FINAL REPORT

Energy Intensive Industries for Alaska
Volume II: Case Analysis

September 1978

Prepared for
Alaska Division of Energy and Power
Development and the U.S. Department of
Energy under Contract 300A 01123

Institute of Social and Economic Research,
University of Alaska

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by
Battelle
Memorial Institute

PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
Under Contract EY-76-C-06-1830

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ENERGY INTENSIVE INDUSTRY FOR ALASKA

VOLUME II
CASE ANALYSIS

Pacific Northwest Laboratory
The University of Alaska, Institute
of Social and Economic Research
Kent Miller

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VOLUME II

PREFACE: VOLUME II

Volume II of the study "Energy Intensive Industry for Alaska" undertakes a case study of a selected industry (primary aluminum metal production). Part 1 of this volume provides discussion of the economics of the industry and provides a discription of a conceptual Alaskan smelter including its physical nature, employment and tax consequences, and its environmental attributes.

Part 2 of this volume discusses the social and economic impacts and was prepared by the Institute of Social and Economic Research, University of Alaska.

Part 3 discusses the State management options for involvement with the industry and was prepared by Kent Miller.

Energy Intensive Industry for Alaska

VOLUME II

PART 1: CASE ANALYSIS OF PRIMARY ALUMINUM METAL INDUSTRY

prepared for

Division of Energy and Power Development

Department of Commerce and Economic Development

by

Pacific Northwest Laboratory

Richland, Washington

September 1978

ENERGY INTENSIVE INDUSTRY FOR ALASKA

VOLUME II: CASE ANALYSIS

PART 1: CASE ANALYSIS OF THE PRIMARY ALUMINUM METAL INDUSTRY

1.0 INTRODUCTION

Volume I of "Energy Intensive Industry for Alaska" evaluated a number of energy industries that might be attracted to the state as a consequence of the availability of its large and diversified sources of primary energy. For a number of economic reasons, it was concluded that the availability of energy resources per se would not be sufficient to overcome the higher capital, operating, and marketing costs for a world scale primary industry located in the state.

However, it was also concluded that of all industries examined, the primary aluminum metal industry (the most energy intensive) appeared to be the most likely to succeed in Alaska assuming the future availability of a large block of low cost hydropower. It was further concluded that, due to the trends in the domestic and worldwide aluminum industry and markets and the potential implications a large electroprocess industry would have to Alaska's electric power supply planning, a more detailed analysis of that industry's potential was warranted. Thus, the following pages examine the aluminum industry in some detail as a model locational analysis of an industry along with the environmental, economic and electric power implications.

2.0 SUMMARY

SUPPLY AND DEMAND

- U.S. domestic demand for primary aluminum is expected to grow at 4.5 to 5% per year; world demand at a somewhat higher rate.
- The U.S. is a net importer (10% in 1973) and the percentage of imports is expected to increase to ∿16%.
- The domestic industry is currently running at ∿80% of capacity could conceivably expand an additional 20% through plant extentions and upgrading. Additional new plants will be required in the 1980's to the extent of about 2.9 million tons per year.
- Due to high energy costs (high dependance on imported oil), the Japanese primary aluminum industry has ceased expansion and is in fact cutting back capacity in spite of increasing demand. The Japanese industry is, in effect, being "exported" through the establishment of joint ventures with overseas countries desiring industrial development and willing to provide a degree of subsidization through low power costs.

ECONOMIC FACTORS

- The price of aluminum has increased markedly following the rapid increase in world energy prices initiated in 1973. Further price increases near 2.5% per year in constant dollars are expected.
- The cost of electric power is the dominant factor in the industries decision on location of new or expanded production capacity. Low cost domestic hydropower opportunities are essentially exhausted in the contiguous states and the domestic industry will be increasingly dependent upon thermally produced power and more and more purchased at the margin, i.e., in the range of 30 to 40 mills/kwh.
- An example discounted cash flow analysis of a conceptual 180,000 ton per year Alaskan aluminum smelter suggests that such a venture could be successful at a discount rate of 10% and assuming power could be available at 10 mills/kwh and that a 2.5%/year rate of escalation in

the price of aluminum occurs. Future outcomes in the costs of alternative power and the world price of aluminum could lead to more favorable economics.

- Alaska's major competition in the siting of a new, "greenfield" smelter will come from overseas rather than from the "lower 48". Balance of trade and national security considerations may thus play a role.

CONCEPTUAL ALASKAN ALUMINUM SMELTER

- A conceptual 180,000 ton per year Alaskan smelter would involve a capital investment of about $480 million, including a marine terminal.

- Employment associated with operation of the smelter would be approximately 1,200 workers with a total payroll of about $30 million.

- Power requirements would range from 240 to 330 MW and 2.1×10^9 to 2.8×10^9 kwh annually. For perspective, this represents approximately 15 to 21% of the proposed Upper Susitna hydroelectric projects capacity and 30 to 40% of the hydroelectric projects annual energy production.

- Should the State wish to actively pursue the development of the aluminum industry, the following are the clearly apparent initiatives required.

  1) Develop an electric power supply plan including outlining of prices over time and related power marketing policies. Such policies and marketing arrangements should be consistant with tax conditions surrounding financing power projects and equity for utility consumers.

  2) Make the results of the above available to the industry and solicit comment and expressions of interest.

  3) Assuming favorable industry expressions, prepare appropriate siting, regulatory and tax information and provisions in consort with local governmental bodies.

  4) Inform potentially implicated Federal agencies of the state interests and national implications.

  5) Evolve optional plans for state or local government involvement in necessary infrastructure (transportation facilities, community services, etc.).

  6) Analyze and present to the state citizens and the Legislature, the consequences of recruiting the industry into its economic framework.

3.0 CHARACTERISTICS OF THE INDUSTRY

3.1 Structure of the World Aluminum Industry[1]

Internationally, the aluminum industry consists of large, vertically integrated multinational firms, six of which have equity interests in 50% of the world production capacity.[2] About forty other firms own 25% of the capacity frequently nonintegrated, but in association with one or more of the six large firms. It is also significant to Alaska's economic development to note that host governments of 24 countries own or have equity positions in the remaining 25%. Local governments, through bond issues, may assist financing of new plants and may also provide tax incentives and, in some developing countries subsidies via reduced power costs. Joint and transnational ventures are becoming increasingly frequent. The very high capital costs (now > $2000 per annual ton of capacity) makes it difficult for new companies to enter the industry.

The principle raw material for aluminum is bauxite of which about 40% is produced in the Western Hemisphere - Jamaica, Surinam and Guyana producing about 35%. Australia is the world's largest producer and along with Guinea and the U.S.S.R. accounted for 40%. United States production (Arkansas) is less than 3% and reserves are very small.

Most of the bauxite mined is processed (Beyer process) tc alumina in the country of origin in order to reduce transportation costs to the aluminum smelters. The latter are generally located in association with low cost thermal or hydroelectric power generation.

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[1]The reader is referred to "Mineral Facts and Problems" 1975 edition Bureau of Mines Bulletin 667, U.S. Department of the Interior for additional detail.

[2]Alcan Aluminum Ltd., Aluminum Company of America-Alcoa, Reynolds Metals, Kaiser Aluminum and Chemical Corp., Pichiney Ugine Kuhlmann Group-PUK, and Swiss Aluminum Ltd.-Alusuisse.

3.2 U. S. Domestic Industry Structure

The domestic industry structure is not dissimilar from the world industry. Table 3.1 summarizes the domestic industry capacity status as of January, 1978.

TABLE 3.1
U.S. DOMESTIC PRIMARY ALUMINUM CAPACITY
January, 1978

Company	Capacity 10^3 TPY	Capacity %
Alcoa	1,707	34
Reynolds	856	17
Kaiser	723	15
Anaconda	299	6
Ormet	260	5
Intalco	260	5
Martin Marietta	252	5
National Southwire	180	4
Consolidated	176	4
Noranda	140	3
Revere	113	2
	4,966	

Source: U.S. Bureau of Mines

Not all of the capacity listed in Table 3.1 is currently in operation. Due to the recent rapid increase in thermal power costs, some plants in the southern U.S. are currently idle and imports are taking up the slack. Alumax (joint venture with the Japanese Mitsui Co.) has proposed 296,000 TPY of new "greenfield" capacity with one plant each in Oregon and South Carolina scheduled for early 1980's start-up.

The United States is a net importer of aluminum (> 70% from Canada). On the domestic side, it is important to recognize where the market exists for an Alaska aluminum smelters ingot product, i.e. locations of downstream fabrication industries. Based on 1975 statistics the five largest fabrication industries in terms of tonnage throughput were:

	millions of tons
Sheet and Plate	4,159
Extruded Shapes	1,299
Wire and Cable	671
Foil	615
Rod and Bar	261

Using maps prepared by the Aluminum Association Inc. for locations of sheet and plate, foil, and extrusions (Figures 3.1 - 3.2) it is apparent that these consuming industries are located primarily in the industrialized eastern states, i.e. east of the 90^{o} meridian. To a far lesser extent a market for aluminum ingot occurs in Southern California. This situation exists despite the fact that more than one third of the primary metal production occurs in the Pacific Northwest based on federal hydropower availability. Very limited fabrication to intermediate products occurs in the same region.

