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MARKETS FOR ALASKAN COAL

HOUSE RESEARCH AGENCY
ALASKA STATE LEGISLATURE
January 1981

House Research Agency Report No. 80-3

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Coal Policy Paper:

MARKETS FOR ALASKAN COAL

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ALASKA STATE LEGISLATURE
January 20, 1981

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INTRODUCTION

The current demand for alternatives to oil as a source of energy has focused attention on the exploitation of the Nation's coal resources. As Alaska holds a large portion of these resources, there has been a great deal of interest among Alaskan policymakers in where, when and how Alaskan coal will be commercially exploited on a large scale.

The Usibelli mine, near Healy, is currently the only operating mine in Alaska. It produces about 750,000 tons of low-sulfur subbituminous coal a year for use by local utilities in Healy and Fairbanks. This amount of coal is roughly the energy equivalent, measured in Btus, of 5,670 barrels per day of crude oil production. For the future, however, companies holding leases on this and other coal fields are considering large-scale development plans which may increase Alaska's coal production by as much as twenty times within the next ten to fifteen years. Most, if not all, of this increased production will be exported. Development on this scale will have a large number of environmental, social and economic impacts.

As the first in a series of papers examining the public policy implications of coal development in Alaska, this paper describes the potential markets for Alaska's coal resources. The impact of coal development on taxation and leasing policies, on environmental protection efforts, and on rural energy problems will be examined in subsequent papers.

This paper provides a framework for understanding the economic factors which will determine the competitiveness of Alaskan steam coal in Alaskan and export markets. Its focus will be on answering these questions:

- When will domestic/export markets become large enough to justify expanded Alaskan production?
- How much Alaskan coal might be demanded?
- Which Alaskan coal deposits are likely to be developed in the next twenty years?

Our findings are summarized briefly on the following pages.

SUMMARY OF FINDINGS

Resources

- The Division of Geological and Geophysical Survey (DGGS), of the Department of Natural Resources, estimates that Alaska's onshore coal resources equal 1.9 trillion tons. This is a "best estimate" that was compiled in 1979, based on a review of the available geologic literature.

- This estimate includes measured, indicated and inferred, and hypothetical resources. Measured resource estimates carry the highest degree of geological assurance, as they are based on actual field exploration and drilling. Indicated and inferred resource estimates are based on more limited geological data. Hypothetical estimates reflect an assessment of resources that geologists expect to find, based on an analysis of the general geology of the area.

- Most Alaskan coal is found in four areas of the State: on the North Slope, along the northern side of the Alaska Range, in the Susitna River Basin and on the southeastern side of the Alaska Peninsula. The North Slope alone is estimated to contain 1.8 trillion tons of coal, or 96% of the total DGGS estimate for Alaska.

- Hypothetical resources constitute approximately 96% of the DGGS's "best estimate" of Alaska's coal resources; most of these hypothetical resources are found on the North Slope where little geological work has been done.

- Eighty-three percent of the measured resources are found in areas other than the North Slope; most of these occur in the Nenana field, where the Usibelli mine is located, and the Beluga field, where extensive geological studies have been conducted by leaseholders.

- Estimates of Alaska's coal resources vary widely; the DGGS estimates are about twice as high as those provided by the U. S. Geological Survey. Estimates by coal leaseholders are likely to be higher than those of the DGGS for individual fields, as most have performed extensive drilling and testing on their coal properties.

- Most Alaska coal is subbituminous; it has a heating value between 7,000 and 9,000 Btu/lb., less than 1% sulfur, and is 35% to 50% ash and moisture. Compared to the coals found in Montana and Wyoming, Alaskan coals have a lower heating value, a slightly lower sulfur content and a much higher ash and moisture content. Additional description of Alaskan coal is found in Appendix A.

Markets

- There are two major uses of coal: metallurgical coal is used in steel-making and steam coal is used as a boiler fuel in electrical utilities and industrial plants. In addition, there is a growing interest in the use of coal as a raw material for synthetic liquids (methanol) or gas production. Coal characteristics such as heat value, moisture content, and burning properties determine its end use. Most of the Alaskan coal that might be exploited in this century is steam coal.

- Metallurgical coal has a significantly higher value than steam coal, and is widely traded in international markets. However, until the worldwide 'energy crisis' of the past decade, there was no comparable interest in shipping high bulk, low-value steam coal any great distance. Currently, countries are diversifying their energy sources, creating a greatly expanding worldwide market for steam coal. This expanding market creates an opportunity for the export of Alaskan steam coal.

- There are three potential markets for Alaskan steam coal: Alaska, the West Coast and Asia. The most significant problem faced in developing new, large-scale coal mines in Alaska is finding a single user or group of users whose demand, demonstrated by long term (up to 30 years) contracts, is sufficient to justify development. Leaseholders on the Beluga field estimate that production of about 5 million short tons a year is necessary to justify the required investment in a port facility.

- The Asian market appears to be the only one where incremental increases in coal demand are sufficient to justify the capital expenditures required to open a new mine(s) in Alaska within the next ten years.

- Alaska is likely to capture a growing share of this Asian market because it has large, low-sulfur coal reserves at tidewater; it has a shipping advantage over competitors in the western U. S. and Canada to the Pacific Rim; and its potential customers are seeking a diversity of supply sources to reduce the impact of possible supply interruptions caused by such things as labor problems or political unrest.

Supplies

- The two most likely sources of Alaskan coal supply which might serve this market are the Nenana field and the Beluga field. For economic and environmental reasons, it is unlikely that any large amount of coal will be produced from Alaska's largest field, which lies north of the Brooks Range, within the next twenty years.

- The long lead-times required to acquire and explore coal properties, build production and shipping facilities, and construct coal burning power plants will result in a three-phased development of these markets over the next twenty years.

  - During Phase I - 1981 to the mid/late 1980's - any increases in demand could only be filled by increasing production at the Usibelli mine. This mine could expand capacity to about four million tons a year. Any demand increases would probably be the result of conversions of existing oil and gas-fired facilities to the use of coal or the increased use of coal in coal-burning plants. Such demand might come from Asian countries, but is unlikely to come from either Alaska or the West Coast.

  - During Phase II - mid/late 1980's to early 1990's - Alaskan coal production may increase significantly. Decisions which will determine supply and demand in this period are being made now or will be made in the near future. Current leaseholders on the Beluga field estimate that new Alaskan capacity could come on-line as soon as five to six years after contracts for substantial portions of planned output are obtained. Increased demand in this period would be the result of construction of new Asian coal-fired power plants. Again, neither Alaska nor the West Coast markets are likely to be a factor in expanding production in this period.

  - Increases in demand in Phase III - early 1990's and beyond - may come from facilities designed to convert coal into synthetic fuels for the West Coast market, as well as continued construction/conversion of coal-fired facilities in Asia, and possibly in Alaska and on the West Coast. Additional capacity may come from new mines on newly-issued leases, as well as expanded production from existing leases.

- The following table summarizes the probable market volumes which may develop during each of these three phases and shows possible production volumes from each field. It is important to remember that the beginning and ending dates of each phase, as well as the production volumes and market sizes are "best guesses" based on the information currently available.

