	27	19	32	15	7	100
Married, youngest child under age 6	43	22	22	9	4	100
Married, youngest child age 6 or older	40	22	24	8	6	100
Age 45 or older						
Married, has children	35	17	19	11	18	100
Married, no children, head in labor force	23	9	10	17	41	100
Married, no children, head retired	34	1	15	11	39	100
Unmarried, no children, head in labor force	39	8	26	13	14	100
Unmarried, no children, head retired	45	2	7	15	31	100
Any age						
Unmarried, has children	69	9	9	6	7	100

[a]Including certificates of deposit.
*Less than 0.5 percent.

SOURCE: Institute for Social Research, Surveys of Consumers: 1971-72, p. 64.

Based on comparative gasification worker income of about $15,000 in 1971 dollars, around 74-87 per cent of the workers would have savings accounts. Between 26-39 per cent of these would maintain a balance over $2,000. Based on age, only about half of the younger workers would have accounts and only 7-17 per cent of these would run over $2,000. Again offsetting the lower account frequency of young workers with the high frequencies of high income workers, an average incidence of 66 per cent of the families would seem representative.

Research performed on the Metro Minneapolis-St. Paul area in 1970 indicated that potential time deposits averaged about $2,000 per family.[12] At this level, savings of permanent workers could amount to $4.0 million, and of construction-related workers to $8.0 million.

In aggregate, checking and savings could total $11.2 million during the construction phase, and about half this amount when the plants begin operating. Even though temporary, the availability of construction-related deposits could be an important source of funds in the early years of town development.

Certificates of Deposit

Based on research done in 1971, about 10 per cent of the workers with incomes typical of gasification employees could be expected to invest in certificates.[13] The proportion of such investments increases with the age of the family head. It is probable that the proportion of families investing in certificates may have increased considerably since 1971, as periods of high interest rates have made depositors more interest rate sensitive.

Western Deposit Levels

A review was made of the actual per capital deposit levels in Western areas. The results of this analysis are summarized in Table 63. These show that demand deposits, including commercial accounts, could average about $1,000 per capita. For the permanent workforce population of 6,000, demand deposits would therefore total $6 million, several times the $1.6 million of individual deposits estimated earlier. Combined savings accounts and other time deposits averaged about $2,000 per capita. This would indicate total savings deposits of $12.0 million, again about three times the $4.0 million estimated earlier on the basis of the surveys.

It is expected that combined demand and savings deposits will fall somewhere between the $5.6 based on the surveys, and $18.0 million based on the actual Western averages.

TABLE 63

SUMMARY OF PER CAPITA[a] WESTERN DEPOSITS

State	Total Deposits			Demand IPC ($99,999 or Less)			Savings ($99,999 or Less)		
	High	Low	Avg.	High	Low	Avg.	High	Low	Avg.
Montana:									
Coal counties	$3,220	2,797	3,003	959	658	757	445	360	403
Other counties	$5,496	1,465	3,470	1,944	387	1,095	920	107	544
			$3,345			$1,005			$506
North Dakota:									
Coal counties	$6,560	1,049	3,505	1,839	358	1,130	934	113	455
Other counties	$5,642	2,140	3,712	1,768	826	1,144	635	117	415
			$3,629			$1,138			$431
Wyoming:									
Coal counties	$5,004	3,181	4,275	1,328	987	1,169	1,713	507	875
Other counties	$5,012	4,094	4,344	1,257	1,074	1,160	1,154	707	915
			$4,302			$1,165			$890

[a]Based on deposits as of June 30, 1974, and population in 1970.

SOURCE: Federal Deposit Insurance Corporation, Summary of Accounts and Deposits in All Commercial and Mutual Savings Banks, June 29, 1974.

TABLE 63

SUMMARY OF PER CAPITA[a] WESTERN DEPOSITS

State	Other Time IPC			State & Pol. Subdivisions		
	High	Low	Avg.	High	Low	Avg.
Montana:						
Coal counties	$ 2,085	1,052	1,419	871	242	579
Other counties	$ 1,911	1,343	1,619	670	280	452
			$ 1,499			$ 528
North Dakota:						
Coal counties	$2,924	323	1,558	714	207	347
Other counties	$2,830	775	1,800	290	739	228
			$ 1,704			$ 275
Wyoming:						
Coal counties	$1,882	1,328	1,445	423	127	270
Other counties	$2,018	433	1,252	512	261	337
			$ 1,303			$ 319

[a]Based on deposits as of June 30, 1974, and population in 1970.

SOURCE: Ibid.

Pike County, Kentucky has been heavily affected by the recent boom in coal mining, and was also surveyed for an indication of what could be expected in the West. In this county, per capita demand deposits averaged $700 and combined savings and other time deposits averaged $1,973. These amounts also approximate the average account balances of $1,000 and $2,000 experienced in the West.

TABLE 64

PIKE COUNTY, KENTUCKY
COMMERCIAL BANK DEPOSITS PER CAPITA

(Three banks, fourteen offices)

	As of 6/29/74	
	$000	$ Per Capita[a]
Deposits $99,999 or Less		
Demand IPC	$ 42,719	$ 700
Savings	53,306	873
	96,025	1,573
Deposits Over $99,999		
Demand	42,544	697
Savings	2,310	36
	44,854	733
Other Time IPC	64,988	1,064
State & Pol. Subdivision	5,894	96
Total Deposits	$ 215,723	$ 3,533

[a]Based on 1970 population of 61,059.

SOURCE: Ibid.

Other Retail Services

Commercial banks provide a wide range of special services in addition to loans and depository accounts. Each of these satisfies a personal financial need. While it is difficult to quantify the demand for these services, the fact that they are being used and paid for confirms their need. In 1974, the customers of the 13 banks located in Forsyth, Harden, Beulah, Hazen, Rock Springs, Gillette and Sheridan paid a total of $720,000 in other fees, charges, and other income.[14] Those services which could be expected to be of greatest need would be cashiers and certified checks, safe deposit, life and casualty insurance, tax return preparation, and money orders.

Financial Needs of Business

A coal gasification plant and mine, and related workforce, will have substantial needs for products, supplies and services. Initially it is expected that businesses in nearby trade centers will satisfy these requirements. Eventually a local business infrastructure should develop. However, this will take time, as has proved the case in Colstrip. This town, with a population of over 3,000 persons, still has virtually no commercial enterprise.

Gasification should stimulate both an increase in the sales of existing companies, both directly and indirectly, and provide an attraction for new enterprises. Glendive, Montana, and Hibbing, Minnesota, examples of resource boom towns, have experienced a meaningful influx of new business establishments. It is primarily commercial development which will produce the estimated 1,000 secondary employment opportunities associated with the construction and operation of a gasification facility.

Primary economic stimulus and business attractions in a gasification based economy would include:

1. construction expenditures and payroll for gas plant, mine and pipelines ($300 million total, including payroll of $95 million);

2. construction expenditures for new housing ($32.3 million, assuming one-third of housing comes from each of three sources: single family houses, trailers, and apartments-1972 dollars);

3. construction expenditures for new business structures ($6.1 million-1972 dollars);

4. municipal expenditures for new public facilities ($13.7 million-1972 dollars);

5. gasification operating expenditures for products, supplies and services ($ 8.1 million per year-1972 dollars);

6. gasification payroll ($11.7 million per year-1972 dollars).

Funding the development of the business infrastructure is expected to pose a substantial financial need, and one of the more difficult financing problems. Business is expected to have other financial needs of a non-credit nature.

Retail Sales

During the operating phase, local gasification retail purchases and payroll will affect a wide range of economic sectors. North Dakota economists have used an input/output model to estimate the gross business volume of individual kinds of business from gasification. Their work, done in 1972 dollars, assumed that annual payroll and purchases would total $19.8 million, and result in gross receipts of $53.0 million.[15] This implies a multipler of 2.7 times, which corresponds to earlier work done by another group of North Dakota economists in 1973.[16] A somewhat lower multiplier, ranging between 1.5 to 2.5, is expected for construction-related payroll and other expenditures. On the average, North Dakota contractors spend about $51 in the local economy for each $100 of gross receipts.[17]

The sales by individual sectors will create jobs and the need for capital, working capital, real estate, and other kinds of business financing. An estimate of sales and jobs by sector is provided as Table 65. Sales of over $1 million annually are projected for agriculture, livestock (1); construction (4); communications and utilities (6); retail (8); fire, insurance and real estate (9); and professional services (11).