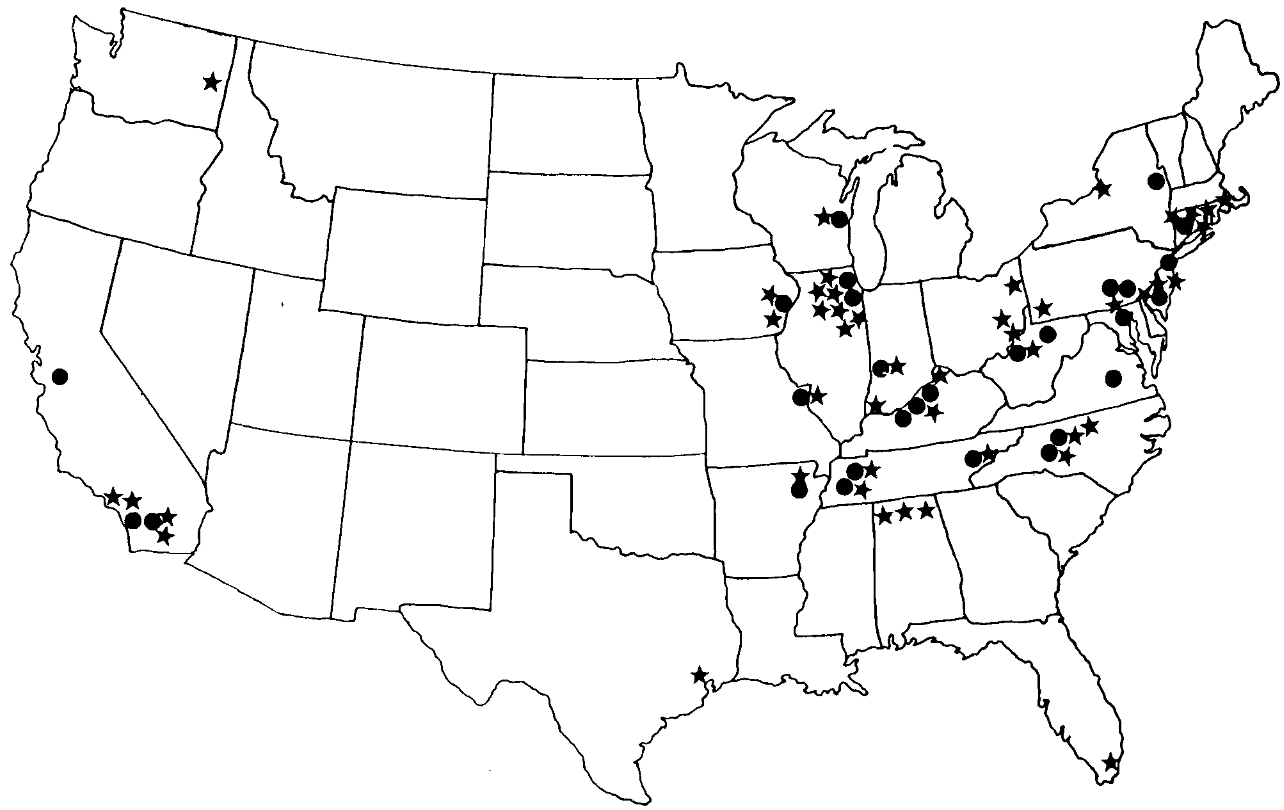

FIGURE 3.1 Aluminum Foil, Sheet and Plate Fabrication Plants

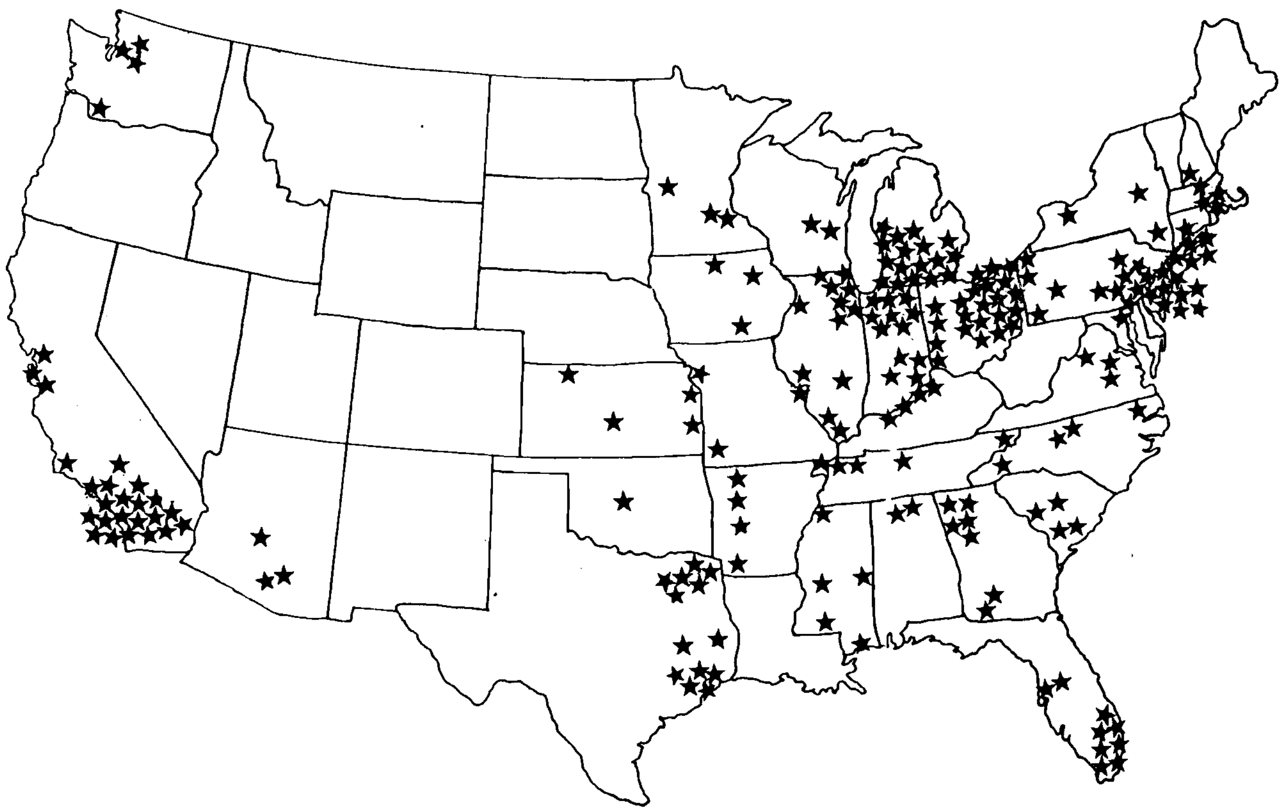

FIGURE 3.2 Aluminum Extrusion Plants

4.0 PRIMARY ALUMINUM SUPPLY AND DEMAND

Traditionally, the demand for primary aluminum has been cyclical but as penetration of new markets has occurred, aluminum demand has generally increased at rates greater than the gross national product. Figure 4.1, prepared from U.S. Bureau of Mines(1,2,3) and Battelle(4) estimates, depicts the U.S. domestic, Japanese and world demand for aluminum from 1970 with forecasts to the year 2000.

The U.S. domestic demand is expected to grow at 5% per year through 1985 from a base year of 1977 declining to 4.5% per year from 1985 through 1990. However, announced expantions through 1983 are expected to be only at a rate of 1.5% per year leading some analysts to conclude that increased reliance will be placed on imports. Other analysts tend toward a somewhat lower growth rate forecast. One of the uncertainties is the extent to which aluminum will increase its penetration in the transportation market. For example, from model year 1978 to 1979, aluminum use in automobiles is expected to increase from 115 to 127 pounds ($\sim$10%). The possible upper limit in automobile use is in the range of 300 to 500 pounds per car.

The argument is often put forth that many U.S. domestic aluminum plants are old and becoming technologically obsolete and that new "green-field" smelters will have to be built in the near future. In actuality, the nature of the Hall process is such that the plants are almost continuously updated in the course of normal maintenance and pot replacement. For example, the Alcoa Massena, New York plant built in 1903 is currently operating and will be shifting its power source from hydro to more costly nuclear power and presumably still remain economic. Similarly, the Alcoa Tennessee plant built in 1914 is being considered for expansion.

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[1] U.S. Bureau of Mines "Primary Aluminum Plants Worldwide", December 1977

[2] U.S. Bureau of Mines "Mineral Commodity Summaries" 1978

[3] U.S. Bureau of Mines "Mineral Facts and Problems" 1975 Bulletin #667

[4] Battelle-Northwest "Identification of consumation Patterns from Eleven Strategic Materials in the United States, Canada and Japan" Report to Federal Prepaedness Agency, August, 1977.

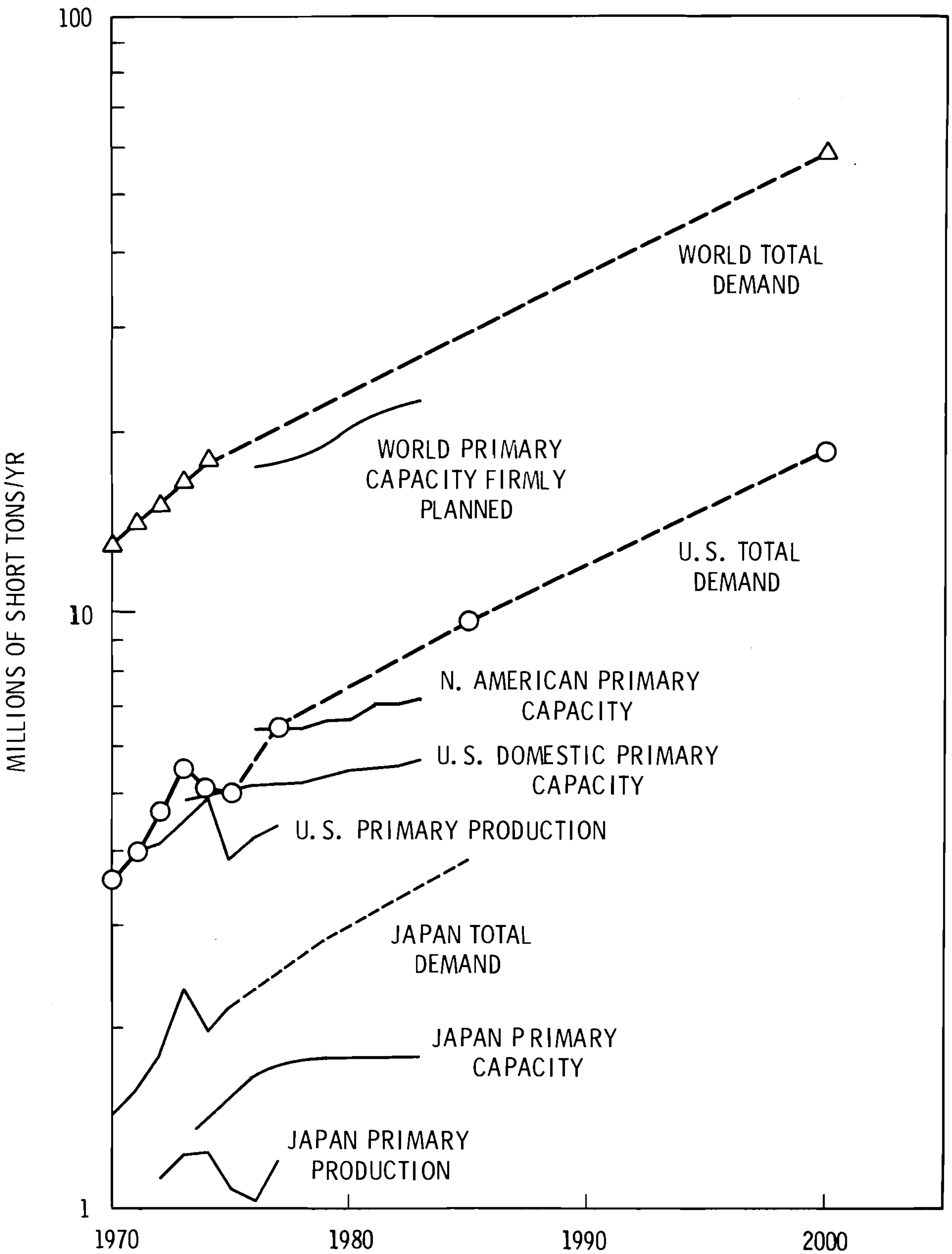

FIGURE 4.1 PRIMARY ALUMINUM METAL DEMAND

The Federal Preparedness Agency believes that the domestic aluminum demand (primary plus secondary) will increase according to the following pattern:

TABLE 4.1 Aluminum Requirements Projected Growth Rates, Peacetime 1973--1990 (Compounded Annual Percent Rates of Growth)

To	From 1973	1980	1985
1980	4.9	-	-
1985	4.8	4.6	-
1990	4.7	4.5	4.4

The Bureau of Mines forecasts that imports will account for an increasing portion of the total supply in future years, rising from 10% in 1973 to 14.8% and 16.2% in 1985 and 1990, respectively. Tables 4.2 and 4.3 summarize Bureau of Mines estimates of supply sources and future trends.

The above Bureau of Mines estimates suggest that between 1980 and 1990, a 68% expansion in primary production may occur (3.74 million TPY). The industry is currently running at 80 to 85% of capacity and could conceivably expand an additional 20% through plant additions and upgrading. In any event it appears that new "greenfield" plants will be required in the 1980's to the extent of about 2.9 million TPY unless imports increase more rapidly than forecasted.

Currently approximately 62% of U.S. imports are from Canada and this is expected to decline to 37% by 1990 although still increasing in total tonnage.

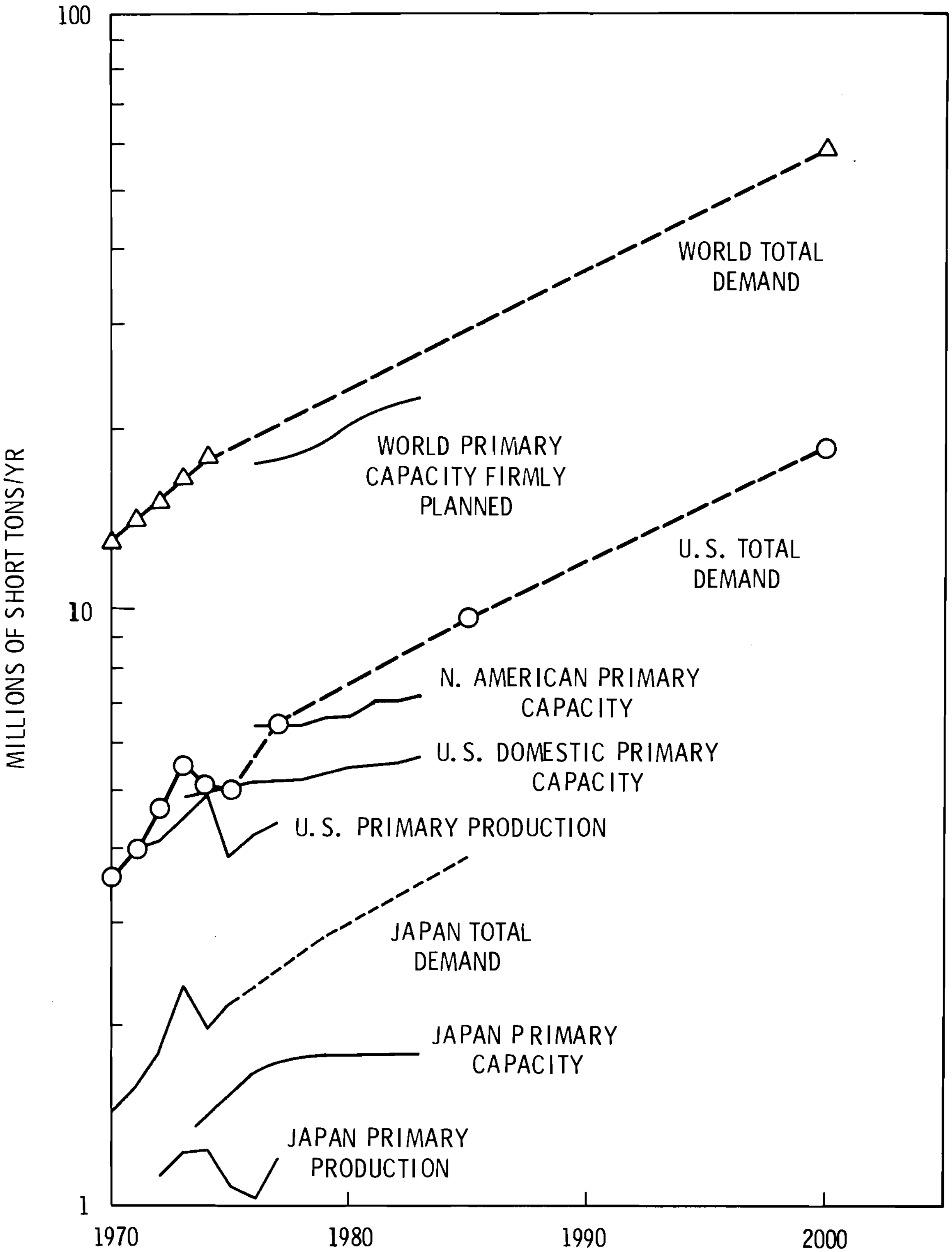

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TABLE 4.2. U.S. Imports of Aluminum By Source
(Thousands of short tons)

	Estimated	Forecast		
	1976	1981	1986	1990
Total U.S. imports	643	1100	1750	2300
Source:				
Canada	400	575	675	850
Brazil	-	-	150	300
Other - Americas	10	25	100	175
Ghana	53	100	125	150
Other - Africa	-	-	175	200
Near East Asia	44	175	250	300
Oceania	8	25	50	100
Europe	53	125	125	125
Other - (Includes U.S.S.R.)	75	75	100	100

SOURCE: Bureau of Mines

TABLE 4.3. U.S. Aluminum Supply Sources, Peacetime 1973-1990*
(Thousands of short tons)

Year	Total supply	Primary production	Secondary production[1]	Imports	Imports as percent of total
1973	6183	4529	1040	614	9.9
1974	6525	4903	993	629	9.6
1975	5369	3879	940	550	10.2
1976	6303	4600	1060	643	10.2
1977	6659	4800	1120	739	11.1
1978	7036	5010	1195	831	11.8
1979	7434	5230	1280	924	12.4
1980	7855	5460	1380	1015	12.9
1981	8300	5700	1500	1100	13.3
1982	8875	6000	1625	1250	14.1
1983	9500	6400	1750	1350	14.2
1984	10125	6800	1875	1450	14.3
1985	10800	7200	2000	1600	14.8
1986	11475	7600	2125	1750	15.3
1987	12150	8000	2250	1900	15.6
1988	12850	8400	2400	2050	16.0
1989	13500	8800	2550	2150	15.9
1990	14200	9200	2700	2300	16.2
	(Compounded annual percent rates of growth)				
1973-1990	5.0	4.3	5.8	8.1	

[1] Estimated metallic recovery from purchased metal scrap only. Portion recovered from purchased scrap could change over time.

*Unpublished Bureau of Mines Estimates

Figure 4.2 summarizes the timing of domestic smelter start-ups. (Not included is ALCOA's chloride process pilot plant in 1976.) Major additions to smelting capacity in the 1950's were partly in response to federal defense stockpile acquisitions. No new plants are anticipated until the early 1980's with most capacity increases being through expansion of existing plants. Also, since the rapid increase in energy cost starting in 1973, major emphasis has been on reducing power requirements per unit of production. Some domestic capacity based on power generated with natural gas has actually been placed on standby pending development of lignite fired thermal generation.

Forecasting the future development of the domestic industry is subject to several uncertain factors. However, the availability of lower cost base-load hydropower in the contiguous states appears to be at saturation and its availability to the industry is declining. Domestic companies are thus increasingly placing new ventures overseas in association with new hydroelectric projects in developing countries in South America and Africa or very low cost thermal energy such as in Saudi Arabia, United Arab Emirates, Malaysia, Bahrain, Libya, etc. Quite frequently these are joint ventures with the host government with power costs receiving a subsidy to attract investment. Given the power conditions in the "lower 48" and the relative attractiveness of overseas ventures, it does not appear likely that additional "greenfield" plants will be constructed soon (absent federal intervention) in the contigous states. Possible exceptions to this are the proposed Alumax units in South Carolina and Oregon.

The above discussion suggests that Alaska's "competition" for siting of an aluminum smelter will not come from the "lower 48", but rather from overseas.

The Japanese aluminum industry situation is in a considerbbly different situation than the U.S. domestic industry. As illustrated in Figure 4.1, expansion of reduction capacity has ceased despite forecasts of continued growth in demand. In fact in 1977 the primary industry operated at only 68% of capacity and imports probably reached 50% of consumption. Previously planned projects are being deferred or abandoned.

The condition of the Japanese aluminum industry was recently illustrated (The Japan Economic Journal, June 6, 1978) by the announcement by the Ministry of International Trade and Industry (MITI) that the primary production capacity will be cut back by about 30% to 1.2 million tons/year through shutdown of internationally noncompetitive smelters.