TABLE I
Time Frames for Potential Large-Scale Development in Alaska
(annual demand in mst-A*)

		Phase I 1981-Mid/Late 1980s	Phase II Mid/Late 1980s -Early 1990s	Phase III Early 1990s & Beyond
Markets	Asia	0 - 3.3	3.3 - 13.3	13.3+
	West Coast	0	0	5.0 - 7.0
	Alaska	.7	.7	.7
	TOTAL	.7 - 4.0	4.0 - 14.0	19.0 - 21.0
Supply	Nenana	.7 - 4.0	4.0	4.0
	Beluga	0	0 - 10.0	15.0 - 17.0
	TOTAL	.7 - 4.0	4.0 - 14.0	19.0 - 21.0

* mst-A = million short tons of 8,000 Btu/lb. Alaskan subbituminous coal

Assumptions

- Asia: utility demand in Japan, Korea and Taiwan is filled by expanded production at Usibelli in the short-term and by new mines on the Beluga field in the longer term.
- West Coast: Alaskan coal is converted into methanol and then shipped to the West Coast sometime in the early 1990's.
- Alaska: a 1500 MW hydroelectric facility is built at Susitna substantially eliminating the need for new coal-fired generation.
- Nenana: only the Usibelli leases are developed. The development plans of Meadowlark Farms (subsidiary of AMAX), which is another leaseholder on the Nenana field, are unknown. Two of our reviewers questioned whether the necessary rail and port facilities will be available to export 4 million tons a year.
- Beluga: Phase II data assume two 5-million ton a year export mines; Phase III data assume additional capacity to service a methanol plant.

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OVERVIEW OF GROWING WORLD DEMAND FOR COAL

A recent, comprehensive study of the world's energy needs, conducted by the Massachusetts Institute of Technology, reached the following conclusion:

> It is now widely agreed that the availability of oil in international trade is likely to diminish over the next two decades. Vigorous conservation, the development and rapid implementation of programs for nuclear power, natural gas, unconventional sources of oil and gas, solar energy, other renewable sources, and new technologies will not be sufficient to meet the growing energy needs of the world. A massive effort to expand facilities for the production, transport, and use of coal is urgently required to provide for even moderate economic growth in the world between now and the year 2000. Without such increases in coal the outlook is bleak.[1] (Emphasis added.)

These conclusions were reached after an eighteen-month study of growing worldwide demand for coal. The World Coal Study (WOCOL) data were compiled by sixteen teams, each representing a major energy-using country. Members of each country's team included representatives from industry and government; representatives from the United States included senior officers of AMAX, Commonwealth Edison, Bechtel and Atlantic Richfield, as well as the former directors of the Energy Research and Development Administration (ERDA) and the Environmental Protection Agency (EPA). The final report was compiled from the individual country reports by the project staff at the Massachusetts Institute of Technology, directed by Carroll Wilson. Project staff also developed supplementary material on coal demand in those countries not participating in the Study. Volumes I and II of the Study were published in the spring of 1980. This report seems to be highly regarded by the coal industry and is widely quoted as a source on the future demand for coal; consequently, we will use its findings to establish the potential markets for Alaskan coal.

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[1] Carroll Wilson, Project Director, COAL - A Bridge to the Future, Report of the World Coal Study, Massachusetts Institute of Technology, Ballinger Publishing Company, Cambridge, Massachusetts, 1980. Volume I, page xvi.

Note on Coal Conversions

The WOCOL findings are reported in terms of tons of coal equivalent, or tce; one tce equals a metric ton (2,205 lbs./ton) of 12,600 Btu/lb. coal. The following table indicates conversion factors for different types of coal. Data for a "typical" Alaskan coal from the Nenana or Beluga fields is included for reference.

TABLE II
Conversion Factors for Coals of Various Calorific Contents

Type of Coal	Typical Calorific Content	1 tce =
Bituminous	12,000 Btu/lb.	1.16 short tons
Subbituminous	9,000 Btu/lb.	1.54 short tons
Alaskan	8,000 Btu/lb.	1.74 short tons
Lignite	7,000 Btu/lb.	1.98 short tons

Adapted from WOCOL, Vol. I, page 58.

WOCOL also provides the following comparisons of the energy provided by different amounts of coal.

TABLE III
Illustrative Scaling Comparisons for Various Quantities of Coal

Annual Quantity	Indicator of Amount of Energy Provided
2 mtce (3.5 mst-A)	Annual primary fuel requirement for a 1,000 Mwe electric power plant if it operates at 65% capacity and generates 5.7 billion Kwh per year electricity (Note: the Alaska Railbelt consumed approximately 2.8 billion Kwh in 1980.)
5-7 mtce (9.0 - 12.0 mst-A)	Annual coal feedstock requirement for a 50,000 barrels per day synthetic liquids plant or a 250 mcf synthetic gas facility. (Note: the proposed methanol plant on the Beluga field would produce 54,000 bbls/day of synthetic liquid.
76 mtce (132.2 mst-A)	Amount of energy supplied by 365 million barrels or annual production of 1 million barrels per day of oil. (For reference, a mtce equals 4.8 million barrels of oil. A mst-A equals 2.8 millon barrels of oil.

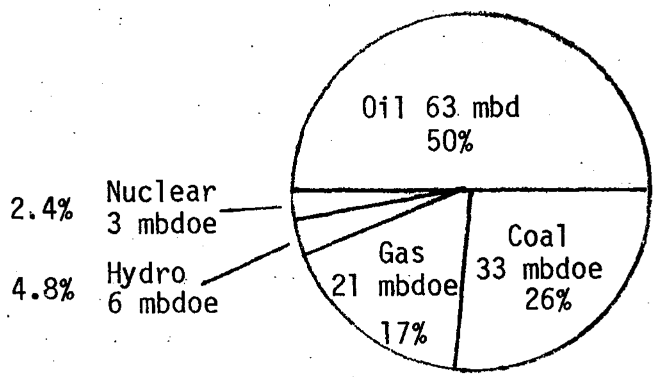
* mst-A = million short tons of 8,000 Btu/lb. Alaskan subbituminous coal.

Source: WOCOL, Vol. I, Page 59.

Current and Projected Energy Consumption

WOCOL reports that in 1978, the world's energy was supplied in these proportions by the following fuels:

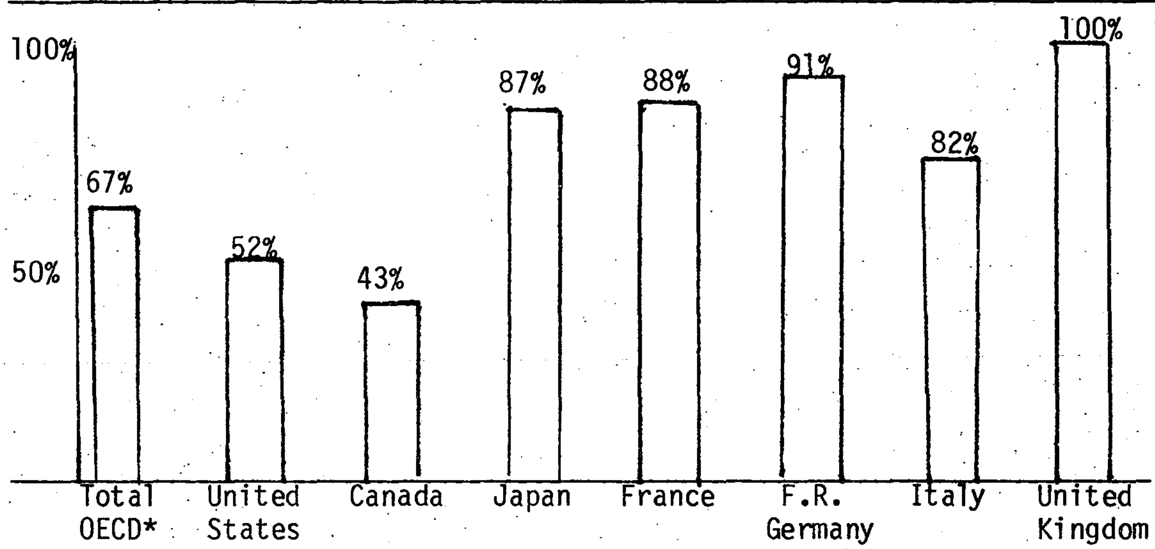
TABLE IV
World Energy Supplies by Fuel in 1978



Source: WOCOL, Vol. I, page 76.