TABLE 65

PROJECTED GROSS RECEIPTS AND EMPLOYMENT RESULTING FROM OPERATION OF A GASIFICATION FACILITY

Economic Sector	Gross Receipts 1972 Dollars In Millions	Secondary Employment
1. Agriculture, livestock	$ 1.58	68
2. Agriculture, crops	.57	26
3. Mining	.09	1
4. Construction	1.32	69
5. Transportation	.19	35
6. Communications & utilities	1.66	82
7. Wholesale & ag production	.87	35
8. Retail	19.02	452
9. Fire, insurance & real estate	2.44	62
10. Business & personnel services	.87	62
11. Professional & social services	1.37	183
12. Households	21.45	
13. Government	1.58	466

SOURCE: A. Leholm, F. Leistritz, T. Hertsgaard, Local Impacts of Energy Resources Development, p. 71.

Of the 13 economic sectors, the local financial needs of the construction industry, wholesale and retail operations, and perhaps transportation services, would have the greatest need for local financing. It should be noted that certain of the preceding economic sectors, specifically (1), (2) and a portion of (3), would be located outside the immediate area, reducing local business volumes and employment generated within the gasification community.

The preceding analysis dealt only with the operating phase of a gasification facility, after the plant and supporting infrastructure had been built. As such, it excludes the impact of housing, business structure and public facilities construction, estimated by North Dakota economists at $52.1 million, and having an additional gross business volume impact of around $117 million. This is substantially more than the $53 million estimated in gross business volume from gas plant operation.

TABLE 66

ESTIMATED GROSS BUSINESS IMPACT OF INFRASTRUCTURE CONSTRUCTION (1972 DOLLARS)

	Cost (In Millions)	Multiplier	Gross Business Volume (In Millions)
Housing	$ 32.3	2.31	$ 74.7
Business Sector	6.1	1.70	10.4
Public facilities	13.7	2.31	31.6
Total	$ 52.1		$ 116.7

SOURCE: A. Leholm, F. Leistritz, T. Hertsgaard, Local Impacts of Energy Resources Development, pp. 82, 87, 91.

The construction of the gas plant itself would have the greatest local economic impact of all, estimated at five times the infrastructure construction cost of $52.1 million and over ten times the annual sales and salaries of $19.8 million.

Another group of North Dakota economists estimated the aggregate gross business receipts from construction of a $254 million gas plant (1972 dollars) at between $237 to $395 million. This indicates multipliers of between 1.5 to 2.5 times the direct impact. However, since that time costs have doubled, causing an impact ranging between about $470 to $790 million. [18]

Putting this in perspective, the Market Guide estimates total retail sales in Billings of only $305 million, in Burleigh County (location of Bismarck) of $116 million, and of Campbell County (location of Gillette) of $41 million. [19]

Real Estate Financing

As was just reviewed, new business structures are estimated to cost $6.1 million. This estimate is based on research done by North Dakota State University which indicates that the investment in business structures is about 22 cents per dollar of gross business volume, here assumed to be $27.7 million. [20] Such buildings could include banks, motels, hotels, and other business facilities perhaps contained in a single shopping center. This selection is representative of what is being developed in Colstrip, Montana.

Financing commercial real estate will pose one of the more difficult funding problems accompanying the development of the infrastructure. Institutional lenders, the traditional source of long-term real estate loans, have displayed an aversion to small, company-dominated, single-industry towns. Generally these lenders rely on the property collateral value and its lease agreements as the primary basis for determining creditworthiness. In view of the uncertainty facing gasification, and accompanying high degree of risk, lenders may require long-term leases with substantial chain store operations which match the loan terms, may require the owner to be of substantial financial condition, or may require that the gasification company guarantee occupancy and related payments. The last alternative is already being practiced in Northern Minnesota.[21]

The development of commercial properties generally involves commercial banks, often in conjunction with mortgage banking firms, in what is called "interim construction lending". It is expected that this practice would be utilized on gasification-related commercial structures. It represents a unique and specialized form of credit extension, and a special local financial need accompanying gasification.

<u>Other Commercial Services</u>

Business uses numerous different kinds of financial services, including those of commercial banks, leasing companies, commercial finance companies, mortgage bankers, SBIC's, and various other firms.

Long-term financing for business real estate and interim construction financing have already been noted as areas in which a high level of demand could be expected. Other kinds of significant financial needs are expected to exist in the areas of (1) insured and uninsured loans on four-plex residential properties and multi-family residential properties, (2) floor-plan financing (mobile homes), and (3) all forms of loans to expanding, capital-short business. Included among the last item would be leasing, capital, working capital, equipment, inventory, and accounts receivable loans.

With potential construction expenditures in the local area aggregating over $350 million, the most frequent and substantial source of financial need is expected to be the local construction industry. The unique needs of this customer group, including "interim-construction lending" and equipment financing, could well dominate the finance business. If these needs are not satisfied, they could pose an important obstacle to Western energy development.

Companies Involved in Gasification Development

It would be helpful in further refining the nature and level of demand for financial services to know the kinds of companies which will participate in development. These could be segregated into three groups, including support companies, indirect participants, and new businesses.

Support Companies

These would be the businesses which are expected to provide products, supplies and services directly to the mines, power plants, gas plants, or major contractors. Personal interviews were made in October of 1975 with a Montana mining company and power plant and mining company, and with a Minnesota power company, to determine types of support mines and power plants. A listing of these is included as Table 67. The business volumes and financial needs of these companies could also be directly effected by gasification.

Indirect Participants

These would be businesses which would be indirectly involved because of their involvement with support companies. Examples would be nearby wholesalers of products consumed in the gasification economy. Initially these might consist mainly of food, lumber, building materials and appliance suppliers.

TABLE 67

COMPANIES IMPACTED BY COAL DEVELOPMENT

I. Companies Supplying Mining Companies

1. auto dealers
2. tires, repair and replacement
3. heavy equipment dealers
4. petroleum products (bulk)
5. office supplies, equipment and furniture
6. consultants: geological, engineering and auditing
7. legal services
8. warehouse buildings
9. machine shops
10. drilling operators
11. laboratories, soil, water and coal analyses
12. meal catering, food stores
13. office space
14. explosives
15. batch concrete
16. structural steel
17. steel fabrication
18. telephones
19. freight services
20. bank

II. Companies Supplying Electric Paper Plant

1. construction material warehouses
2. office supplies, equipment and furniture
3. batch concrete
4. structural steel
5. precast concrete
6. hoists, cranes
7. foundation pilings
8. paint and painting
9. partitions and ceilings
10. plumbing
11. roofs
12. soil investigations
13. steel fabrication
14. steel erection
15. aerial mapping
16. architects
17. drilling and exploration
18. explosives
19. flooring
20. appliances
21. equipment

22. telephones
23. freight services
24. auto dealers
25. food stores
26. bank
27. sand and gravel
28. consultants: foundations, meteorology, ecological
29. petroleum products (bulk)
30. legal services
31. machine shops
32. janitorial supplies
33. hardware and tools
34. welding supplies and equipment, safety glasses and hardhats
35. lodging
36. oxygen and acetylene
37. boiler chemicals
38. sand and gravel

III. Other Impacted Companies

1. contractors:
   - a. roads
   - b. dams, bridges
   - c. housing
   - d. metal buildings
   - e. electrical
   - f. general
   - g. roofs
   - h. cement
   - i. equipment erection
   - j. earthmoving
   - k. painting
   - l. asbestos
   - m. mechanical
   - n. sheet metal
   - o. pile drivers
   - p. masonry
2. landscape gardening
3. mobile and modular home dealers
4. wholesale grocery