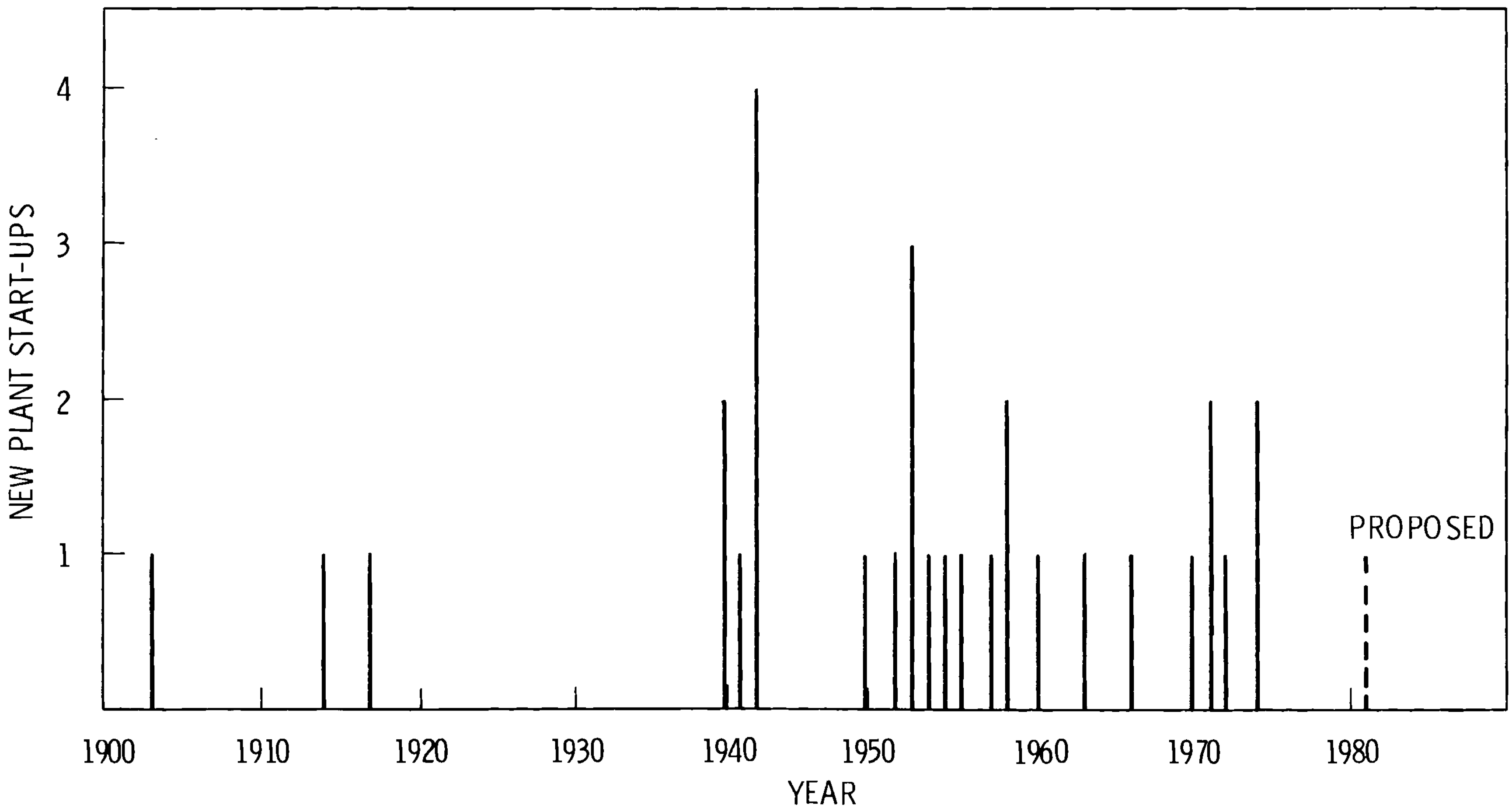

FIGURE 4.2. Growth in the Domestic Aluminum Industry

TABLE 4.4. CURRENT STATUS OF DOMESTIC PRIMARY ALUMINUM INDUSTRY 1978

Company	Plant	State or Country	Capacity 10^3 TPY	Type of Power	Start-Up	Remarks
Reynolds	Listerhill	Alabama	200	20% Hydro 80% Thermal	1940	
Revere	Scottsboro	Alabama	113	100% Thermal	1971	TVA Contract Would Permit Expansion to 360,000 TPY
Reynolds	Arkadelphia	Arkansas	68	32% Hydro 68% Thermal	1954	
Reynolds	Jones Mills	Arkansas	124	40% Thermal (Gas) 60% Thermal	1942	Expansion Under Consideration
ALCOA	Evansville	Indiana	290	100% Thermal(Coal)	1960	
Anaconda	Sebree	Kentucky	120	100% Hydro	1974	Expanding to 180,000 TPY in 1979, Could Go to 240,000 TPY
Nat. So. Wire Al.	Hawesville	Kentucky	180	100% Thermal (Coal)	1969	
Kaiser	Chalmette	Louisiana	260	100% Thermal (Nat. Gas)	1951	
Consolidated	Lake Charles	Louisiana	36	100% Thermal (Nat. Gas)	1974	
Eastalco	Frederick	Maryland	176	100% Thermal	1970	Expanding to 264,000 TPY in 1980
Noranda	New Madrid	Missouri	140	100% Thermal	1971	Expansion to 209,000 TPY possible
Anaconda	Col. Falls	Montana	179	100% Hydro	1955	BPA Contract Expires 9-8-87
ALCOA	Massena	New York	214	100% Hydro	1903	Will Convert to Thermal (nuclear) Power
Reynolds	Massena	New York	125	100% Hydro	1953	
ALCOA	Badin	N. Carolina	124	100% Hydro	1916	
Ormet	Hannibal	Ohio	260	100% Thermal (Coal)	1958	

TABLE 4.4 (Continued)

Company	Plant	State or Country	Capacity 10^3 TPY	Type of Power	Start-UP	Remarks
Reynolds	Troutdale	Oregon	130	100% Hydro	1942	BPA Contract Expires 12-28-86
Martin-Marietta	The Dalles	Oregon	132	100% Hydro	1958	Expanding to 204,000 TPY BPA Contract Expires 2-13-88
Alumax	Umatilla	Oregon	(186)	--	?	Proposed BPA Contract Expires 1986
Alumax	Berkley	So. Caroline	(110)	100% Thermal (Coal)	1981	Expansion to 220,000 TPY Possible
ALCOA	Alcoa	Tennessee	236	20% Hydro 80% Thermal	1914	Feasibility Study on Expansion Underway
Consolidated Aluminum Corp.	N. Johnsonville	Tennessee	144	20% Hydro 80% Thermal	1963	
ALCOA	Pt. Comfort	Texas	185	100% Thermal (Nat. Gas)	1949	Currently Shutdown Pending Conversion to Coal-Fired Power
ALCOA	Rockdale	Texas	309	100% Thermal (Lignite)	1952	Could Expand to 500,000 TPY by 1988
ALCOA	Palistine	Texas	30	50% Hydro 50% Thermal	1976	Experimental Chloride Process
Reynolds	Corpus Christi	Texas	113	90% Nat. Gas 10% Oil	1952	Placed on Standby in 1975 Due to High Gas Prices
ALCOA	Vancouver	Washington	114	100% Hydro	1940	BPA Contract Expires 6-15-87
ALCOA	Wenatchee	Washington	205	100% Hydro	1952	BPA Contract Expires 6-15-87
Reynolds	Longview	Washington	209	100% Hydro	1941	BPC Contract Expires 12-28-86
Kaiser	Mead	Washington	220	100% Hydro	1942	BPA Contract Expires 10-10-86
Kaiser	Tacoma	Washington	80	100% Hydro	1972	BPA Contract Expires 10-10-86
Martin-Marietta	Goldendale	Washington	120	100% Hydro	1972	BPA Contract Expires 2-13-88. Being expanded to 185,000 TPY.
Intalco	Ferndale	Washington	260	100% Hydro	1966	BPA Contract Expires 10-22-84
Kaiser	Ravenswood	W. Virginia	163	100% Thermal (Coal)	1957	Could Expand by 50,000 TPY

Also, in May 1978, Japan and Brazil reached agreement on a jointly sponsored 352,000 ton per year smelter to come on line in 1982. The joint venture, Nippon Amazon Aluminum Company, is formed by 32 Japanese firms including the five largest Japanese smelters and the Brazilian state-run mining company. Hydropower from the Amazon River development with a real generation cost of 17 mills/kWh may be offered by the Brizilian government at a discounted price as low as 10.5 mills/kWh to assure a competitive venture.

The reason for this situation in Japan is the near total dependency upon high cost imported oil for power generation. Given these conditions, along with the high costs (land, environmental controls) of construction of new plants, further expandion of the primary aluminum industry in Japan appears unlikely. In effect Japan is exporting its aluminum industry to an even greater extent than the U.S.

Table 4.5 summarizes Bureau of Mines data on the current state of the Western Pacific Rim primary aluminum industry.

TABLE 4.5. CURRENT STATUS OF WESTERN PACIFIC RIM PRIMARY ALUMINUM INDUSTRY

Company	Plant	State or Country	Capacity 10^3 TPY	Type of Power	Start-Up	Remarks
Mitsui	Omuta	Japan	183	100% Thermal (Coal)	1970	
Sumitomo	Isoura	Japan	88	90% Thermal (Oil) 10% Hydro	1967	
Sumitomo	Nagoya	Japan	60	90% Thermal (Oil) 10% Hydro	1961	
Sumitomo	Toyama	Japan	200	100% Thermal (Oil)	1970	
Sumitomo	Toyo	Japan	110	90% Thermal (Oil) 10% Hydro	NA	
Sumikei	Sakata	Japan	100	100% Thermal (Oil)	1977	
Showa	Chiba	Japan	176	100% Thermal (Oil)	1962	
Showa	Kitakata	Japan	31	50% Thermal (Oil) 50% Hydro	1943	
Showa	Omachi	Japan	46	100% Hydro	1933	
Nippon Kambara	Kambara	Japan	105	100% Hydro	1940	
Nippon	Hokkaido	Japan	143	100% Thermal (Oil)	1969	
Nippon	Nugata	Japan	160	100% Thermal (Oil)	1941	
Mitsubishi	Naoetsu	Japan	176	100% Thermal (Oil)	1963	
Mitsubishi	Sakaide	Japan	209	NA	1972	
Showa	Oita	Japan	--	NA	--	Construction not yet started in 1977. To 300,000 TPY.
Furukawa	Mikuni	Japan	154	100% Thermal	--	Project postponed indefinitely (12/76).