Of world oil consumption, 55% - or about 35 million barrels per day (mbd) moves in international trade, of which about 80% comes from the OPEC countries. Oil has provided for most of the growth in developed countries' energy needs in the last twenty years as the following table indicates:

TABLE V
Oil's Share of the Increase in Energy Use, Selected Countries (1960-1978)



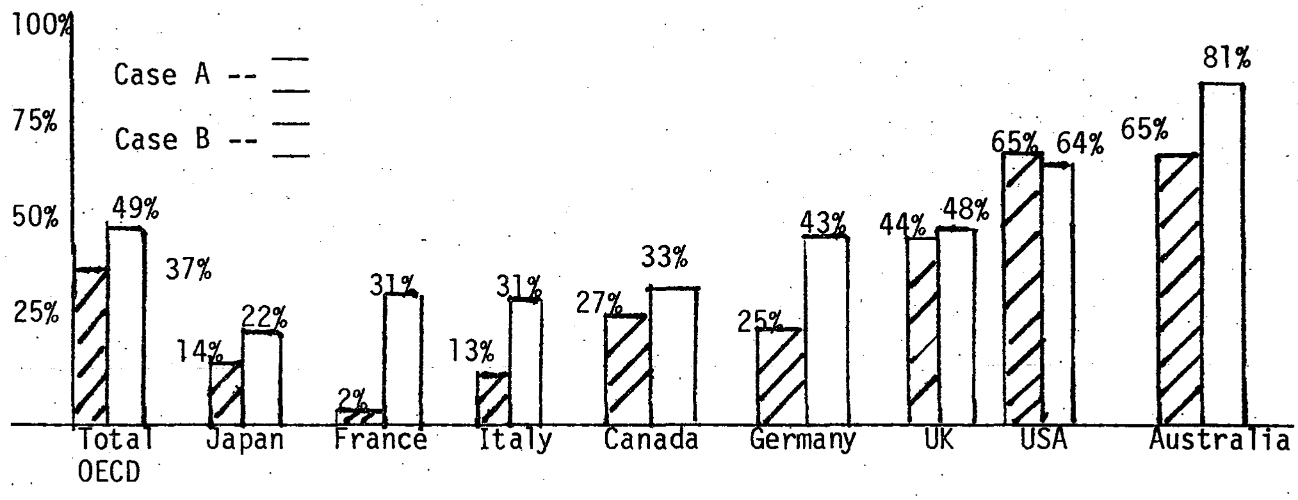
*OECD--The Organization of Economic Cooperation and Development, an organization of major western industrialized countries and Japan.
Source: WOCOL, Vol. I, page 62.

However, it is unlikely that oil will continue to meet the growing energy needs of the world. As WOCOL states:

> It is with considerable concern, therefore, that we support the principal conclusion of nearly every recent world energy study: that world production of oil from traditional sources is likely to peak before the end of the century and probably much sooner. Of even greater consequence to most developed countries is that, after allowing for the increased consumption of oil by producer countries, and the growing energy needs of developing countries, the availability of oil for import to the OECD countries may have already peaked and will very likely be less in the year 2000 than today. (WOCOL, Vol. I, page 63)

While increased use of natural gas, unconventional oil and gas supplies, and nuclear power and conservation will be able to fill some of the needs left by shortages of oil, WOCOL projects that coal will be the major source of fuel to meet growing energy requirements. In projecting the future use of coal, WOCOL established two scenarios: Case A is the "low-coal" scenario, with modest growth in electricity demand, a strong reliance on nuclear power and limited synfuels production. Case B is the "high-coal" scenario, where electricity demand grows more quickly, nuclear power is less prominent and there is extensive synfuels production. Using these two scenarios, WOCOL projected coal's share of the expanding energy needs between 1977 and the year 2000:

TABLE VI
Coal's Share in Meeting the Increase in Energy Needs - Total OECD and Selected Countries (1978-2000)



Source: WOCOL, Vol. 1, Page 104.

Overall, WOCOL projects that total world coal use will increase from 2.5 billion tce in 1977 (33 million barrels per day oil equivalent - mbdoe) to 6-7 billion tce in 2000 (79 mbdoe).

Projected World Steam Coal Trade

Many countries which are planning to increase their reliance on coal, such as the U. S., Australia and Canada, have large indigenous coal resources and will not be buying coal in the world market. However, many countries will have to rely on imported coal to provide for their energy needs. As a consequence, international trade in steam coal is projected to increase by five to eleven times by 2000 in order to meet this demand. WOCOL has projected that Japan will become the world's largest importer of coal by 2000, and that the Asian countries together will be importing between 38% and 44% of the world's total import shipments. This is shown on the table below:

Table VII
World Steam Coal Imports by Country and Region
(mtce)

Country/Region	1977	2000 Case A	2000 Case B
OECD Europe	37	146	333
Canada	6	8	4
Japan	2	53	121
Sub-Total OECD	45	207	458
East and Other Asia	--	60	179
Africa and Latin America	1	6	10
Centrally Planned Economies	17	30	30
TOTAL WORLD	63	303	677

Source: WOCOL, Vol. I, page 107.

Most of these imports will come from four exporting countries: the United States, Australia, Canada, and South Africa. The following table indicates possible steam coal export capacities by the year 2000:

TABLE VIII
Steam Coal Export Potential for Leading Countries (mtce)

Country	1977	2000
United States	5	65 - 280
Australia	4	85
Canada	1	44
Republic of South Africa	13	55
TOTAL	23	249 - 464

Source: WOCOL, Vol. I, page 111.

These countries are expected to command between 37% and 68% of the world steam coal market, as shown in Table VII, by 2000. The People's Republic of China represents large export potential; however, no one has been able to estimate its coal export intentions.

The balance of coal exports will come from Poland, the Soviet Union, West Germany, Latin America and Africa. As demand levels approach those in the "high-coal" case, the United States and Australia will be supplying about half of the world's import requirements. Because the U.S. is believed to be the only country where it is "technically and economically feasible to expand coal exports significantly beyond 200 mtce by 2000," the U.S. will become the "balancing supplier" of steam coal in the world. (WOCOL, Vol. I, page 24.)

Capital Costs

As the world steam coal trade increases dramatically over the next twenty years, a great deal of new capital will be required to build the necessary production and transportation facilities. WOCOL has estimated that the following capital costs are required to build a coal "supply chain":

TABLE IX
Capital Costs in Coal Supply Chains
($1978 U.S.)

	Per Annual tce	Per Annual Short Ton*
Mines	$53	$48
Inland Transport	23	21
Ports	23	21
Ships	59	53
TOTAL	$158	$143

* These figures are provided as reference. They are approximately 10% less than the WOCOL data reflecting the difference in weight between metric and short tons.

Source: WOCOL, Vol. I, page 213.

Another $500 per annual tce ($454 per annual short ton) of coal consumed is required to build the coal-burning facilities for the user. It costs approximately $1 billion to build a 1,000 MWe (1 Gigawatt) facility, which uses about 2 mtce of coal a year. Consequently, about 75% of the total cost of producing and using coal is borne by the utility investing in a power plant.