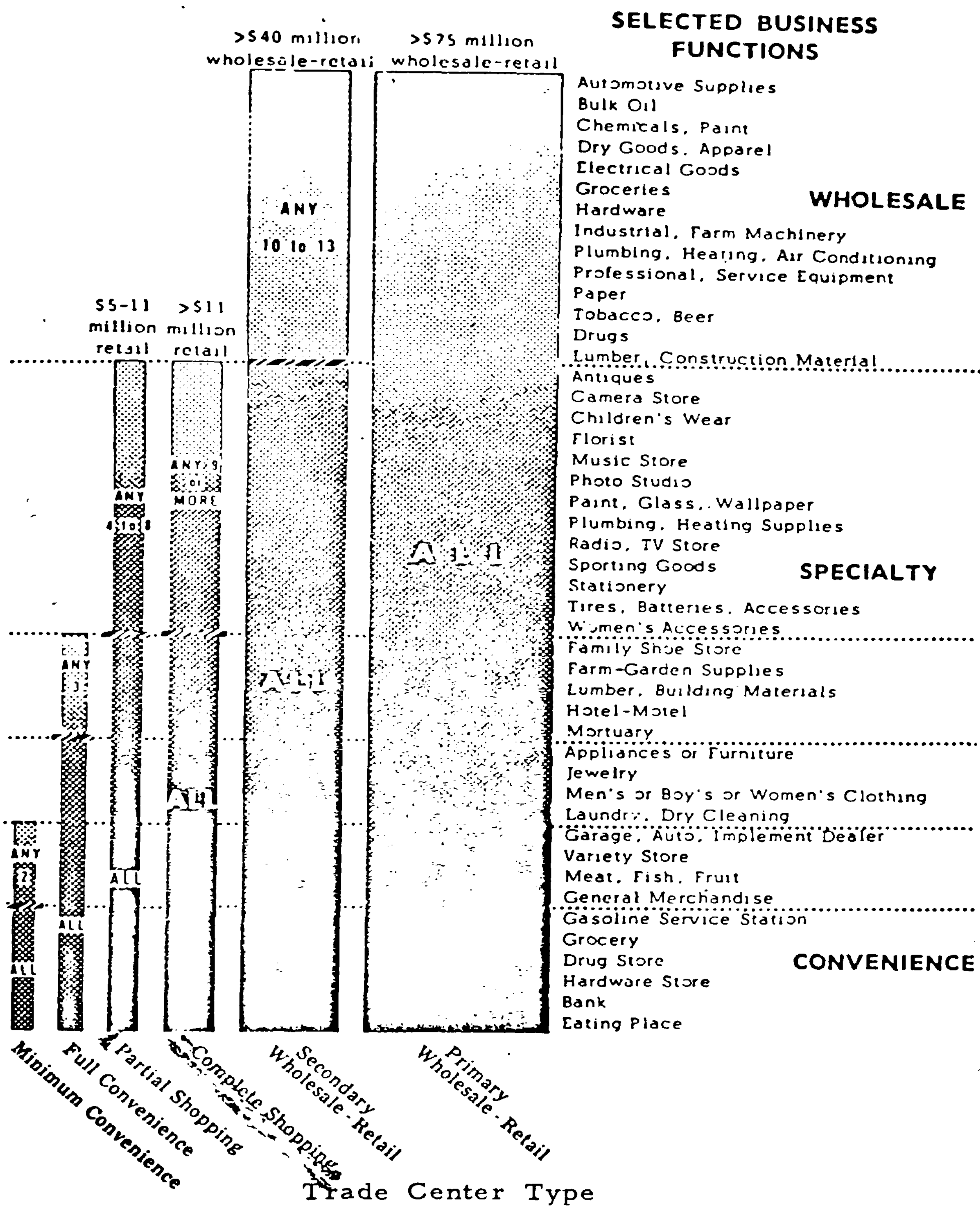
New Business

As the local population and personal income grow, new types of businesses and additional businesses can be expected to be established. For example, a bank was recently opened in Colstrip, and a laundromat, drugstore, hardware store, theater, grocery store, and Dairy Queen are expected to follow in 1976.

Trade center types, and the business functions that each includes, give an idea of the possible kinds of business that will be formed as the gas town expands. A breakdown of the business included in each type of trade center is included in the following table.

TABLE 68

TRADE CENTER TYPES DEFINED BY BUSINESS FUNCTIONS



SOURCE: Borchert and Adams, Trade Centers and Trade Areas of The Upper Midwest, Urban Report No. 3, Upper Midwest Economic Study, University of Minnesota, 1963, p.4.

It is interesting to note that the businesses proposed for Colstrip closely correspond to the basic "convenience" businesses of the "minimum convenience" trade center type. It is reasonable to expect that the future firms to locate in Colstrip, or any gas town would be those next highest on this list. How far this development would go poses an interesting question. In response, it was noted earlier that gas town population would be about 6,000, and have retail sales of about $19.0 million per year. On the basis of population, a gas town would qualify as somewhere between a "minimum convenience center" and a "full convenience center".[22] Based on retail sales, a gas town would qualify as a "complete shopping area".

As is apparent from the trade center table, there is a significant number and variety of new business and associated financing needs between "complete shopping area" status and rolling pasture.[23]

Examples of Montana towns classified as complete shopping centers and having population in 1970 approximating a gas town include: Glendive (6,300 population); Lewistown (6,400); Livingston (6,800); Sidney (4,500). In North Dakota, examples would be: Devil's Lake (7,100); Grafton (5,900); and Valley City (7,800).

DEMAND FOR TRUST SERVICES

By generating a substantial increase in the wealth of the region, gasification is expected to generate a substantial increase in demand for trust services. Land sales for gasification, mining, housing, commercial and municipal development, is expected to make a number of the current residents rich. The bonuses and royalty payments under land leases could have the same impact. In the rapidly expanding economy, escalating land values could substantially inflate the value of various residents' estates. The transition from "rags to riches" of a local rancher, farmer, Indian, or other resident, may be difficult and may require the specialized counseling, investment management and other services normally available from trust companies and the trust departments of commercial banks.

Indians or Indian associations are expected to have particular need for such services in view of their lack of financial sophistication, and of the tremendous amount of coal resources they control. At a conference the author attended, a representative of one of the southeastern Montana tribes stated that the Crow and Cheyenne Indians of Montana control in the aggregate 26 billion tons of coal. If only 10 per cent of this, or 260 million tons, was mineable, this would represent a financial asset of $130 million based on Indian royalties of 50 cents per ton. One of the kinds of services expected to be needed by the Indian associations, and available through trust companies and departments, is investment management. Under these arrangements, often subscribed to by institutional funds of colleges and hospitals, the trust company is established as an agent for the customer, with investment supervision over the funds involved. Such arrangements are easy to start and terminate, and enable the customer to retain as much control over the investment decisions as they like.

An alternative to the agency account with investment supervision is the revokable living trust. This arrangement imposes greater discipline over distributions from the funds, and can be established for long periods of time. In the case of individuals, such as ranchers and Indians, this arrangement avoids probate and therefore saves the customer executor fees, attorneys fees, and time. A revokable living trust could also be applied to those situations where the customer's property is leased, with royalty income accruing over a long period of time. In this case, the royalty payments could be made directly into the trust, and investment decisions and distributions thereafter controlled by the trustee.

The development and operation of a gasification complex will require the importation of a number of highly paid executives, and provide business opportunities which could be expected to increase the wealth of local entrepreneurs. These individuals, having greater financial sophistication and substantial assets, are likely to require a full range of trust services. A listing of the kinds of trust services they might require is included as Appendix 14. Briefly, these include estate and financial planning, trust, investment management, and executor responsibilities.

The gas plant and mining workers should have trusts for life insurance and other corporate benefits available. This service enables the rapid and inexpensive investment of union and corporate benefits, provides any beneficiaries with on-going income, or serves to expedite the availability of funds in case of death.

In developing trust business, the specialized personnel of trust companies and departments provide a vitally important estate and financial planning service. The availability of this, and the other services of trust operations, in a gas town would definitely be desirable.

Financial Needs of Banks

While themselves the primary source of financial services in coal development areas, the local banks are also projected to have substantial needs for financial services. In the past, banks have relied on their correspondent banking relationships with other, perhaps larger banks.

Correspondents have normally been a major source of financing for equity investments by bank owners. The substantial economic growth generated by a gas plant may justify the formation of new banks, requiring substantial equity investments. The rapid economic growth may also cause bank deposits and loan growth to outstrip its ability to generate adequate equity capital through internal retention. Maximum internal equity growth is limited to a bank's return on equity, normally between 10-15 per cent per year (assuming no dividend payments). Deposit growth in excess of this ratio will therefore create a need for new equity capital amounting to $1 for every $12 of additional deposits. Typically, the bank investor can borrow between 75-80 per cent of the equity investment from one of his correspondent banks.