TABLE 4.5 (Continued)

Company	Plant	State or Country	Capacity 10^3 TPY	Type of Power	Start-Up	Remarks
Indonesia Asakan	Kuala Tanjing	Indonesia	--	100% Hydro	1981	Indonesia government, Nippon Asakan to 250,000 TPY in 1983.
--	Sarawak	Malaysia	--	100% Thermal (Nat. Gas)		Reynolds, Malaysian Govt. $110,000 TPY
Koralu	Ulsan	Korea	20	100% Thermal		Negotiating for expansion.
Daihan	--	Korea	--	NA	NA	100,000 TPY under consideration
Taiwan Al. Co.	Kaoshiung I	Taiwan	42	100% Thermal	1935	
Taiwan Al. Co.	Kaoshiung II	Taiwan	41	100% Thermal	NA	Expanding to 66,000 TPY 1979, could expand an additional 132,000 TPY
ALCAN	Kuni-Kuni	Australia	50	100% Thermal (Coal)	1969	Expanding to 75,000 TPY 1980
ALCOA	Port Henry	Australia	101	100% Thermal (Lignite)	1963	
COMALCO	Tassuania	Australia	123	100% Hydro	1955	
COMALCO	Boyne Island	Australia	--	100% Thermal (Coal)		Construction to start 1978, initially 176,000 TPY, expansion later to 352,000 TPY. Project awaiting resolution of power cost.
--	Purari River	New Guinea	--	100% Hydro		Proposed 660,000 TPY. Feasibility study underway for hydro project. Australian, Japan, Papua, New Guinea interests.
New Zealand Al.	Bluff	New Zealand	165	100% Hydro	1972	

5.0 ECONOMIC FACTORS

5.1 THE PRICE OF ALUMINUM

The future market price of aluminum is quite obviously the key to economic viability of a new smelter but unfortunately is difficult to forecast. Figure 5.1 illustrates recent aluminum ingot price performance in current dollars. From 1955 to 1973, the price remained quite stable in the $0.23 to $0.29 per pound range. Thus in real dollars, the price was actually declining. Following the marked increases in energy costs starting in 1973, this price has increased rapidly and has essentially doubled in a five-year period.

The aluminum industry is extremely competitive, and with the current state of about 20% of overcapacity, it is likely that prices are somewhat depressed from an equilibrium level. Most industry observers, however, believe that the price of aluminum will increase at about the rate of inflation plus escalation for energy.

A reasonable indicator of the future energy costs for an aluminum industry can be developed from costs expected by the direct service industry (DSI's) customers of the Bonneville Power Administration in the Pacific Northwest. Based on the expected unit of generation and customer groups and a 5% annual inflation rate, costs to DSI's are expected to increase at an annual rate of 7.5% and possibly higher. Since more than 30% of the domestic primary aluminum capacity is located in the Northwest, it appears that a 2.5% annual escalation in the price of aluminum is a reasonably conservative basis for estimaticn. The consequence of this escalation is illustrated in Figure 5.2.

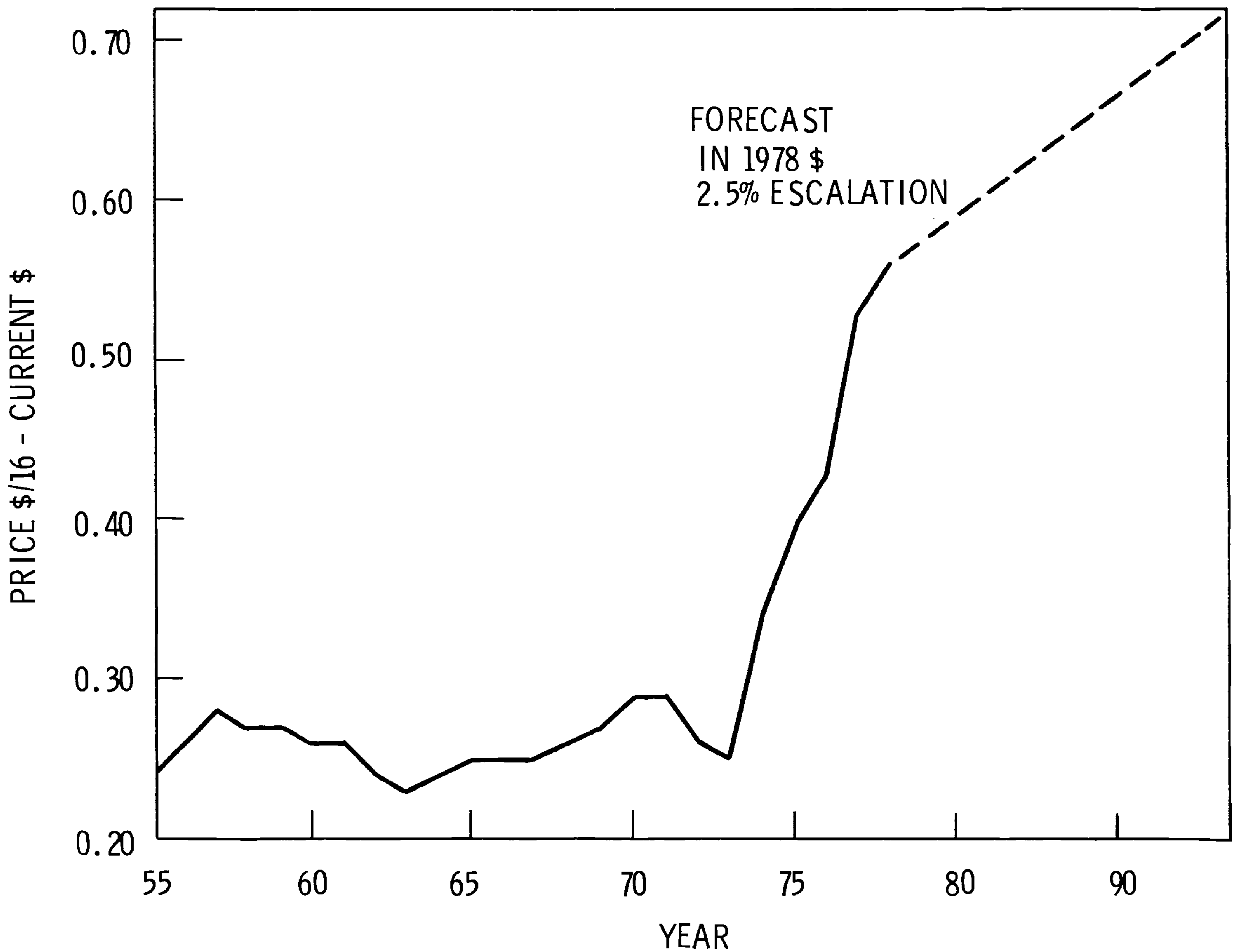

FIGURE 5.1. Price of Primary Aluminum

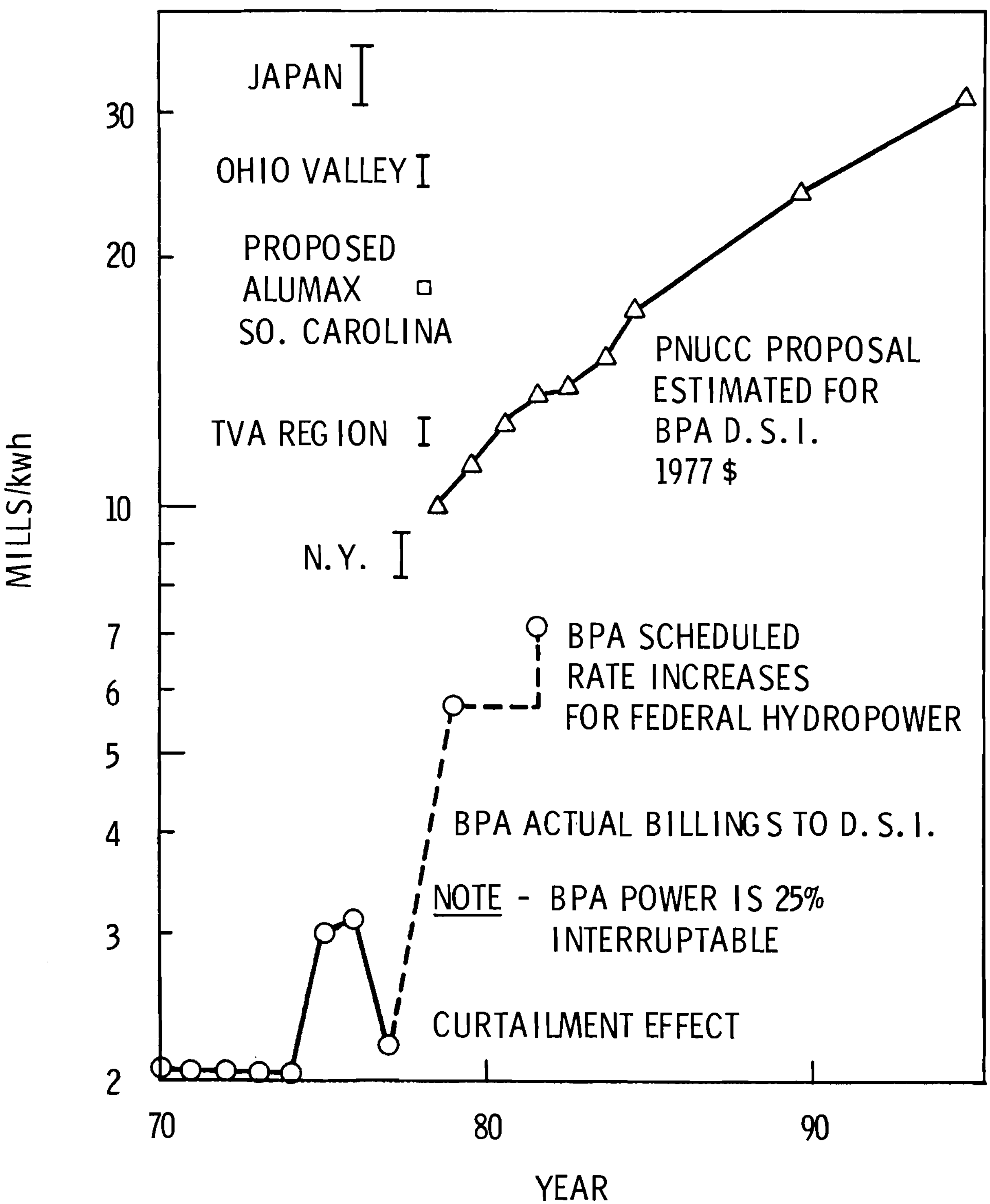

FIGURE 5.2. Representative Power Costs

5.2 COMPETING POWER COSTS AND AVAILABILITY

Electric power constitutes one of the major costs to aluminum smelters. In addition, it is the expense element most sensitive to plant location and primary metal smelters will strongly favor locations having access to low cost thermal or hydropower.