Pricing

Coal is currently priced at about one-fourth to one-third the price of oil, per delivered Btu. Over the long term, WOCOL projects that real costs will rise as the low cost reserves are depleted and new higher cost mines are opened, the costs of environmental protection increase and as labor costs rise. Much of the coal with export potential is found in high labor-cost countries, such as the U.S. However, WOCOL concludes that:

> In the long run, because of its abundance, and provided a free and competitive international market is maintained, there is little reason to expect that steam coal prices will be directly coupled to world oil prices. This will be particularly so as oil is increasingly removed from the heating market for use in transport and as a specialized petrochemical feedstock. (WOCOL, Vol. I, page 26)

Timing

WOCOL clearly states that the projections it has made depend on decisions made in the early 1980's. If decisions to support coal's production and use are not made then, there may be insufficient energy supplies to fuel growth by the year 2000.

> Given the long lead times involved both for coal using and coal producing projects, the required expansion of coal demand and coal trade will be realized by the year 2000 only if both producers and consumers are willing to make commitments in the early 1980s, even before all the uncertainties about future coal supply and demand are resolved. Unless these commitments are made, there is a real risk that the bulk of the new facilities needed to meet the required acceleration in demand and trade from 1985 onwards will not be available in time. (WOCOL, Vol. I, page 24)

ASIAN MARKET POTENTIAL

The developed Asian countries on the Pacific Rim - Korea, Japan and Taiwan - provide the largest potential export market for Alaskan steam coal. Beluga coal is the most likely Alaskan source of long-term supply for this market, even though some limited quantities might be shipped from the Nenana field pending development at Beluga.

In a report prepared for the Division of Policy Development and Planning, Battelle Pacific Northwest Laboratories concluded that Beluga coal must be marketed in a sufficiently large or rapidly growing market where the incremental increase in demand exceeds "the critical size necessary to support a Beluga delivery system." The report goes on to state that in contrast to the West Coast markets "all forecasts for growth in East Asian steam coal markets indicate the need for opening a large number of mines regardless of location."[2]

Alaska is a likely location for some of this new capacity because it has large, low-sulfur coal reserves at tidewater, it has a shipping advantage to the Pacific Rim over competitors in the western U.S. and Canada and its potential customers are seeking a diversity of supply sources to reduce the risk of supply interruptions due to labor problems, etc. This section will review WOCOL forecasts of coal demand in the Pacific Rim and the competitive position of different suppliers, including Alaska.

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[2] W.H. Swift, J.P. Haskins, M.J. Scott, Beluga Coal Market Study, Battelle Pacific Northwest Laboratories, September 1980, Draft Final Report.

The following table summarizes the expected import requirements for the Asian countries on the Pacific Rim:

TABLE X
WOCOL Projections of Asian Import Demand
(mtce)

Country	1977	2000 Case A	2000 Case B
South Korea	--	69	88
Japan	2	53	73*
Taiwan	--	54	65
Phillipines	--	12	12
Hong Kong	--	6	6
Singapore	--	5	5
Malaysia	--	3	3
TOTAL, these countries	2	202	252

NOTE: Data for Vietnam, Thailand, Indonesia, North Korea and the People's Republic of China (PRC) is not available. The PRC is expected to be a net exporter of steam coal as it has the third largest reserves in the world, after the Soviet Union and the United States. Indonesia also has some export potential.

* Japanese projections for import demand go as high as 121 mtce, as noted earlier, if demand for 48 mtce for synfuels production is included. However, this synfuels demand is speculative.

Source: WOCOL, Volumes I and II.

Japanese Demand

In Japan, the major projected uses of steam coal in 2000 are in electrical power generation and synfuels production. In the electrical generation market, between 57 and 72 mtce would be required, according to the projections of the WOCOL Japanese team. The table below indicates how Japan is planning to reduce its reliance on oil in electrical generation by 2000.

TABLE XI
Japan's Electricity Balance
(Gwe capacity)

Power Plant Type	1977	%	2000 Case A	%	2000 Case B	%
Nuclear	8	7%	94	33%	100	32%
Hydro/Pumped Storage	25	23%	51	18%	62	20%
Geothermal/Solar/Other	--	-	1	--	3	1%
Fossil Steam						
Oil	61	56%	50	18%	50	16%
Gas	11	10%	44	16%	46	15%
Coal	4	4%	41	15%	52	16%
TOTAL CAPACITY	109	100%	281	100%	313	100%

Note: This data seems to assume that the coal-fired power plants will be operating at slightly higher than 65% capacity.

Source: WOCOL, Vol. II, page 27.

Even though coal-fired capacity will contribute only between 15 and 17% of Japan's electrical needs, it will have to increase its current capacity by at least a factor of ten, if not more. Most of this new coal-fired capacity is scheduled to begin coming on-line in the late 1980's and early 1990's. The following table shows the timing of coal requirements for the planned additions to Japanese coal-fired capacity; all tonnage quantities are stated in terms of "specfication coal", that which meets Japanese utility heating value requirements.

TABLE XII

Projected Additions to Annual Coal Requirements
Japanese Utilities, 1981-1993
(million metric tons)

	Annual Additions Japanese specs.	% Procured 8/80	Cumulative Additions	Cumulative % Procured, 8/80
1981	2.67	82%	2.67	82%
1982	3.36	46%	6.03	63%
1983	1.74	0%	7.77	49%
1984	2.32	0%	10.09	37%
1985	1.90	61%	11.99	41%
1986	5.94	0%	17.93	27%
1987	2.86	0%	20.79	24%
1988	10.78	0%	31.57	16%
1989	5.28	0%	36.85	13%
1990	11.00	0%	47.85	10%
1991	1.32	0%	49.17	10%
1992	5.94	0%	55.11	9%
1993	1.32	0%	56.43	9%

Source: Estimated Demand and Procurement of Steaming Coal by Japanese Power Utilities, Energy Development Department, Marubeni Corporation, August 1980.

As the table above shows, about 63% of Japan's anticipated coal requirements will be needed after 1987. As of August 1980, no suppliers had been contracted for these supplies. In all, Japan has committed supplies for only about 9% of its projected coal needs over the next 13 years.

The timing of the major Japanese requirements for coal - after 1987 - corresponds with the likely time of startup for a large-scale Beluga mine, assuming that contracts were signed in the near future and that inevitable delays lengthen the projected startup of a mine beyond the six years estimated for planning purposes.

Japanese requirements are stated on the above table in terms of its "specification" coal. As of August, 1980 the Japanese were requiring coal that has approximately 11,880 Btu/lb. Given these current Japanese coal specifications, no Alaskan coal would be able to compete in this market. A Japanese buyer would incur both a transportation and operating cost penalty if he substituted lower quality Alaskan coal for "specification" coal. However, these "specifications" are subject to change as the Japanese develop and modify their existing equipment and their planned equipment to correspond to the characteristics of other coals, such as Beluga coal, which may be in greater supply. Lower quality coals might be attractive to the Japanese for a number of reasons including security of supply, balance of payments considerations, and the quantity available.

Alaskan coal is currently being tested by Japanese utilities to determine its burning characteristics. The Japanese are particularly interested in some sort of a coal/oil mixture, which would upgrade the low-heating value of Alaskan coals and would reduce problems of spontaneous combustion in transit.

The other major Japanese use for steam coal is as a raw material for synfuels. Under the low-coal growth Case A assumption, synfuels only require about 7 mtce in 2000. However, under the Case B assumption, 48 mtce of steam coal would be required for synfuels. It is most likely that synfuels will be produced at mine-mouth plants and then imported into Japan.

Korean and Taiwanese Demand

In Korea, steam coal demand will come from two major sectors--residential consumption and electrical power generation. The residential market probably will require a high grade coal, possibly anthracite. Alaskan coal would be unlikely to compete in this market. However, the electrical market is projected to require between 28 mtce and 47 mtce by 2000; this represents between 29% and 47% of total Korean coal requirements projected for 2000. Again, nuclear power is expected to predominate in the electrical generation market, accounting for between 36% and 54% of power requirements. (WOCOL, Vol. II pages 532-533)

Within the past two weeks, 30,000 metric tons of Usibelli coal has been shipped from the Port of Anchorage to Korea. A Korean utility company will be testing this coal in its facilities before deciding on a larger purchase.