The correspondent banks could also be of important assistance in participating in loans, or purchasing loans made by the coal-area bank. It is expected that loan demand in gas plant localities will be greatly in excess of locally available capital. Through his correspondents, the local banker can import the badly needed capital to finance the development of the local business, residential and governmental infrastructure needed to support a gas plant. Generally, correspondents are interested mainly in working capital-type loans rather than term or mortgage loans. By assuming some of the local banks' loans, however, additional funds are made available locally for allocation at the discretion of the local banker.

A listing of the financial needs of local banks is included in Appendix 14, under Correspondent Bank Services.

It is expected that the local banks will eventually grow to a size where they can take care of their own needs. This has nearly happened in Alaska in the opinion of various correspondent banks.[24]

Financial Needs of Local Government

While an indepth analysis of the financial needs of local government is not within the scope of this paper, it is important that these needs be recognized. The developmental and operating expenditures of local government will have a significant impact on local economies, and on local banks. Local governments will be important sources of deposit funds, as well as users of funds and of banking services. See Appendix 14 for a listing of banking services used by local government.

It has been estimated that the development of a new town to support a large coal conversion plant will cost about $4,500 per person, or about $15,000 for the average family.[25] Therefore, the creation of a new town in support of a gas plant assuming a population influx of 6,000 persons could require a capital expenditure of $27 million. In those areas where facilities with excess capacity already exist, less than this would be required. Several North Dakota economists have performed a detailed regional analysis of municipal capital expenditures, taking into account excess capacity and other local factors. Their work estimates that capital expenditures will range between $13.6 million and $3.1 million, depending on the level of population growth. This estimate corresponds to that provided by another leading authority on the municipal impact of coal development, as well as the estimates of the State of Wyoming.[26] Under the concentrated settlement situation resulting in expenditures of $13.6 million, the average per capita expenditure was about $2,000. This is about half of the federal projection.

According to these economists, expenditures for new schools could amount to about $2,000 per pupil. Under the alternative situations described earlier, this could amount in construction expenditures of between $4.2 million (Situation I), and $1.5 million (Situation II).

The construction of new roads or resurfacing of existing roads was projected to range between $4.3 (Situation I) and $1.2 million (Situation II). The average cost to construct a mile of new road was estimated at $200,566.

Development of a new water system was estimated to cost $172 per capital, or between $1.1 million (Situation I) and $185,000 (Situation II). A new water treatment plant included in

Situation I would cost about $2.4 million.

A new sewage system could cost between $1.6 (Situation I) and $146,000 (Situation II), with a treatment plant included in situation I at a cost of $800,000.

Coal development could also necessitate the construction of larger governmental offices, jails and other buildings to house the police, fire and administrative activities. However, the North Dakota analysis did not include these impacts because of the excess capacity of existing facilities.

TABLE 69

MUNICIPAL CAPITAL EXPENDITURES

	1972 Prices	
	Situation I Concentrated Settlement	Situation II Dispersed Settlement
Schools	$ 4.2	$ 1.6
Roads & streets	4.3	1.2
Water system	3.5	.2
Sewage system	1.6	.1
Total	$ 13.6	$ 3.1

SOURCE: Leholm, Leistritz, Hertsgaard, Local Impacts of Energy Resources Development, pp. 103-14.

Normally, capital expenditures for public facilities are financed through the issuance of various tax-exempt obligations of the municipality or other politcal sub-divisions. It is expected that such obligations from coal areas could be marketed to banks and other financial institutions located throughout the West and Midwest. On occasions, local and nearby banks may have to assist in funding these outlays through bond purchases. Investments in long-term tax-exempt bonds could reduce a bank's ability to satisfy the term lending needs of its local commercial and retail customers.

The balance sheets of banks in coal areas provide an indication of the possible level of tax-exempt bonds and of the offsetting public deposits available from local government. The following table shows that public deposits do not always offset tax-exempt investments. Tax-exempt investments range between 3.4 per cent to 20.2 per cent of assets in this group.

TABLE 70

LOCAL GOVERNMENTAL IMPACT ON WESTERN BANKS

	As of Dec. 31, 1974			
	State and Local Tax-Exempt Bonds		Deposits of State and Pol. Subsidiaries	
	Dollars (000)	% Assets	Dollars (000)	% Assets
Rock Springs, Wyoming				
First Security	$ 2,221	10.2%	$ 2,798	12.9%
North Side	864	3.4	1,116	4.4
Rock Springs	2,069	5.0	2,871	6.9
Montana				
First State (Forsyth)	3,347	16.5	3,041	15.0
Big Horn (Harden)	4,155	18.2	2,512	10.9
North Dakota				
Bank of Beulah	1,777	16.2	742	6.8
Union State (Hazen)	2,767	20.2	777	5.7

SOURCE: FDIC Tapes of Bank Call and Income and Dividend Reports, December 31, 1974.

A review of the Western coal impact areas showed that deposits per capita by local governments could range between $228 and $579 per capita, averaging $400. Based on a permanent population of 6,000, such deposits would amount to $2.4 million.

Summary

The development of a coal gasification facility, and of the requisite local infrastructure, is expected to create financial needs which would greatly exceed the financial services available from local sources. It has been estimated that the housing, business structures and municipal facilities needed to support a gasification workforce would cost about $50 million to build in 1972 dollars. The construction of these facilities would generate a commesurate need for interim-construction and permanent financing. About 60 per cent of the gas plant cost, or $300 million is estimated to be spent in the local area in the form of construction expenditures. This would generate a substantial need for construction and contractor financing. About one-half to three-fourths of the families are expected to require installment financing. This alone could create a need for $1.4 million in financing, which could go as high as $3.0 million, based on borrowing levels experienced in the West. During the construction phase, when twice as many workers would be employed, these needs could easily double.

Estimates of deposit availability from the local area indicates that local sources would not be able to service the projected level of financial demand. Taking into account the high incomes, but lower average ages of permanent and construction employees, about 80 per cent of the families would have checking accounts. Based on an average balance of $900 per account, about $3 million in demand deposit funds would be available during the construction phase, and about half this amount on a permanent basis. About two-thirds of the workers are expected to have savings accounts, with average balances of $2,000. Even though temporary, the $11 million in savings available during the construction phase would be an important source of front-end funds. Following plant construction, this would probably decline to about half this amount.

In aggregate, total deposits could amount to $14 million during construction when 4,000 workers would be employed, and about $7 million during the operating phase when 2,000 direct and secondary workers would be employed. It is to be noted that surveys of Western deposit levels would indicate that as much as three times these amounts could be available, taking into account potential commercial deposits. Individual savings are expected to be the primary source of local funds, and it is evident that these will be nowhere near sufficient.

If the financing of infrastructure and plant development are to take place, a substantial amount of capital must be imported into the gasification locality. Financial institutions can play a key role in making this happen. Conceivably, all kinds of firms should appropriately participate in this effort, including: banks, savings and loan associations, mortgage bankers, commercial finance companies, leasing companies, credit unions, and others. Besides representing a business opportunity, it is in the interest of these institutions and their customers to facilitate energy development and availability.

Providing for the financial needs of gasification areas is not expected to be either simple or easy. The uncertainty relating to the single-industry nature of the area, the small size of the town, the vulnerability to strikes and seasonal layoffs, the social problems, and the high cost of doing business in a boom area will all pose significant barriers to the creditworthiness of the area and its people. Only through innovation and adequate pricing will the job get done.

It is important that regional financial institutions resolve to service the needs of gasification areas. Without this, the financial demands of individuals, business, local government, and of even the local financial institutions themselves might go unfulfilled.

Areas of need which are expected to experience substantial demand would include interim-construction and permanent financing for housing, business structures and municipal facilities; contractor financing; mobile home financing; municipal bond financing; new business financing; support company financing; correspondent banking; and financial counseling and trust services.

It has been estimated that a gas plant will take four years to build and require a peak construction force of about 3,000 workers.