U.S. domestic costs of industrial power vary considerably from region to region as shown in Figure 5.2 for those regions containing primary aluminum smelters. The Ohio Valley (also the centroid of aluminum demand) has the highest cost at about 25 mills/kWh followed by South Carolina where Alumax has proposed a new smelter of the same scale as the conceptual Alaska smelter. Lowest cost power has traditionally been the federal hydropower marketed by the Bonneville Power Administration in the Pacific Northwest. Until recently this power has been sold to the direct service industries (D.S.I's) at under 3 mills/kWh.

However, more recently BPA has been unable to meet area loads and the industry is on notice that power contracts will not be renewed as they expire in the 1980's. During the major part of 1977 for example BPA was able to meet only 75% of DSI requirements and industry was required to purchase replacement power (mostly from Canada). The industries were able to secure only 5% of these needs at an average cost of 22.8 mills/kWh. Fully 20% of their requirements were not available at an affordable cost and production was curtailed.

The Pacific Northwest Utilities Conference Committee (PNUCC) has recently proposed legislation that would establish three rate groups. The DSI's would be served by the higher two rate groups and would gradually shift to 100% thermal power by 1989-90. By 1994-95 the Pacific Northwest Aluminum industries of composit cost of power is forecasted at 31.7 mills/kWh and the marginal cost of power at that time is forecasted at 38.3 mills/kWh.

The power situation in the Pacific Northwest is currently in a very uncertain state. Legislation has just been introduced in the Congress to restructure the manner in which the Bonneville Power Administration operates to market the low cost Federal hydroelectric power. As of September 1978 it is not clear what power costs the industry will face in the future. One strong possibility is that the electro process industries will be required to pay costs comparable for that paid replacement thermal power with some allowance consideration given for the fact that, in accepting interruptable contracts, the industry in effect reduces the generating reserve margin the system must maintain for reliable service.

5.3 DISCOUNTED CASH FLOW

The economic feasibility of any project similar to the conceptual Alaskan aluminum smelter is best analyzed using the discounted cash flow method. This method accounts for the streams of revenues and expenditures over the project lifetime and discounts the time value of money to the present to assure the required rate of return on the investment.

In addition to the capital investment prior to the actual start of operations, a number of expenditures contribute to the cost of goods sold. These include raw materials, salaries and wages, purchased services, taxes, marketing expenses, and overheads. These are summarized in Table 5.1 based on estimated mid-1978 conditions.

Table 5.2 presents an example discounted cash flow analysis for the conceptual smelter based on a number of assumptions:

1. Hydroelectric power is available at 10 mills/KWh and the process requires 8.02 KWh/lb of aluminum produced.
2. Fuel and carbon materials costs will not escalate at a rate > inflation.
3. The price of aluminum will escalate at 2.5% per annum from current 1978 prices.
4. A minimum discount rate of 10% per annum inflation free is required.
5. Borough property taxes levied at $0.016/$ of full value. (Mat-Su Borough site assumed)
6. State corporate income tax remains at present level of 9.4%.
7. Plant capital cost is $500 million ($2,780/annual ton).
8. Alumina raw material imported from Australia.
9. Aluminum ingot and slab product is marketed in Japan using foreign flag vessels.
10. Plant employment can be held to 800 through automation.

TABLE 5.1. Cost of Goods Required by a Conceptual Alaskan Aluminum Smelter

	1978 $/Year Millions
Alumina (308,800 AMT) @ $140/MT.CIF	43.2
Bath Materials (5,120 AMT) @ $550/MT.CIF	2.8
Carbon Materials[1]	10.3
Pot Lining Materials	2.3
Fuel Oil (1.92×10^{12} Btu/yr) @ $\$2.50/10^{6}$ BTU[1]	4.8
General Supplies	6.1
Transfer Expenses	2.0
Purchased Services	0.6
Maintenance Materials	7.0
Salaries, Wages and Allowances[2]	20.0
Overheads, General	2.6
Shipping @ $0.01/lb	3.6
MANUFACTURING COST EXCLUSIVE OF TAXES AND POWER	105.3

(1) These costs have assumed to remain constant. In actual fact they may be subject to escalation in addition to inflation.

(2) Adjusted to Alaskan conditions but with employment held to 800 through maximum use of automation.

TABLE 5.2. Conceptual Alaskan Aluminum Smelter Discounted Cash Flow Analysis 98% Plant Factor ($ Million)

		1	2	3	4	5	6	7	8	9	10	11	12
1	Year	1	2	3	4	5	6	7	8	9	10	11	12
2	Capital. Expenditure(1)	125	125	125	125	0	⟶						
3	Annual Revenue(2)					201.6	206.5	211.8	217.1	222.5	228.1	233.8	239.6
4	Manufacturing Costs(3) Exclusive of Taxes and Power					105.3	⟶						
5	Power (8.02 kwh/lb) @ 10 mills/kwh					28.8	⟶						
6	Borough Taxes(4)	2.0	4.0	6.0	8.0	8.0	⟶						
7	Costs of Goods Sold					142.1	⟶						
8	Gross Income					59.5	64.4	69.7	75.0	80.4	86.0	91.6	96.9
9	Depreciation(5)					62.5	58.5	54.0	50.0	46.0	41.5	37.5	33.5
10	State Income Tax Base					(3.0)	2.89	15.7	25.0	34.4	44.5	54.1	63.0
11	State Income Tax @ 9.4%					0	0.27	1.48	2.35	3.23	4.18	5.09	5.92
12	Federal Income Tax Base					3.0	2.62	14.22	22.7	31.2	40.3	49.0	57.1
13	Federal Income Tax @ 48%					0	1.26	6.83	10.9	15.0	19.3	23.5	27.4
14	Investment Tax Credit @ 10%					50.0							
15	Net Cash Flow	(127)	(127)	(131)	(133)	109.5	61.3	61.4	61.8	62.2	62.5	63.0	63.6
16	Discount Factor @ 10%	1.000	.909	.826	.751	0.683	0.621	0.564	0.513	0.467	0.424	0.386	0.350
17	Discounted Cash Flow ($ Million)	(127)	(117.3)	108.2	99.9	74.8	38.1	34.6	31.7	29.0	26.5	24.3	22.3

		13	14	15	16	17	18	19	20	21	22	23	24
1	Year	13	14	15	16	17	18	19	20	21	22	23	24
2	Capital. Expenditure(1)												
3	Annual Revenue(2)	245.6	251.8	258.1	264.5	271.1	279.9	284.9	292.0	299.3	306.8	314.4	322.3
4	Manufacturing Costs(3) Exclusive of Taxes and Power												
5	Power (8.02 kwh/lb) @ 10 mills/kwh												
6	Borough Taxes(4)												
7	Costs of Goods Sold												
8	Gross Income	103.5	109.7	116.7	122.4	129.0	135.8	142.8	149.9	157.2	163.9	172.3	180.2
9	Depreciation(5)	28.5	25.0	21.0	16.5	12.5	8.5	4.0	--	--	--	--	--
10	State Income Tax Base	75.0	84.7	95.0	105.9	116.5	127.3	138.8	149.9	157.2	163.9	172.3	180.2
11	State Income Tax @ 9.4%	7.05	7.96	8.93	9.95	11.[illegible]	12.0	13.0	14.1	14.8	15.4	16.2	16.9
12	Federal Income Tax Base	68.0	76.7	86.1	95.9	105.5	115.3	125.8	135.8	142.4	148.5	156.1	163.3
13	Federal Income Tax @ 48%	32.6	36.8	41.3	46.0	50.6	55.3	60.4	65.2	68.4	71.3	74.9	78.4
14	Investment Tax Credit @ 10%												
15	Net Cash Flow	63.9	64.9	65.8	66.4	67.5	68.5	69.4	70.6	74.0	77.2	81.2	84.9
16	Discount Factor @ 10%	0.319	0.290	0.263	0.239	0.218	0.198	0.180	0.164	0.149	0.135	0.123	0.112
17	Discounted Cash Flow ($ Million)	20.4	18.8	17.3	15.9	14.7	13.6	12.5	11.6	11.0	10.4	10.0	9.4

NET DISCOUNTED CASH FLOW -5.5

(1) Plant Construction Assumed Distributed Equally Over 4-Year Period.

(2) Based on $0.57/lb Price in Japan with 2.5%/Year Escalation.

(3) Includes $0.01/lb Shipping Cost to Japan.

(4) Borough Property Tax @ $0.016/$ Full Value.

(5) Sum-of-the-Years Digits Method of Depreciation - 15 Years.

11. Raw material and other costs are not subject to special escalation greater than inflation.

12. Plant operating rate will be at 95-98%.

The above assumptions may be variously optimistic or conservative. However, given the current uncertainties in the international aluminum markets, they appear reasonable as a starting point.

Nevertheless, the reader is cautioned that the analysis can only be regarded as an example. The future price of aluminum is probably the most significant factor in project feasibility and the base 1978 price of $0.57 per pound may reflect the current condition of overcapacity. Furthermore, the aluminum price escalation rate assumed at 2.5% per annum may be on the conservative side. Additionally, technological improvements may be generally available by the mid-1980's that could reduce power requirements by about 25%. Finally, subsequent plant expansion by addition of another potline would substantially increase the economic feasibility of the project.

The analysis as presented in Table 5.2 is carried out only over a 24 year period (20 years in production). At the end of this period the net discounted cash flow is negative by about $5.5 million. However, if the plant continues in operation for at least 30 years it is apparent that the net discounted cash flow will become positive. The analysis also presents the Borough property and State income tax revenues.

One conclusion that can be drawn from reviewing the discounted cash flow analysis of the conceptual Alaskan smelter is that a new "grassroots" smelter, even if built in the "lower 48", would not be economically feasible under todays market conditions. Todays market price for metal, the escalated cost of smelter construction, and the cost of power (particularly the marginal cost) in the "lower 48" offer barriers that would be extremely difficult to overcome.

The implications of these findings are relevant to developing a scenario for the probable evolution of the domestic primary aluminum industry.

1) As demand increases, existing smelter capacity will approach full utilization.

2) Older smelter capacity will be upgraded through introduction of more energy efficient technology and expanded in those cases where land and ancillary facilities permit but with no significant increases in net electric power demands.