The circumstances in Taiwan are similar. Between 50 mtce and 56 mtce are projected to be required by 2000 to serve the electrical needs of the country. Nuclear power is projected to account for between 39% (low-coal case) and 34% (high-coal case). Clearly, in each of these countries, the trade-offs are between nuclear power and coal-fired electrical power generation. Anything that inhibits the growth of nuclear power will probably promote coal-fired generation, given the constraints on oil and gas supplies. Neither Taiwan nor Korea has any significant hydroelectric capability. (WOCOL, Vol. II, pages 534-535)

Competing Sources of Supply

According to WOCOL, the United States and Australia are likely to be the two major sources of supply for steam coal markets in Japan, Korea and Taiwan. As Japan will probably be the major market in Asia, data on its supplier preferences will be used as an indicator of the preferences of the region. The table below indicates projected tonnage shipments, by supplier, to Japan in the years 1977, 1990 and 2000. Data for 1990 and 2000 reflect the Case A (low-coal) assumptions.

Table XIII
Potential Share of the Japanese Market by Supplier
(millions of metric tons*)

	1977		1990		2000	
	tons	%	tons	%	tons	%
U.S. (West Coast)	--	--	10.2	38%	24.8	41%
Australia	.7	50%	10.2	38%	14.7	25%
China (PRC)	.2	14%	2.3	8%	5.6	9%
Canada (West Coast)	--	--	1.1	4%	4.5	8%
South Africa	.2	14%	2.3	8%	4.5	8%
Indonesia	--	--	--	--	2.3	4%
U.S.S.R.	.3	22%	1.1	4%	2.3	4%
India	--	--	--	--	1.1	1%
TOTAL	1.4	100%	27.2	100%	59.8	100%

* This table assumes coal of 11,070 Btu/lb. rather than the 11,800 Btu/lb. coal assumed in Table XII; consequently, the tons of coal required are higher.

Source: WOCOL, Vol. II, page 285. This data was compiled by Japan's WOCOL team for the purpose of determining the number of vessels required by each supplier to meet expected shipping volumes.

However, there is a great deal of uncertainty about the probable market shares of different suppliers. Some forecasts limit the total U.S. market share in Japan and/or the Pacific Rim to 10%, citing the problems of high inland transportation costs and low quality coal. Others give the U.S. and Canada a combined 30% share, again far lower than the 49% combined share attributed by WOCOL. China is another question mark in all forecasts. WOCOL projects it will represent about 5-6% of the Japanese market, while other forecasts place Japan's dependence on Chinese coal as high as 30%.

The source of some of the forecast uncertainty is the fact that both the U.S. West Coast and China lack large-scale coal shipping ports. Certainly, new U.S. coal ports on the West Coast will face a series of delays due to environmental opposition, in addition to the delays that always develop in large-scale building activities. Chinese development activities would probably require foreign captial and expertise; observers are uncertain whether the Chinese want to commit extensive resources to an export effort.

Comparative 1980 Coal Prices. Based on data currently available, including the projections of the Beluga leaseholders, Battelle estimates that dried coal from the Chuitna portion of the Beluga field would be competitive in Asian markets today. The table below was derived from Battelle data and shows estimates for the delivered price of different coals in Japan, Korea, and Taiwan. Clearly, Australia is the lowest cost supplier. However, as noted before, Alaskan coal will not be coming into the market until much later in this decade; by that time, its relative cost postion may be even stronger.

In the following sections, other factors influencing the competitiveness of each country's coal are discussed briefly.

TABLE XIV

Comparison of Delivered Coal Prices (1st Qtr. 1980$)

($/million Btu)

	Alaska		Western U.S.		Western Canada	Australia		South Africa	
	Chuitna		Wyoming	Arizona	S.E. Br. Col.	New S.W.	Queensland	Natal	N. Transvaal
JAPAN									
F.O.B. dock	1.00	1.30	1.11	.75	.93	.45	1.04	.51	1.71
Transportation	.55	.55	.75	.70	.57	.58	.60	1.06	.88
Delivered	1.55	1.85	1.86	1.45	1.50	1.03	1.64	1.57	2.59
KOREA									
F.O.B. dock	1.00	1.30	.75	1.09	.93	.45	1.04	.51	1.71
Transportation	.58	.58	.79	.76	.59	.60	.62	.98	.81
Delivered	1.58	1.88	1.54	1.85	1.52	1.05	1.66	1.49	2.52
TAIWAN									
F.O.B. dock	1.00	1.30	.75	1.09	.93	.45	1.04	.51	1.71
Transportation	.70	.70	.93	.84	.70	.50	.51	.88	.73
Delivered	1.70	2.00	1.68	1.93	1.63	.95	1.55	1.39	2.44

Source: Battelle, op. cit.

U.S., excluding Alaska. The largest economically recoverable reserves of coal found in the U.S. are in Montana and Wyoming. These states contain six of the ten largest mines in the U.S., each averaging about 8.5 million tons of annual strip production in 1978. For Asian markets, coal from these fields could be moved by rail - the Burlington Northern and Union Pacific - to proposed coal ports in Portland and Seattle, a distance of about 1000 miles. At that point, the ocean shipping distance to Japan is about 4,300 miles. The Montana and Wyoming coals have heat values ranging from 8,740 Btu/lb. to 10,750 Btu/lb. and sulfur contents between .4% and .8%.

The alternative source of export coal is found in the fields of southwestern Wyoming, Utah, Colorado, Arizona and New Mexico. Coal from these states could be fed to a California port - Los Angeles or San Francisco by the Atchison, Topeka and Santa Fe, the Western Pacific or the Union Pacific railroads, a shipping distance of about 800 miles. Coal in these states is higher quality, about 10,750 Btu/lb. to 12,250 Btu/lb., and about the same sulfur content as Montana/Wyoming coal. In Utah, where 12,250 Btu/lb. coal is mined underground, production costs are about three times those in strip mines.

There are two major factors which will affect the competitiveness of these coals in the Pacific Rim market: the lack of large coal-handling ports on the West Coast and the sensitivity of delivered prices to the cost of inland rail transportation. While there are limited exports of metallurgical coal out of California ports, no facilities are currently available to handle large shipments. As noted above, environmental problems may preclude or delay the construction of the needed port facilities.

Inland shipping charges constitute a large portion of the delivered Asian price of western coals. According to data compiled in the Battelle report, inland shipping charges constitute between 33% and 45% of the current delivered cost of western coals in Japan. Given current expectations that rail rates will rise rapidly, this is seen as a major potential competitive problem for these coals, assuming port facilities are available to ship the coal.

The impact of inland transportation costs on the competitiveness of western coals may prove to be a short-term (ten to fifteen years) problem. Other suppliers face rising costs as annual production volumes increase, whereas cost projections for the largest western U.S. fields show that relatively small increases in cost accompany large increases in output. Consequently, as other suppliers, notably Australia and South Africa, begin to exhaust their lowest cost reserves, their costs may rise enough to offset the transportation disadvantage of western coals. It seems likely that these two countries will supply most of the short-term demand for steam coal in the Pacific Rim and, as a consequence, deplete their lowest cost reserves.