Permanent gasification employment is estimated to be around 1,000 workers for both the mine and gas plant. Secondary employment of around 1,000 jobs could be created by accompanying commercial development during both the construction and operating phases of plant life. The development of a local business community is expected to take time. Until this occurs, it is to be expected that most gasification expenditure and payroll, having an aggregate impact on gross business volume of $53 million, would be expended in nearby trade areas. Even after local development reaches maturity, these trade centers should continue to share in this volume. Based on an estimated permanent workforce related population of 6,000 people, a single-plant gas town would be a minimum, to full convenience shopping area. This implies the potential for a substantial expansion in the kinds and numbers of new businesses.

Because coal deposits are concentrated in a limited number of geographic areas, the development of a coal gasification facility could be accompanied by simultaneous development of mines, electric power plants and additional gas plants. For example, the gasification plants proposed for Beulah and Dunn Center, North Dakota are separated by less than forty miles. Gas plant electric requirements and other factors have caused at least one gas company to consider siting an electric plant in proximity to the gas facility. In addition, most gas proposals have been for multi-plant complexes, with the first plant being only one of as many as four such operations. The first gas plant, then, is expected to be only the beginning of a much more substantial and long lasting development.

With 69 per cent of the nation's fossil fuels in the form of coal, and with 51 per cent of the strippable coal concentrated within a relatively confined part of the West, the magnitude of future development and associated impact on financial needs would be immense. Conceivably, Montana, North Dakota and Wyoming could develop energy-related economies on a scale even larger than that of existing oil and gas areas such as Texas.

Chapter V

Footnotes

1. J. Roscow, "Oil Fuels Alaska's Bank Boom", Banking, July 1975, p. 46.

2. "Coal Revival Stimulates Industry", The Money Manager, Volume 4, No. 37, August 25, 1975, p. 11.

3. Joe Regent, "Range is Gold Mine in a Jobless Time", Minneapolis Tribune, April 27, 1975, p. 1B.

4. Ibid., p. 15.

5. University of North Dakota, Extensive Utilization of Lignite in the West River Diversion Area, p. 73.

6. Montana Energy Advisory Council, Coal Development: Information Packet, p. 16.

7. Resource City, Rocky Mountains, Federation of Rocky Mountain States, Denver, Colorado.

8. F. Linden, "The Top Five Percent", The Conference Board Record, April 1973, p. 25.

9. Institute for Social Research, Surveys of Consumers: 1971-72, p. 5

10. Ibid., pp. 8-9.

11. "A Financial Survey of Minneapolis and Suburban Areas", Minneapolis Star and Tribune, 1968, p. 28.

12. Northwest Bancorporation, Minneapolis, Minnesota

13. Institute for Social Research, Surveys of Consumers: 1971-72, p. 63.

14. FDIC Tapes of Bank Call and Income and Dividend Reports, December 31, 1974.

15. Leholm, Local Impacts of Energy Resources Development, p. 77.

16. University of North Dakota, Extensive Utilization, p. 74.

17. Ibid., p. 76.

18. Ibid., p. 60.

19. Editor & Publisher, Co., Market Guide: 1975, pp. 240, 306, 468.

20. Leholm, Local Impacts of Energy Resource Development, p. 81.

21. "Range", Minneapolis Tribune, p. 4B.

22. J. Borchert and R. Adams, Trade Center and Trade Areas of the Upper Midwest, p. 10.

23. Ibid., p. 11.

24. J. Roscow, "Oil Fuels", Banking, p. 46.

25. Jack Carlson, Assistant Secretary of the Interior, (remarks at Western Governors' Conference), Albuquerque, New Mexico, October, 1975.

26. R.L. Lindauer, Jr., "Solutions to the Economic Impacts of Large Mineral Development on Local Governments", (presentation to Federation of Rocky Mountain States), 1975.

APPENDIX 1

ESTIMATED COAL RESOURCES OF THE WORLD
(MILLIONS OF NET TONS)

	Recoverable Reserves[2]	% World Total	Total Reserves[3]	% World Total	Total Resources[4]	% World Total
U.S.S.R.	150,576	23.1	301,151	19.5	6,298,158	53.1
China, Peoples Rep. of	88,185	13.5	330,693	21.4	1,102,310	9.3
Rest of Asia	19,344	3.0	44,620	2.9	119,108	1.0
United States .	200,379	30.8	400,758	25.9	3,223,709	27.2
Canada	6,103	0.9	9,958	0.6	119,906	1.0
Latin America . .	3,090	0.5	10,142	0.7	36,297	0.3
Europe	139,745	21.4	352,526	22.8	669,676	5.6
Africa . . .	17,227	2.6	33,390	2.2	64,864	0.6
Oceania . . .	27,026	4.2	82,341	5.3	220,081	1.9
World Total . .	651,676	100.0	1,545,741	100.0	11,854,109	100.0

[1]Excludes peat.
[2]Amount of reserves in place that can be recovered under present local economic conditions using available technology.
[3]The porton of total resources which have been carefully measured and assessed as being exploitable under local economic conditions and available technology.
[4]Total amount available in the earth that can be successfully exploited and used by man within the foreseeable future.

Source: World Energy Conference Survey of Energy Resources, 1974.

Note: Estimates of U.S. coal reserves in this survey do not agree with other domestic data; among other reasons, criteria used for thickness of seam and depth of overburden are not those employed by the U.S. Bureau of Mines or U.S. Geological Survey.

SOURCE: National Coal Association, Coal Facts: 1974-75, p. 72.

COAL RESOURCES OF THE UNITED STATES
(MILLION SHORT TONS)

State	Mapped, Explored and Above 3,000 Feet					Est. Total Remaining Resources In The Ground 0-6,000 ft. Overburden
	Bituminous Coal	Subbituminous Coal	Lignite	Anthracite	Total	
Alabama	13,518	0	20	0	13,538	39,538
Alaska	19,415	110,674			130,089	265,089
Arkansas	1,640	0	350	430	2,420	6,420
Colorado	62,389	18,248	0	78	80,715	371,715
Georgia	18	0	0	0	18	78
Illinois	139,756	0	0	0	139,756	239,756
Indiana	34,779	0	0	0	34,779	56,779
Iowa	6,519	0	0	0	6,519	20,519
Kansas	18,686	0		0	18,686	22,686
Kentucky	65,952	0	0	0	65,952	117,952
Maryland	1,172	0	0	0	1,172	1,572
Michigan	205	0	0	0	205	705
Missouri	23,359	0	0	0	23,359	23,359
Montana	2,299	131,877	87,525	0	221,701	378,701
New Mexico	10,760	50,715	0	4	61,479	109,479
No. Carolina	110	0	0	0	110	135
North Dakota	0	0	350,680	0	350,680	530,680
Ohio	41,864	0	0	0	41,864	43,864
Oklahoma	3,299	0		0	3,299	33,299
Oregon	48	284	0	0	332	432
Pennsylvania	57,533	0	0	12,117	69,650	79,650
South Dakota	0	0	2,031	0	2,031	3,031
Tennessee	2,652	0	0	0	2,652	4,652
Texas	6,048	0	6,878	0	12,926	26,926
Utah	32,100	150	0	0	32,250	115,250
Virginia	9,710	0	0	335	10,045	13,145
Washington	1,867	4,194	117	5	6,183	51,183
West Virginia	102,034	0	0	0	102,034	102,034
Wyoming	12,699	108,011		0	120,710	545,710
Other States	618	4,057	46	0	4,721	5,721
Total	671,049	428,210	447,647	12,969	1,559,875	3,210,060

Source: U.S. Geological Survey, Coal Resources of the U.S., Jan. 1, 1967, Bulletin #1275, p. 13.