3) The domestic industry will approach capacity saturation in in the 1980's and dependance on foreign imports will increase from regions with low cost hydro power (e.g., Canada, Brazil, and Africa) or thermal power (e.g., Australia, Middle East).

4) National security and trade balance concerns will increase possibly leading the federal government to increase strategic stockpiles. Prices may increase more rapidly as a result of stockpile acquisitions to the point where new domestic smelter capacity can be justified. The search for lower cost hydropower will intensify.

6.0 CONCEPTUAL ALASKAN ALUMINUM SMELTER

There have been two fairly recent descriptions of modern day aluminum smelter complexes. In 1975 Kaiser Aluminum and Chemical Company prepared a preliminary assessment for a 176,000 ton per year plant for location in Southern Tidewater Alaska.[1] More recently, Alumax has proposed a 187,300 ton per year smelter to be located near Umatilla in eastern Oregon.

Although nominally of the same annual capacity typical of world scale plants, the two proposals differ slightly in that the Alumax proposal power requirements are 7.99 kWh/pound vs the Kaiser plant at 8.21 kWh/pound with both figures including plant auxiliary power in addition to that required for the reduction process.

The Kaiser assessment, in addition to providing plant facilities comparable to the Alumax proposal, provides for a Marine terminal (772x98x38 feet draft) for 45,000 DWT bulk carriers importing raw materials (primarily alumina and petroleum coke) and exporting ingots and slab.

The conceptual Alaskan aluminum smelter complex described in the following pages draws on elements of both the Alumax proposal and Kaiser Aluminum and Chemical Company assessment.

6.1 Physical Description

The conceptual smelter would be of the classical Hall process for continuous electrolytic reduction of alumina (Al_2O_3) to molten metal. Alumina is reduced in a molten electrolytic bath composed of cryolite, aluminium fluoride, and fluorospar in a series of cells called "pots". The complex would have an initial nominal capacity of 180,000 tons per year with two pot lines and with provision for ready expansion to 270,000 or 360,000 TPY by addition of parallel potline increments.

Principal components of the complex would be:

- Marine terminal
- Bulk raw material conveyor system ($\sim$1000 ft)

(1) Kaiser Aluminum Technical Services, Inc., "Preliminary Assessment of an Alaska Aluminum Smelter," April 1975.

- Raw material storage facilities
- Pot lines (two initially)
- Foundry
- Anode rodding and baking plants
- Warehouse and maintenance shops
- High voltage switchyard and rectifier station
- Office building and laboratories
- Off gas treating facilities

Flow of materials through the plant is illustrated in Figure 6.1 and Figure 6.2 indicates a typical plant layout.

The plant site would require at least 370 acres (4000 ft. squares) and should be located at a minimal distance from the marine terminal to avoid use of a railroad or heavy duty trucks for handling inbound bulk raw materials. Year-round access to the marine terminal will be necessary.

6.2 Power, Fuel and Utility Requirements

Electric power requirements for the initial two potline plants would be 330 MW increasing proportionately as the plant is expanded. The plant factor would be approximately 98% and an assured firm power supply is essential for economic operation.

The possibility exists that technological improvements in the basic Hall process will be demonstrated by the time a smelter could come on line in Alaska. For example, Sumitomo Chemical Company has developed proprietary modifications including lined electrodes, computer control, closer electrode spacing, and improved insulation. A 25% reduction in electrolysis power requirements (to 6 kWh/pound) and would reduce the power requirements for the initial plant to about 240 MW. Sumitomo is currently licensing use of this technology.

Alcoa has been researching a chloride based process at the pilot plant level but the status is not publicly known.

Fuel (light fuel oil or natural gas) is required primarily for anode baking and would be at an initial rate of 5,300 MM Btu/day (910 BBL/day if for distillate fuel).

Water requirements for the plant complex will be approximately 410,000 gallons/day for the initial two pot line system and would increase proportionally as the plant is expanded.