The importance of western coals in the Pacific Rim markets is a point of disagreement between the Battelle study and the WOCOL report. Battelle argues strongly that these coals will be priced out of the market because of transportation costs.* WOCOL, on the other hand, projects a significant role for western coals. The reconciliation of these points of view probably lies in assumptions about the eventual size of the world steam coal market and the rate at which it develops. A study of U.S. coal exports done by the U.S. Department of Energy concludes that:

> The general cost disadvantage of U.S. coal, is valid only for relatively small increments in world steam coal trade. As discussed in the previous section, the U.S. resource base is so large that the cost characteristics of new mines will not be substantially different. Other potential coal suppliers, however, such as Australia, South Africa and Poland, may be able to supply only limited amounts of additional steam coal without major cost increases. As the world steam coal market expands from the current level of about 30 million tons per year toward 100 million tons or more by 1990, U.S. coal could face competition from other sources. But, as the world coal trade expands toward 150 million tons per year or more, the U.S. share of the market will probably increase significantly.[3] (Emphasis added)

Australia. Australian coals originate in Queensland (northeastern Australia) and New South Wales (southeastern Australia). Queensland coals range in heating values of 9,000 Btu/lb. to 12,250 Btu/lb. Coal in New South Wales is a bituminous coal with heating values between 10,500 Btu/lb. and 12,500 Btu/lb. Shipping distance to Japan from Australia is about 4200 miles. There is relatively little inland transportation of Australian coals.

Battelle notes there is uncertainty about Australia as a supplier; the sources of this uncertainty include shortage of labor, labor problems, availability of internally-generated capital in view of foreign investment restrictions and the attitude by the government with respect to coal taxation.

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3 U.S. Department of Energy, Coal Exports Study, December 1979, pages 1, 15.

*Reviewer's note: "Also, we have more recent intelligence on the experience the railroads are having with unit trains. Apparently maintenance costs for rolling stock are much higher than expected, and present rates may be too low." Ward Swift, Battelle Northwest Laboratories

Canada. Western Canadian coals originate in southeastern British Columbia and Alberta. Coals from Alberta are similar to those from Montana and Wyoming while British Columbian coals are bituminous with a higher heating value of around 11,000 Btu/lb. The Canadians have a coal port at Roberts Bank, British Columbia, which has been used for the export of metallurgical coal. Shipping distances to Japan from Roberts Bank is about 4260 miles.

South Africa. South African coals range in heating value between 9,000 and 12,000 Btu/lb. These coals lie about 7200 miles from Japan and are clearly at a disadvantage in shipping distance. It is not clear what portion of South African coals will go to serve the western European market instead of the Asian market.

Alaska. There are two potential sources of export coal in Alaska: the existing Usibelli mine on the Nenana field and proposed mines on the Beluga field. The Usibelli Coal Mine, Inc. has just shipped a small amount of coal to Korea for tests. Of the three active leaseholders on the Beluga field - Mobil Oil Corporation, Bass/Hunt/Wilson group, and Placer Amex Inc./Cook Inlet Region, Inc., the latter two have actively been seeking overseas markets.

The Nenana field is located approximately 230 miles north of Anchorage, on the northern side of the Alaska range. Coal found there has about 8,000 to 8,500 Btu/lb. and less than 1% sulfur. The Usibelli mine is currently producing about 750,000 tons per year for local Alaskan consumption. Coal is either used at a mine-mouth generating plant or shipped on the Alaska Railroad to Fairbanks.

The Beluga field is located on the north side of Cook Inlet, about fifty miles west of Anchorage. There are three major deposits on the field: the Chuitna River, the Capps, and the Threemile. Again, the coal is a low heating value subbituminous coal, with extremely low sulfur contents. Certain coal deposits would require drying to improve their heating values sufficiently for export. The table below summarizes some of the characteristics of coal found in the Chuitna and Capps deposits on the Beluga field.

TABLE XV
Comparative Characteristics
Beluga Coals vs. Japanese Specification Coals

	Japan E.P.D.C.	Chuitna 10% Moisture	Waterfall Seam Run of Mine
Heating Value, Btu/lb.	11,160	9,570	7,536
Ash Content, %	20	9	16
Moisture Content, %	10	10	21

Source: Beluga Coal Market Study, Final Report, Battelle Pacific Northwest Laboratories, December 1980, page 7-2.

Within the next six or seven years, corresponding to Phase I in the Summary of Findings, the only possible source of export coal is the Nenana field. While it would be possible for the Usibelli mine to expand production to about 4 million tons a year, it is unclear whether or not sufficent railroad and port facilities will be available to transport the coal to tidewater.*

A second phase of coal development will occur in Alaska if leaseholders on the Beluga field are able to secure contracts with an Asian buyer. In order to justify the required port infrastructure, an estimated annual volume of five million tons is required. As the Battelle report notes, the Asian market is the only market that is expanding rapidly enough to absorb the opening of new mines in Alaska or elsewhere.

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*Reviewers' Notes: "In this, we also note that the expansion at the Usibelli mine to four million tons per year and assumed unit train shipment of coal to some export facility on the Alaska Railroad would require major upgrading of both roadbed, storage and loading facilities at the mine, as well as a stockpile and reclaim facility at the port. While such legislation may be forthcoming to acquire funds for such work, it may require some time to get the necessary bill prepared and through the Congress to authorize the funding." Cole McFarland, Placer Amex Inc.

"Coal handling, port facilities are a real hurdle for moving Usibelli coal out on the Alaska Railway, at least in large tonnages." Ward Swift, Battelle Pacific Northwest Laboratories.

ALASKAN MARKET POTENTIAL

Currently, about 750,000 tons of coal are supplied to the Alaskan market from the Usibelli mine in Healy. The timing and extent of further development to serve an expanded Alaskan market for coal will be determined, to a large extent, by the decision whether or not to build the Susitna hydroelectric project. If Susitna is built, it is unlikely that there would be any other requirements for Railbelt power within this century. If it is not built, then coal is one of the likely sources of fuel for electrical generation. If coal were to capture all of the increased Railbelt demand for electric power by 2000, an additional 2.5-3.0 million tons of Alaskan coal would be needed annually. This volume of demand would not be sufficient, on its own, to justify opening a facility on the Beluga field, so it would probably be met by expanded production at Healy. However, given that new power plants have lead-times of up to ten years, new Alaskan demand might not begin to develop until the early 1990's, assuming a no-go decision is made on Susitna within the next few years.

Usibelli coal is currently purchased by two Fairbanks area utilities, the University of Alaska, and the military installations around Fairbanks. The table below shows the consumption of coal, by user:

TABLE XVI
1979 Consumption of Alaskan Coal
(thousands of short tons)

	GVEA	FMUS	UA	Military
Coal Purchases				
For Electricity	147	122	20	88
For Steam, Other	0	0	40	313
TOTAL	147	122	60	401

Key: GVEA - Golden Valley Electric Association, a mine-mouth plant at Healy
FMUS - Fairbanks Municipal Utility System
UA - University of Alaska, Fairbanks Campus
Military - Fort Wainwright, Eielson AFB, Clear AFB, Alaska Railroad

Source: House Research Agency, Memorandum to Representative Bill Miles from Alexander Hoke, January 18, 1980

Of the 730,000 tons purchased in 1979, about 55% went to meet military demand. Of the 45% which supplied civilian demand, 88% of the coal was used to produce electricity. In the overall picture of Alaskan energy demand, coal produces only a small proportion of our energy needs. Transportation accounts for about 47% of Alaska's energy requirements while the commmercial, residential and industrial sectors use the remaining 53%.

Coal contributes almost none of the energy consumed by the transportation sector, either in Alaska or in the U.S. as a whole. While the transportation sector does not rely on coal to any extent, the commercial, residential and industrial sectors do. The following table compares Alaska's use of coal for these sectors to that of the U.S. as a whole.