APPENDIX 3

TOTAL ESTIMATED REMAINING MEASURED AND INDICATED COAL RESERVES OF THE UNITED STATES AS OF JANUARY 1, 1970. (In Beds 28 Inches and More Thick, for Bituminous, Anthracite, and 5 Feet or More Thick for Subbituminous and Lignite Beds--Million Tons)

	Remaining Measured and Indicated Reserves				
State	Bituminous	Subbituminous	Lignite	Anthracite Semi-Anthracite	Total
Alabama	1,731	0		0	1,731
Alaska	667	5,345			6,012
Arkansas	313	0		67	380
Colorado	8,811	4,453	0	16	13,280
Georgia	18	0	0	0	18
Illinois	60,007	0	0	0	60,007
Indiana	11,177	0	0	0	11,177
Iowa	2,159	0	0	0	2,159
Kansas	328	0	0	0	328
Kentucky - west	20,876	0	0	0	20,876
Kentucky - east	11,049	0	0	0	11,049
Maryland	557	0	0	0	557
Michigan	125	0	0	0	125
Missouri	12,623	0	0	0	12,623
Montana	862	31,228	6,878	0	38,968
New Mexico	1,339	779	0	2	2,120
North Carolina		0	0	0	
North Dakota	0	0	36,230	0	36,230
Ohio	17,242	0	0	0	17,242
Oklahoma	1,583	0	0	0	1,583
Oregon			0	0	
Pennsylvania	24,078	0	0	12,525	36,603
South Dakota	0	0	757	0	757
Tennesse	939	0	0	0	939
Texas		0	6,870	0	6,870
Utah	9,155	150	0	0	9,305
Virginia	3,561	0	0	125	3,686
Washington	312	1,188	0	0	1,500
West Virginia	68,023	0	0	0	68,023
Wyoming	3,975	25,937		0	29,912
Other States			46	0	46
Total	261,510	69,080	50,781	12,735	394,106

SOURCE: National Petroleum Council, U.S. Energy Outlook: Coal Availability, pp. 117-19.

APPENDIX 4

ESTIMATED STRIPPABLE RESERVES OF COAL AND LIGNITE IN THE UNITED STATES, JANUARY 1, 1968, BY STATES

State	Bituminous Coal	Subbmituminous Coal	Lignite	Total
Alabama	134	0		134
Alaska	480	3,926	5	4,411
Arizona	0	387	0	387
Arkansas	149	0	25	174
California	0	25	0	25
Colorado	500		0	500
Illinois	3,247	0	0	3,247
Indiana	1,096	0	0	1,096
Iowa	180	0	0	180
Kansas	375	0		375
Kentucky--east	781	0	0	781
Kentucky--west	977	0	0	977
Maryland	21	0	0	21
Michigan	1	0	0	1
Missouri	1,160	0	0	1,160
Montana		3,400	3,497	6,897
New Mexico		2,474	0	2,474
North Dakota	0	0	2,075	2,075
Ohio	1,033	0	0	1,033
Oklahoma	111	0	0	111
Pennsylvania	752	0	0	752
South Dakota	0	0	160	160
Tennessee	74	0	0	74
Texas		0	1,309	1,309
Utah	150	0	0	150
Virginia	258	0	0	258
Washington		135	0	135
West Virginia	2,118	0	0	2,118
Wyoming		13,971	0	13,971
Total	13,597	24,318	7,071	44,986

SOURCE: National Petroleum Council, U.S. Energy Outlook: Coal Availability, pp. 117-19.

APPENDIX 5

MONTANA STRIPPABLE COAL DEPOSITS

Coal Deposit	Average Thickness (Feet)	Strippable Reserves (Thousands of Tons)
Subbituminous:		
Decker	60	540,000
Hanging Woman Creek	12	132,000
Kirby	25	66,000
Roland	77	126,000
Smith	29	182,000
Foster Creek	14	224,000
Otter Creek	40	608,000
Greenleaf-Miller Creek	22	30,000
Poker Jim-O'Dell	25	100,000
Sand Creek	12	37,000
Colstrip	24	718,000
Moorhead	51	600,000
Birney	12	28,000
Total	28	3,400,000
Lignite:		
Foster Creek	21	250,000
Pine Hills	25	73,000
Pumpkin Creek Divide	16	118,000
Thirteen Mile Creek	25	180,000
Weldon-Timber Creek	15	290,000
Red Water	18	120,000
Broadus	20	240,000
Sonnette	22	95,000
Pumpkin Creek	27	910,000
Breezy Flat	14	80,000
Fox Lake	11	29,000
Fort Kipp	14	204,000
Rosebud Creek	10	80,000
Coalridge	25	360,000
Reserve	8	100,000
Four Buttes	10	36,000
Wibaux	20	426,000
Total	19	3,497,000
Total All Types	24	6,897,000

Source: Bureau of Mines, Information Circular 8531, pp. 93-96.

APPENDIX 6

NORTH DAKOTA STRIPPABLE COAL DEPOSITS

Coal Deposit	Average Thickness (Feet)	Strippable Reserves (Thousands of Tons)
Subbituminous:		
Beach	18	224,000
Dickenson	24	370,000
Gascogne	21	112,000
Bowman	22	101,000
Harmon	25	263,000
Slope I	22	102,000
Slope II	15	56,000
Kincaid	8	9,000
Noonan	8	3,000
Niobe	15	449,000
Wilton	9	12,000
Dunn	11	23,000
Knife River	15	295,000
Beulah South	15	40,000
Glen Harold	15	18,000
Washburn	9	24,000
Center	8	80,000
Slope III	15	40,000
Slope IV	15	133,000
Velva	12	4,000
Avoca	27	100,000
M & M	12	17,000
Total	16	2,075,000

Source: Bureau of Mines, Information Circular 8531, pp. 98-100.

APPENDIX 7

WYOMING STRIPPABLE COAL DEPOSITS

Coal Deposit	Average Thickness (Feet)	Strippable Reserves (Thousands of Tons)
Subbituminous:		
Clear Creek	20	148,000
Gillette	71	11,800,000
Spotted Horse	22	288,000
Cherokee	25	93,000
Antelope	35	160,000
Dry Cheyenne	8	48,000
Hanna	10	8,000
Dave Johnson	50	45,000
Lake DeSmit	130	800,000
Sorensen	20	140,000
Acme-Kleenburn	23	40,000
Jim Bridger	15	110,000
Red Desert	47	293,000
Total	67	13,971,000

Source: Bureau of Mines, Information Circular 8531, pp. 120-21.

MONTANA COAL MINES

Name	Operator Owner	County	Status	No. of Employees
Rosebud Tongue River Mine	Rosebud Coal Sales Co. Peter Kiewit Sons' Co.	Big Horn	Inactive	-
Milk River Mine	Lauren Sargent	Blaine	Inactive	-
Storm King Mine	Ralph E. Bair	Custer	Inactive	-
Peuse Mine	Gordon Peuse	Dawson	Producing	
No. 1 Mine	R.S. Stephenson Estate	McCone	Inactive	-
Blue Flame Mine	Victor Carlson and Jack H. Carlson	Musselshell	Producing	7
Cow Creek Mine	George Badovinus	Musselshell	Developing	
Divide Mine	Divide Coal Mining Co. Victor Carlson	Musselshell	Producing	6
Johnny's Mine	Johnny Keosky	Musselshell	Inactive	
Nies Mine	Nies Coal Co. William F. Nies	Musselshell	Produced	7
P and M Mine	Paul Meged	Musselshell	Producing	
Square Deal Mine	Virgil Cross	Musselshell	Produced	

Name	Operator Owner	County	Status	No. of Emplo
Western Mine	Glenn Johnson	Musselshell	Inactive	-
Consolidation Mine	Consolidation Coal Co.	Musselshell	Inactive	-
Knife River Mine	Knife River Coal Mining Co.	Richland	Producing	20
Big Sky Mine	Peabody Coal Co.	Rosebud	Producing	53
Rosebud No. 6 Mine	Western Energy Co. The Montana Power Co.	Rosebud	Producing	150
Coal Creek Mine	John Schoonover		Producing	