TABLE XVII
Comparative Consumption of Coal by
Commercial, Residential and Industrial Sectors
(% of Total Btu Consumed)

	U.S.	Alaska's Railbelt
Coal		
As Coal	7%	2%
As Electricity	19%	10%
COAL, TOTAL	26%	12%
Other Fuels--Oil, Gas, etc.	74%	83%
TOTAL Btu CONSUMED	100%	100%

Sources: Department of Energy, Monthly Energy Review, March 1980; Alaska Center for Policy Studies, Energy Alternatives for the Railbelt, prepared for the Alaska House Power Alternatives Study Committee, August 1980.

As Table XVII shows, in Alaska, coal provides a much smaller percentage of the energy consumed to meet commercial, residential and industrial requirements than in the rest of the U.S. One of the major reasons for this is the small contribution coal makes to electricity production in Alaska. While in the U.S., 46% of the energy consumed to produce electricity comes from coal, only about 15 to 20% of the energy consumed to produce electricity in Alaska comes from coal. However, if Susitna is not built and Alaskan utilities are not able to get exemptions from regulations which prohibit the use of oil and gas in new power facilities, coal could become a more important factor in this market.

In the most recent projection of the Railbelt's power requirements over the next twenty years, ISER[4] has estimated that civilian demand for

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[4] Scott Goldsmith and Lee Huskey, Electric Power Consumption for the Railbelt: A Projection of Requirements, University of Alaska Institute for Social and Economic Research June 1980. This report provides the demand projections for the Susitna feasibility study being prepared for the Alaska Power Authority by Acres American.

electricity will increase at an average annual rate of 4.1% per year and that utility sales will increase 4.5% per year between now and 2000. This means that demand will increase from its current level of 2.80 billion Kwh/year to 6.3 billion Kwh/year by 2000. If coal were to supply 100% of this increased demand for electricity, then by the year 2000 approximately 2.0 to 3.0 million tons/year of coal would be required.[5] At this level coal would be supplying almost 60% of the Railbelt's power requirements.

An excellent discussion of the relevant considerations involved in power planning and an analysis of the alternatives to a large scale hydroelectric project for Alaska is provided by Arlon Tussing in Introduction to Electric Power Supply Planning[6]. A copy of this was provided to all Legislators by the House Power Alternatives Committee. Other than noting that coal-fired generation is clearly an alternative to Susitna, it is beyond the scope of this paper to explore the relative merits and problems of each of the alternatives.

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5 Assuming 10,500 Btu/Kwh and 8,000 Btu/lb. coal, the coal requirement is about 2.2 million short tons.

6 Arlon Tussing & Associates, Introduction to Electric Power Supply Planning with Special Attention to Alaska's Railbelt Region and the Proposed Susitna River Hydroeroelectric Project, May 1980.

WEST COAL MARKET POTENTIAL

Within the next ten years, it is unlikely that any Alaskan coal would be required on the West Coast. All current and planned coal-fired facilities have already secured coal supplies from utility-owned mines or through long-term contracts with independent mines in the western states. After 1990, the picture is less clear. If a new coal-fired plant is permitted and sited on the coast, then Alaskan coals may be able to service this market. However, demand from a likely 500 to 1000 MW facility would only be 2.0-3.0 million tons of subbituminous coal; this demand would not be sufficient to warrant opening a mine and requisite port facilities in Alaska and on the West Coast. The other alternative market for Alaskan coal after 1990 is as a coal derivative. Placer Amex estimates that about five to seven million tons/year would be required for a 54,000 bbls/day methanol facility. For environmental reasons, the West Coast has a high demand for clean fuels. Methanol derived from coal would meet that demand. However, assuming a methanol market does develop on the West Coast, Alaska developers would not be alone in wanting to serve the market. Likely sources of competition would be Australia and the Western states.

There are four factors which are important to consider in evaluating the West Coast market for Alaskan goals:

- There is little or no coal found in Washington, Oregon and California. There is none in California and only scattered deposits in Washington and Oregon, one of which is already already the site of a mine-mouth power plant.

- The Coast has a strong dependence on long-distance transmission of energy, either hydroelectric energy for the Northwest from the Bonneville Power Administration or transmission into California of power generated in plants sited in Utah, Nevada and other western states.

- There are no facilities on the West Coast to handle large-scale shipping of coal. While some coal is moved out of Puget Sound and California ports, there are no specific U.S. facilities for coal.

- Any coal shipped into the West Coast by water would have to be used on the coast in order to maintain its cost advantages. The added costs of transferring the product and incurring rail charges inland would eliminate the ocean shipping advantage of Alaskan coal with respect to western coals. As the Battelle study notes, "In considering Beluga (Alaska) coal utilization in California, it is apparent that coastal plant sites would be required as the additional cost of multiple coal handling and transport inland would be prohibitive." (Battelle, page 4-22)

There are no coal-fired electricity plants in California, and only two in the Pacific Nortwest. There is a 1363 MW mine-mouth plant in Centralia, Washington, which is supported by the seventh largest coal mine in the country. The mine supplies the plant with about five million tons of coal annually. In addition, there is a 530 MW plant in Boardman, Oregon; this plant is supplied by rail shipments from Wyoming.

Both of the major California utilities have plans to construct coal-fired facilities for use in the late 1980's. All current production is generated from natural gas, nuclear, oil or hydroelectricity.

Pacific Gas and Electric (PG&E) serves the Northern California market. It has requested permits for two coal-fired plants, originally scheduled to be on-line by 1986 or 1987. Plans for these plants have been delayed two years because load growth has slowed and there are questions about the economic trade-offs between direct-fired coal plants and the cost of complying with air pollution restrictions. Each of the proposed plants would be an 800 MW facility, burning two (12,000 Btu/lb. coal) to three (8,000 Btu/lb. coal) million tons of coal a year. PG&E owns a coal reserve in Utah which will supply these plants.

Southern California Edison (SCE) is trying to locate a site for a single 1500 MW coal-fired plant, scheduled for start-up in the late 1980's. The plant would require low-sulfur coal with a minimum heat content of 11,000 Btu/lb. Based solely on the Btu requirement, Alaskan coals (8,000 Btu/lb.) would not be able to supply a plant of this sort. Of the five sites SCE is considering, only the seacoast location provides a scenario in which Beluga (Alaska) coal might be competitive, as inland shipping would not be required. However, it is unlikely that this site will be chosen because of population density, environmental concerns, and the opposition of the California Coastal Commission. Because of both coal quality and siting considerations, western coals are planned as the fuel source for the probable inland sited plant.

Both of these California utilities indicated that methanol was one potential way of using Beluga coal in this market. Federal funding for a methanol feasibility study was recently received by Placer Amex Inc. and the Cook Inlet Region, Inc. The following was their market justification in the request for funding:

> The Pacific Coast states, principally California, constitute an extremely large potential market for clean-burning synthetic liquid fuels. The increasing cost, and more importantly, impending shortages, of low-sulfur light-distillate fuels and gasoline will provide a market for alternate fuels. Methanol has the burning characteristics and flexibility to meet a variety of fuel uses.

POLICY IMPLICATIONS OF COAL DEVELOPMENT

This paper has presented the market factors which are expected to govern the large-scale development of Alaska's coal resources. Based on these factors, development can be expected to occur in three phases. The first phase, which will probably extend until the mid to late 1980's, may involve additional capacity at the Usibelli mine to serve an Asian export market. During this period, the groundwork will be laid for the next phase of development which will probably include the opening of one or more mines on the Beluga field. These mines will also serve an Asian market. Once Alaska's position as a coal supplier becomes established, the development will enter the final stage which is likely to include incremental additions to capacity to serve new customers in Asia or the West Coast. In addition to raw coal, Alaska may be exporting coal-based synthetic fuels in this third stage of development.