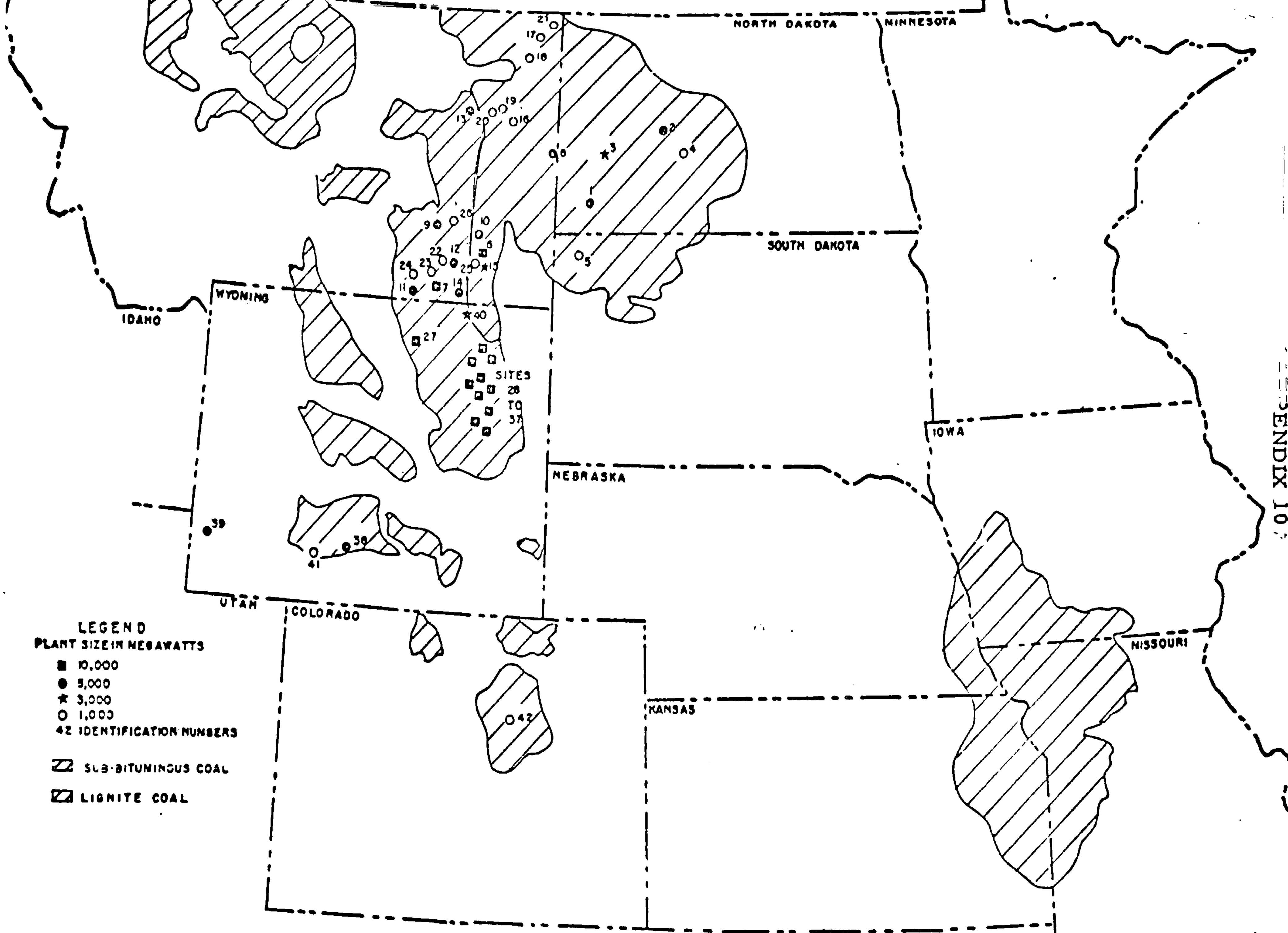
SOURCE: Bureau of Mines and Geology, Montana, Directory of Mining Enterprises for 1974: Bulletin 95.

APPENDIX 9

STRIPPABLE COAL SITES FOR 1,000 MW OR MORE BASE LOAD MINE-MOUTH GENERATING PLANTS

Site Identification Number	State	Plant Size MW	Deposit Name	Location
1	North Dakota	5,000	Slope & Bowman Counties	Bowman, N.D.
2	" "	5,000	Knife River	Beulah, N.D.
3	" "	3,000	Heart River	Dickinson, N.D.
4	" "	1,000	Center	Center, N.D.
5	South Dakota	1,000	Cave Hills	Ludlow, S.D.
6	Montana	10,000	Pumpkin Creek	20 m. N.W. Broadus, Mont.
7	"	10,000	Hanging Woman Creek	10 m. S. Birney, Mont.
8	"	5,000	Beach-Wibaux	Wibaux, Mont.
9	"	5,000	Colstrip	Colstrip, Mont.
10	"	5,000	Foster Creek	Volborg, Mont.
11	"	5,000	Decker	Decker, Mont.
12	"	5,000	Otter Creek	10 m. S.E. Ashland, Mont.
13	"	5,000	"S" Bed	10 m. N.W. Brockway, Mont.
14	"	5,000	Moorhead	Moorhead, Mont.
15	"	3,000	Broadus	Broadus, Mont.
16	"	1,000	North Fork of 13 Mile Cr.	25 m. N.W. Savage, Mont.
17	"	1,000	Reserve	Reserve, Mont.
18	"	1,000	Fort Kipp	Fort Kipp, Mont.
19	"	1,000	Lane	Richey, Mont.
20	"	1,000	Carroll	Paxton, Mont.
21	"	1,000	Coalridge	Coalridge, Mont.
22	"	1,000	Poker Jim - Lookout	Birney, Mont.
23	"	1,000	Birney	Birney, Mont.
24	"	1,000	Kirby	Kirby, Mont.
25	"	1,000	Sonnette	Sonnette, Mont.
26	"	1,000	Sweeney Creek	10 m. N.W. Brandenberg, Mont.
27	Wyoming	10,000	Lake De Smet	10 m. N. Buffalo, Wyo.
28 thru 37	"	10,000 ea. (100,000 mw total)	Gillette	15 miles N. of Gillette to Antelope Creek (55 miles S. of Gillette, Wyoming)
38	"	5,000	Red Desert-Cherokee	N. of Wamsutter, Wyo.
39	"	5,000	Adaville	6 m. W. of Kemmerer, Wyo.
40	"	3,000	Spotted Horse	Spotted Horse
41	"	1,000	Jim Bridger	25 m. N.E. Rock Springs, Wyo.
42	Colorado	1,000	Denver Basin	Watkins, Colorado
	Kansas, Iowa, Nebraska, Missouri, Minnesota		No sites " " " "	

SOURCE: North Central Power Study, Coordinating Committee, <u>North Central Power Study</u>, p. 37.



LOCATION AND POWER GENERATION POTENTIAL OF
STRIPPABLE COAL DEPOSITS IN NORTH CENTRAL POWER STUDY AREA

COUNTY	NAME OF MINE	ADDRESS	SUPERINTENDENT	TONS PRODUCED	MAX. NO. EMPLOYEES
ADAMS	Olson Mine	Haynes	R.K. Collins	5,217	6
	Smith-Ullman Mine	Haynes	R.K. Collins	10,366	6
BOWMAN	Knife River Coal Mining Co.	Gascoyne	Herman Oster	215,960	34
BURKE	Baukol-Noonan, Inc.	Noonan	Duane Dihle	401,867	49
GRANT	Sprecher Coal Mine	New Leipzig	Vernon Sprecher	5,348	2
MERCER	Consolidation Coal Co.	Stanton	Pete Bond	1,380,968	78
	Knife River Coal Mining Co.	Beulah	H.H. Scherbinske	1,800,709	80
	North American Coal Corp.	Beulah	Joe Mitzel	1,195,831	49
OLIVER	Baukol-Noonan, Inc.	Center	Lyle Huwe	1,473,185	39
STARK	Dickinson Coal Mining	Dickinson	Theo. Binek	2,221	3
	Husky Industries	Dickinson	A. Elberg	115,301	8
WARD	Consolidation Coal Co.	Velva	Mike Clark	567,351	33
WILLIAMS	Geo Resources, Inc.	Williston	R.C. Vickers	9,040	1

	VALUATION	TOTAL NO. TONS PRODUCED
TOTAL - FISCAL YEAR 1974	$16,069,720.	7,183,364
TOTAL - FISCAL YEAR 1973	13,567,386.	6,798,607
TOTAL - FISCAL YEAR 1972	12,045,301.	6,343,769
TOTAL - FISCAL YEAR 1971	10,844,675.	5,821,076
TOTAL - FISCAL YEAR 1970	9,053,676.	5,001,828
TOTAL - FISCAL YEAR 1969	8,245,222.	4,590,276
TOTAL - FISCAL YEAR 1884 THRU 1974		159,394,020