In presenting this development scenario, the roles of the federal, State and local governments have been assumed to be neutral, neither encouraging nor discouraging the private development of the State's resources. This may or may not be the case.

There are a number of ways in which the federal government could affect this development. Probably the most significant federal influence would be the way in which it applies surface mining reclamation requirements to Alaska's environmental conditions; such regulations may place an undue economic burden on the coal producer.

Methanol production is another way in which the federal government could become invovled in Alaska's coal development. Currently, Placer Amex's investigation of a potential methanol facility on the Beluga field to serve the West Coast market is funded under the federal government's synfuels effort. With the new administration, the extent of future federal support for synfuels is unclear.

The State is likely to have a more direct impact on development. For the most part, the State controls access to the resources that are most attractive to developers in this century. In the short-term, its planned increase in the royalty rates charged to current leaseholders will be a factor in determining the price competitiveness of Alaskan coal. In the longer term, its willingness to increase the amount of land available for development and the terms and conditions of those new leases will influence the share of the Asian market that Alaska will capture. Currently, only five companies control about 91% of the State's leased acreage; of these, four are actively producing <u>or</u> seeking markets.

In addition to its leasing policy, the State will influence the competitiveness of Alaskan coal with its tax policy. Currently, the State has a minimal Mining License Tax which applies to coal production. While the State's tax is not a large source of revenue, other coal producing states are taxing coal more heavily. The State's course of action in changing its tax policy, as actual development approaches, will have an impact on the extent of that development.

The State may also play a role to encourage development through the financing of necessary infrastructure, such as a dock in the Cook Inlet to load ocean-going freighters with Beluga coal, or to finance improvements to the Alaska Railroad or the Port of Anchorage. Clearly, infrastructure assistance could also be undertaken by local government, through municipal tax-exempt bonding (industrial development bonds).

In the next of this series of papers prepared by the Agency, we will discuss the current and proposed changes to coal leasing and taxation laws and regulations. In a later paper, we will discuss the provisions of the federal Surface Mining Control and Reclamation Act, and how they apply to Alaska. These next papers are intended to provide a more detailed discussion of how these mechanisms are likely to influence the development of coal in the State.

APPENDIX A

The following information is excerpted from a House Research Agency Memorandum to Representative Bill Miles, May 23, 1980.

Marketing Characteristics of Different Forms of Coal

The key question surrounding the exploitation of any coal resource is:

> In what form - solid, liquid or gas - will it be competitive with other fuels?

Users are faced with an economic trade-off between paying higher prices per Btu for coal converted into a liquid or a gas for use in existing facilities, versus making large capital investments to convert existing facilities or construct new facilities to handle solid coal. This economic decision is made within the context of environmental requirements.

The following paragraphs briefly review the advantages and disadvantages of using coal as a solid, liquid or gas.

Coal as a solid. Solid coal can be shipped in a number of different forms: as-mined, washed and dried or as a solvent refiend coal (SRC). The method used depends on the quality of the coal and the buyer's requirements. Solvent refining is the extreme upgrading of solid coal. Coal is dissolved in a solvent and ash, sulfur and moisture are removed. The technology of solvent refining is still being developed for commercial applications.

Coal is awkward to ship as a solid. It is also subject to degradation in transit when exposed to moisture and air. Users must have large areas in which to hold the coal, unless they are assured of constant deliveries from a local mine or coal transportation network. Coals with high ash and moisture content, such as those at Beluga, face a shipping disadvantage; the buyer must make the tradeoff between paying for an upgraded coal to save shipping costs versus incurring the cost of shipping waste material and then disposing of it at his plant. Because of the high cost of shipping solid coal, it is ideally used close to the mine.

Coal as a liquid. Coal can be converted into a liquid in the form of a coal-oil mixture, methanol or a slurry. Coal-oil mixtures (COM) are made by dissolving a pulverized coal in residual fuel oil. This mixture offers heating characteristics similar to 100% oil while conserving oil.

The Japanese have expressed an interest in coal-oil mixtures, possibly from Alaska; however, there are political restrictions to exporting U.S. oil. In addition, the coals on the Beluga field are hard to grind, making the pulverization process more difficult and expensive.

Methanol is a chemically created liquid - a synfuel. The West Coast is considered a potential market for methanol because of its very clean burning characteristics. Methanol technology is only in the preliminary stages of development in the U.S.

Coal slurries are a means of moving coal through pipelines by suspending the coal in water; the water is removed before the coal is burned. Using coal as a liquid, as COM or methanol, allows utilities to capitalize on existing tansportation networks and generating facilities built for petroleum

Coal as a gas. Coal can be converted into a low or medium Btu gas in an enclosed vessel; this gas can then be used in modified existing facilities designed for high-Btu gas. It is likely that the conversion would take place at the power plant as it is not economical to ship a gas or liquify, then regasify, a gas derived from coal.

Coal Characteristics

The table on the following page, compares the characteristics of Beluga coal with those of other coals found in the U.S. Beluga coal is a subbituminous coal, similar to coal found in the area east of the Rockies. It has the following characteristics:

- Lower heating value per lb. than other western coals and lower than Chinese, Australian and South African coals.
- Higher ash and moisture content than competing subbituminous coals.
- Sulfur levels significantly lower than those found in other coals.

Fewer Btu/lb. and higher ash and moisture contents are unattractive to buyers becuase they increase the costs of shipping given amounts of Btus. Low sulfur levels are attractive to U.S. and Japanese buyers concerned with meeting air quality standards.

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TABLE I

Comparison between Beluga and Other U.S. Coals

	Btu/lb.	Fixed Carbon	Sulfur Content	Ash Content	Moisture Content	State
Anthracitic						
Anthracite	12,925	79.4%	.60%	11.9%	2.5%	PA
Bituminous						
High Volatile B Bituminous	12,600	50.2%	.90%	6.4%	5.2%	UT
Subbituminous						
Subbituminous A	11,140	46.2%	.43%	7.0%	14.1%	MT
Subbituminous B	9,345	40.8%	.30%	3.7%	25.0%	WY
Subbituminous C	8,320	32.8%	.55%	4.8%	31.0%	WY
Beluga Seams -						
Waterfall*	7,400	28.1%	.16%	14.1%	24.0%	AK
Capps*	5,746	21.4%	.14%	27.5%	23.0%	AK
Chuitna**	7,250#	N/A	.15%	12.8%	26.0%	AK
Threemile*	7,000	N/A	N/A	N/A	N/A	
Lignitic						
Lignite A	7,200	32.2%	.40%	4.2%	37.0%	ND

Sources: All data for non-Beluga coals is taken from: The Direct Use of Coal, Congress of the U.S. - Office of Technology Assessment, April 1977. All data for Beluga coal is taken from: Beluga Status Report, Placer Amex Inc., September 1979.

Notes: Analysis of non-Beluga coals was done on a "bed moisture" basis. Bed moisture is the inherent moisture of the coal under specific temperature and pressure conditions. Analysis of the Beluga coal was done on an "as received" basis. "As received" is defined as the condition of the coal when it reaches the buyer's delivery point, a railroad siding, port, etc. In this case, it is at mine-mouth. These are roughly comparable bases for comparison for the purposes of this report.

* Dilution included. This measure includes the weight of the top and bottom three inches of sand above and below a seam in the analysis of coal constituents. If the seam is very deep, the dilution, the ratio of sand to coal, is less than if the seam is thin. ** Undiluted. The weight of the upper and lower layers of sand has not been included in the analysis. # Average.

House Research Agency/AHD 5/14/80