TOTAL - FISCAL YEAR 1974 - Strip Mine Forman Certificates Issued - - - - - - - - - - - - - - - 14

APPENDIX 12

WYOMING

1973 PRODUCTION IN TONS

	Mine	Company	County	1973 Production (Tons)
1.	Belle Ayr South	Amax Coal Company	Campbell	867,544
2.	Seminoe No. 1	Arch Mineral Corporation	Carbon	2,865,100
3.	Seminoe No. 2	do	do	1,497,675
4.	East Antelope	Best Coal Company	Converse	1,195
5.	Big Horn No. 1	Big Horn Coal Company	Sheridan	444,545
6.	Jim Bridger	Bridger Coal Company	Sweetwater	1,000,000*
7.	Rimrock	Energy Development Company	Carbon	624,996
8.	Vanguard No. 1	do	do	331,855
9.	Vanguard No. 2	do	do	200,000*
10.	Rainbow No. 8	Gunn-Quealy Coal Co.	Sweetwater	95,524
11.	Elkol	Kemmerer Coal Company	Lincoln	400,241
12.	Sorensen	do	do	2,546,435
13.	Grass Creek	Northwestern Resources	Hot Springs	8,000*
14.	Dave Johnston Fuel Recovery Pit	Pacific Power & Light Co.	Converse	2,897,383
15.	Roncco	Roncco Coal Company, Inc.	Hot Springs	2,870
16.	Rosebud Pit No. 4	Rosebud Coal Sales Co.	Carbon	) 1,509,736
	Rosebud Pit No. 5	do	do	)
17.	Welch	Welch Coal Company	Sheridan	18,708
18.	Wyodak North & South	Wyodak Resources Development	Campbell	727,019

*Opened in 1974. Estimated 1974 production, January, 1975.

SOURCE: Wyoming Geological Survey. January, 1975.

APPENDIX 13

WYOMING PROPOSED COAL PRODUCTION

	Mine	Company	County	Proposed Opening	Production Year	Production Estimate
1.	Belle Ayr North	Amax Coal Company	Campbell	1977	1980	- 10 to 20 million
2.	Black Thunder	Atlantic Richfield	Campbell	1975	1980	- 7 to 10 million
3.	Black Butte	Black Butte Coal Co.	Sweetwater	1977	1980	- 4 to 4.5 million
4.	North Rawhide	Carter Mining Co.	Campbell	1976	1980	- 5 to 12 million
5.	FMC	FMC Coal Company	Lincoln	1975	1975	- 600,000
6.	Jacobs Ranch	Kerr-McGee Coal Corp.	Campbell	1977	1980	- 9 to 16 million
7.	East Gillette	do	do	1978	1980	- 5 to 11 million
8.	Medicine Bow	Medicine Bow Coal Co.	Carbon	1975	1980	- 3 million
9.	Rochelle	Rochelle Coal Co.	Campbell	1977	1980	- 11 million
10.	Stansbury No. 1	Stansbury Coal Co.	Sweetwater	1975	1975	- 100,000
11.	Belle Fourche	Sunoco Energy Development Co.	Campbell	1976	1980	- 12 million
12.	(Name Unknown)	Texaco, Inc.	Johnson	1977		

SOURCE: Wyoming Geological Survey, January, 1975.

APPENDIX 14

COMMERCIAL BANKING SERVICES

I. Services Used by Individuals

Retail Checking Services

Regular checking account
Special checking account
Personalized checks and deposit tickets
Direct payroll deposit
Automatic bill paying for insurance payments, etc.
Instant cash cards

Retail Savings Services

Savings accounts
Savings certificates
Certificate of deposit
Automatic savings
Automatic savings certificates
Payroll savings plans
Check-a-month annuities
Christmas Club
Special occasion savings

Other Retail Services

Credit cards
Bond investment consulting and bond sales
Cashier's checks
Certified checks
Bank-by-mail and telephone
Financial planning
Safe deposit
Warehousing
U.S. Savings Bonds
Life and casualty insurance
Income tax preparation
Travel agency
- Auto and hotel reservations
- Tickets
- Charters, cruises, tours

Personal money order
Savings bond redemption
Traveler's checks
Traveler's letter of credit
Escrow agent for real estate taxes
Escrow agent for insurance payments

Retail Loans

Auto installment loans
Retail credit card plans
Check credit and revolving credit plans
Mobile home loans
Other retail consumer goods
Aircraft and boat loans
Bill consolidation loans
Time tuition loans - government insured
- conventional loans
Medical and rental loans
Personal loans
Vacation, recreation and travel loans
Appliance
Trailers
Television
Life insurance (cash value)
Musical instruments
Home improvement loans
Real estate loans
  Insured by FHA
  Guaranteed by VA
  Uninsured by private insurers
Car leasing
Stock option loans

II. Services Used by Commercial Firms

Commercial Loans

Real estate loans:
  Secured by Farmland
  Secured by 1-4 Family Residential Propertis
    -Insured by Federal Home Administration
    -Insured by Farmers Home Administration
    -Guaranteed by VA
    -Uninsured or guaranteed
  Secured by multi-family residential properties
    -Insured by FHA
    -Not insured
  Other real estate loans
Loans to financial institutions
Loans for purchasing or carrying securities
Loans to farmers
Commercial and Industrial loans
  SBA loans
  Interim construction loans
  Business loans--secured and unsecured

Lines of credit
Land loans
Land development financing
Floor-plan financing
Working capital loans
Equipment financing
Participations with commercial finance companies
Participations with life insurance companies
Permanent mortgage loans
Capital loans
Revolving credit agreements

<u>Commercial Services - Large Customers</u>
Lockbox
Lockbox analysis
Concentration accounts
Wine transfers
Depository transfer checks
National Data Corporation-deposit information service
Preauthorized drafts
Preauthorized drafts-printing
Zero balance accounts
Payable through drafts
Data capture, transmission and reception
Account reconciliation plans (ARP)
Check sequencing
Depository and disbursing checking accounts
One check payroll

<u>Commercial Investment Services</u>
Bond investment consulting
Certificates of deposit
Bonds: local, state, national governments
Commercial paper sales and issuance
Repurchase agreements
Money market securities
Custody accounts
Coupon collections
Securities clearance
Safe deposit
Corporate savings accounts
Bankers acceptances

<u>Other Commercial Services</u>
Addressograph
Cashier's checks
Certified checks
Credit information and agency reports

Foreign currency, drafts, remittances
Night depository
Payroll EDP accounting
Tax deposit preparation
Bank deposit preparation
Commercial checking accounts
Trade acceptances
Coin and currency counting and sales
Property accounting and management
Collections
  Bank drafts
  Bills of lading
  Coupons
  Mortgage payments
  Contract for deed payments
  Note payments
  Securities sight drafts
  Depository for federal withholding tax payments
  Depository for federal corporate income tax payments
Equipment leasing

III. Trust Services
Employee benefit plans
  Trustee of pension & profit sharing plans
  Master retirement plans
    Corporations
    Self employed
  Investment advisory services
  Employee benefit studies
  Collective investment funds
  Trustee for foundations

Personal Trust
Executor and trustee under wills
Living trusts
Agency and custody accounts
Estate and financial planning
Guardianships
Investment advisory services
Collective investment funds
Escrow agent
Safekeeping

IV. Municipal Services

Fiscal advising services
Paying agent for bonds and coupons
Investment consulting and bond sales
Certificates of deposit
Repurchase agreements
Employee benefit plans
Short-term financing - Long-term financing
Depository and Disbursing
Checking accounts
Account reconciliation
Preauthorized debits
Wire transfers
Payroll EDP accounting
Lockbox services
Underwriting of municipal bonds
Sale of tax anticipation notes

V. Correspondent Banking Services

Investment consulting and bond sales
Safekeeping and collections
Overlines - working capital loans
Mortgage, other loan participation
Credit information and assistance
Student loan servicing
Bank wire and money transfers
Bank acquisitions - financing
Bank equity additions - financing
EDP services
- Loans
- Credit Card
- Savings
- Payroll

Loan pools
Cash letters and collections
Money orders
Credit card affiliate bank programs
Repurchase agreements
Fed funds trading

VI. Other Services

International banking
Corporate trust
Corporate finance
Business advisory

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