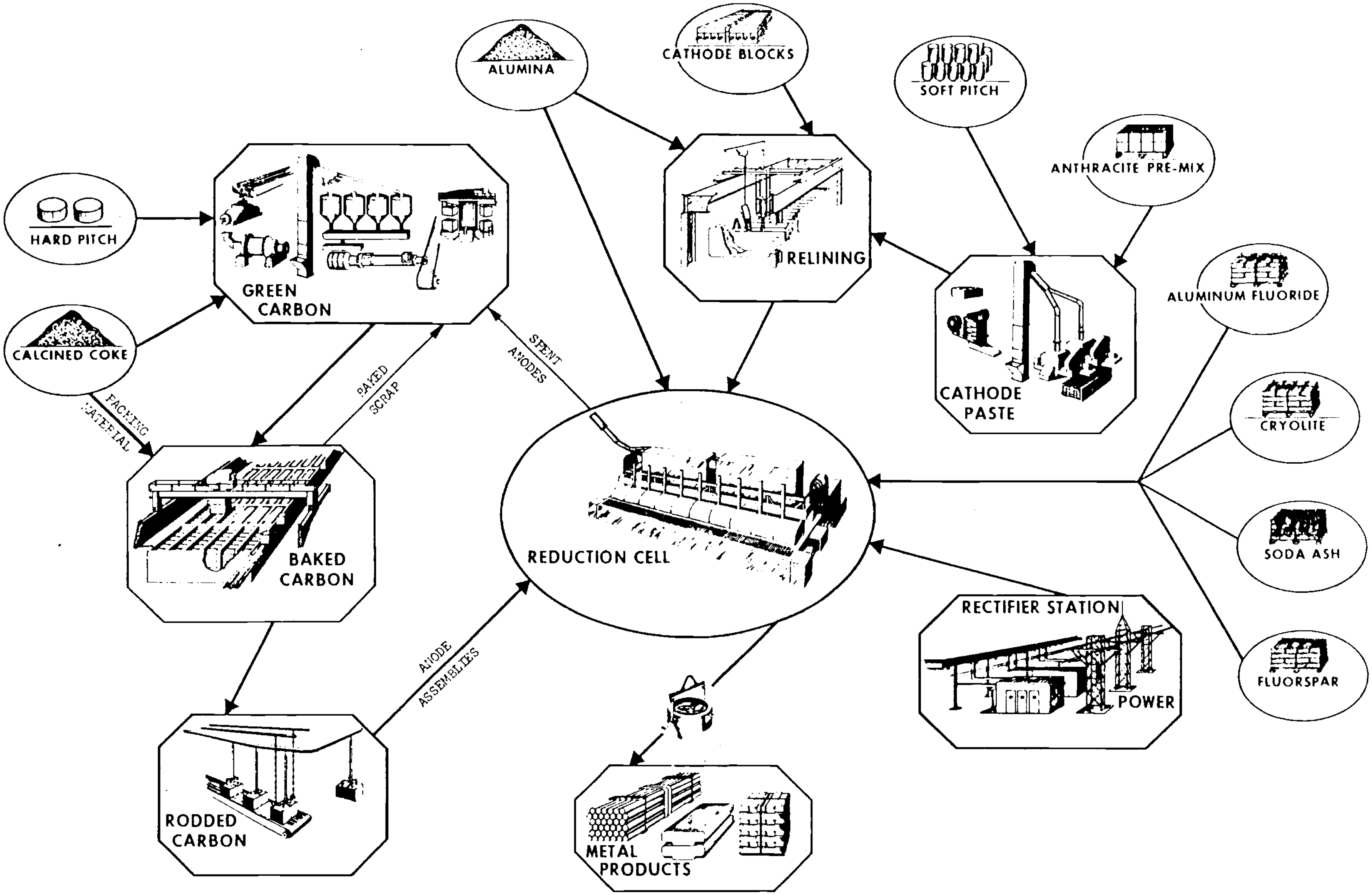

FIGURE 6.1. Reduction Plant Pictorial Flow Diagram

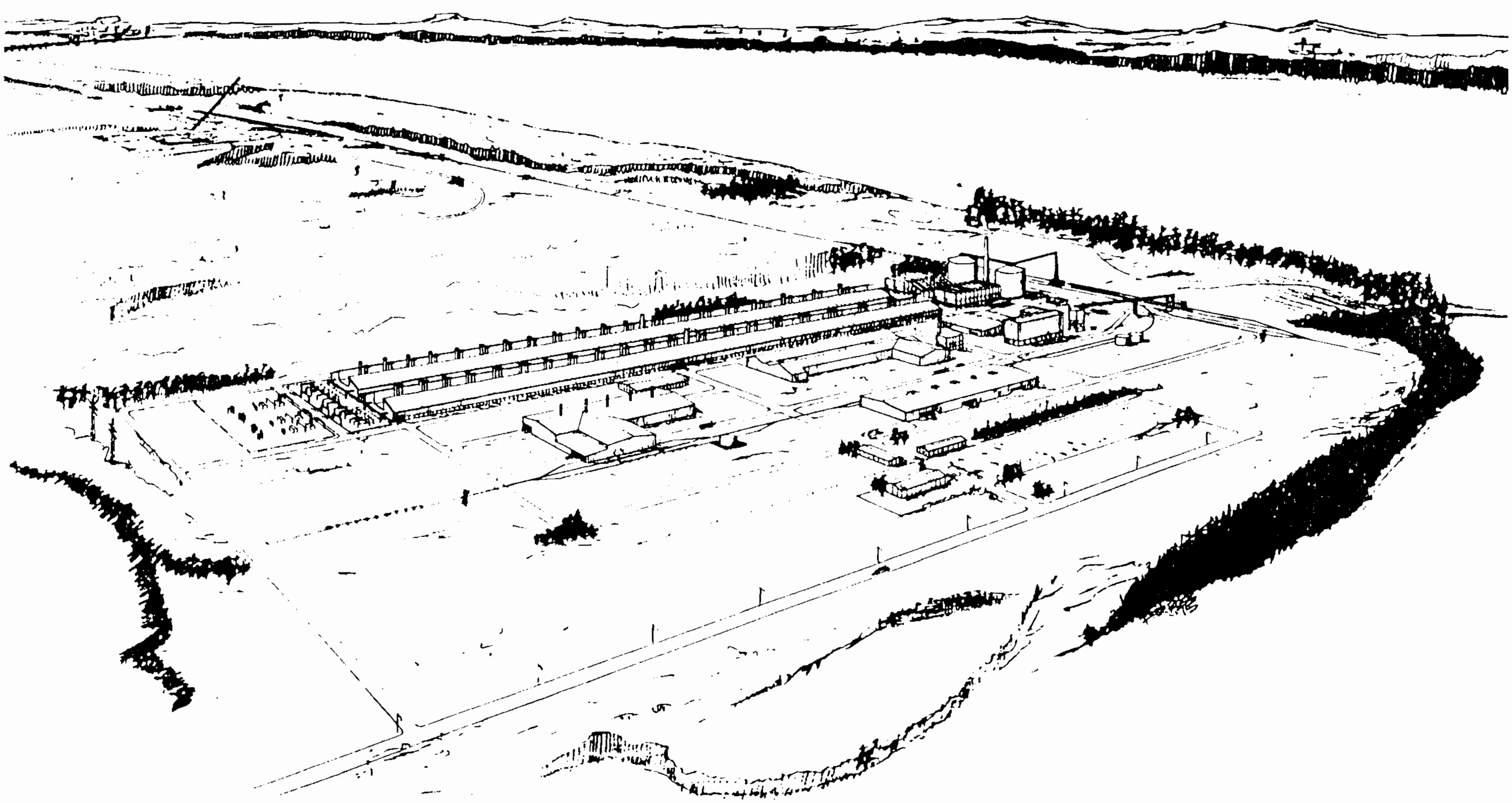

FIGURE 6.2. Typical Plant Layout

6.3 Capital Investment

The capital cost of new primary aluminum smelters has in recent years been severely impacted by inflation and escalation in construction projects and new environmental control requirements. Currently industry estimates that a new "lower 48" plant will cost in the range of $2000 to $2300 per ton of annual capacity depending on the amount of supporting regional infrastructure. Conversely, expansion of existing plants can be achieved at about 60% of this cost if power is available and the plant was initially built with expansion in mind.(1)

Kaiser Aluminum and Chemical Company in 1975 estimated the capital cost for an Alaska smelter complex including marine terminal facility at $2043 per annual ton for 1975 startup. Inflating and escalating these costs at 9% per year to 1978 suggests the investment would be $2650/annual ton in todays dollars. (Kaiser in 1975 suggested 12% per year escalation; i.e., $2870/annual ton in 1978.)

At this point in time it is impossible to clearly resolve the true 1978 basic cost of an Alaskan smelter except to conclude that the probable total fixed assets cost of the conceptual smelter complex may range between $480 million and $520 million.

The reader is warned that the actual capital cost will be significantly influenced by what might be termed a special "Alaska Escalator". That is, if construction of the smelter occurred concurrently with another major construction project significantly drawing on the available labor force, the upper Susitna hydroelectric projects, the costs might be considerably higher.

The reader should also recognize that, in the case of the aluminum industry, the so-called "Alaska disadvantage factor" is not as pronounced as with other energy intensive industries. The aluminum industry, being so strongly sensitive to electric power costs, is seeking locations world wide and, more frequently than not, in lesser developed countries where similar and other "disadvantages" occur; i.e., lack of infrastructure, higher product marketing costs, lower worker productivity, higher costs of construction, etc.

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(1) Federal Preparedness Agency, General Services Administration, "Long Range Aluminum Utilization Outlook 1985-1990," February 1978.

Regardless of the uncertainty in capital cost, the development of a primary aluminum smelter in Alaska would add a considerable increase in tax bases to the state and lesser jurisdictions.

6.4 Employment Effects

The employment effects include both the creation of job opportunities during construction and operation and the resulting payroll.

6.4.1 Construction Employment

The proposed Alumax smelter in eastern Oregon envisioned a construction period of 32 months with a construction work force peaking at 1400 about two-thirds through the period. The Kaiser assessment for an Alaska plant complex envisioned a total construction period of 48 months but did not estimate the work force required.

Since the construction conditions in Alaska (elimate, lack of infrastructure) are more severe than in eastern Oregon where year-round steady progress can be made, we believe the Kaiser estimate may be more reasonable. The total construction work force estimate for the Alumax proposal is probably applicable for the Alaskan smelter as the somewhat lower labor force productivity can be offset to some extent by increased use of modular construction techniques and prefabrication. Adjusting for additional construction work required for the marine terminal, it appears that the total construction employment would represent approximately 2000 man years over a four year period. The payroll associated with construction would amount to about $50 million (1977 basis) over this period, assuming contract construction labor rates are not escalated by coincidental projects.

6.4.2 Operations Employment

Alumax estimated a work force of 800 for the eastern Oregon smelter proposal, whereas Kaiser estimated a 1,182 labor force in Alaska of whom 1,112 would be local hire. Given Alaskan working conditions and the additional employment associated with the marine terminal, we feel the Kaiser estimate of approximately 1,200 is the most reasonable for the conceptual Alaskan complex.

Kaiser estimated a manning roster for the smelter and associated marine terminal as follows:

Operators, craftsmen, clerks, and technicians	1,080
Foremen, junior professionals	67
General Foreman, supervisor	15
Professionals	15
Management	5
	1,182

Pay scales associated with the primary aluminum industry are approximately 147% of the average of all manufacturing. Thus, we expect that the average annual salary for the Alaska smelter employee would be about $24,500 and the total payroll approximately $30 million per year (1977 dollars).

6.5 Environmental Implications

The environmental effects of a new smelter complex located in an undeveloped area can be both direct; i.e., due to the smelter complex itself, and indirect; i.e., from the population and community developing in association with the plant. In addition, environmental effects of emissions and effluents are highly dependent upon the specific site selected for the plant. Thus, the following paragraphs treat the environmental implications in terms of the primary or direct source terms for emissions, effluents and land use largely by the smelter complex per se.

6.5.1 Land Use

The primary land requirement for the smelter complex is about 370 acres as previously noted. The major land impact however will come from the associated community. With a population of about 3000, we would expect the community to require about 1000 acres based on U. S. average urban conditions.

6.5.2 Water Quality

Modern day aluminum smelters process waste water is completely recycled. Domestic waste water and sewage would presumably be routed to the community sewage treatment plant and would be equivalent to that from a population of about 480 people.

Atmospheric emissions of fluorides and sulfates could enter surface and marine waters via direct deposition or precipitation scavenging. By analogy to the proposed Alumax plant, the total projected maximum emissions of gaseous and particulate fluoride amount to an average of 256 pounds per day and the Oregon Department of Environmental Quality conservatively concluded that the plant's emissions would increase the fluoride concentration in the nearby Columbia River by 0.0023 ppm or <1 percent of the natural existing concentrations. They concluded that no significant aquatic effects would be expected at this insiginificant increase.

Sulphur dioxide emissions of about 10 tons per day would result in acidic products upon entering the surface waters around the plantsite. The extent to which this could be a problem would depend on the degree of atmospheric dispersion at the site, the buffering capacity of the surface waters, and their natural turn over rates. Impounded surface waters without natural surface runoff presumably would be the most sensitive.

6.5.3 Air Quality

Emissions from new aluminum smelters are regulated under the Environmental Protection Agency (EPA) standards of performance based on the application of the best demonstrated air pollution control technology taking into account cost. These are summarized in Table 6.2 along with standards (Table 6.2).

Based on analogies to the proposed Alumax plant, the conceptual Alaska aluminum smelter would have the following emissions:

TABLE 6.1. Projected Maximum Emissions from Conceptual Smelter

	lb/Ton Al	Tons/Year
Particulate	5	450
Total Fluoride	0.5	45
Sulphur Dioxide	40.3	3,632
Carbon Monoxide	518	46,700
Chlorine	0.0094	0.85

TABLE 6.2. Emission Limits Applicable to New Aluminum Reduction Plants

	Fluorides	Particulates	Visible Emissions
Oregon State Standards for New Aluminum Reduction Plants(1)	1.3 lbs F^-/ton Al produced monthly average 1.0 lbs F^-/ton Al produced annual average 12.5 tons F^-/month from any single Al plant without prior approval	7.0 lbs/ton Al produced monthly average 5.0 lbs/ton Al produced annual average	Not to exeed 10% opacity from any source(4)
Federal EPA Standards of Performance for New Aluminum Plants(2)	1.9 lb F/ton Al produced for potroom groups at prebake plants 0.1 lb F/ton of Al equivalent(3) for anode bake plants 2 lb F/ton of Al produced for vertical or horizontal stud Soderberg plants		Not to exceed 10% opacity from any potroom group Not to exceed 20% opacity from any anode bake plant

(1) Oregon Administrative Rules, 1974.

(2) *Federal Register*, 1976a.

(3) "Aluminum equivalent" is the amount of aluminum in tons produced from a ton of anodes at a particular plant.

(4) Condensed water vapor is exempted.

Visible condensed water vapor plumes would occur above the stacks of the secondary scrubbers and over the cooling towers. Formation of these plumes depends on humidity and wind speed. When the humidity is low, the scrubber plumes would probably not be visible and the cooling tower plumes will be very short. At 90% relative humidity with a two-mile-per-hour wind, the scrubber plumes would extend for about 2,200 feet downwind. Although water vapor discharged would not normally cause problems, an analysis of the potential for icing should be conducted for the specific site.

6.5.4 Solid Waste

Table 6.3 summarizes the plant generated solid wastes.

TABLE 6.3. Plant-Generated Solid Waste to Local Landfills

Condition	Content	Source	Quantity
Solid	Inert Sludge -- 35% Solids, CaF_2, $CaCO_3$, $CaSO_4$	Plant Water Treatment	240 tons/year Dry Solids
Solid	Refractory Material Brick	Bake Ovens Cast House Refractor waste from bake ovens will commence in second year of operation - not before fifth year of operation from cast house.	1,890 tons/yr
Solid	Induction Furnace Slag, $FeO-FeSiO_2$	Anode Rodding	29 tons/yr
Collected Air Contaminants	Carbon, Iron Oxide Fluorides Fine Particulate	Baghouse -- Anode Rodding	625 tons/yr
Collected Air Contaminants	Pitch Fumes Pitch Particulate	Filter Pitch Storage & Mixers	140 tons/yr
Solid	Mixed Refuse	General Plant	48 tons/yr

SOURCE: AMAX Pacific Aluminum Corporation, 1974, p. IV 21-22.

7.0 IMPLICATIONS FOR ALASKA ELECTRIC POWER SYSTEMS

Capacity and energy requirements for the conceptual Alaskan aluminum smelter is expected to range between 240 to 330 MW and 2.06×10^9 to 2.83×10^9 kWh annually, respectively, depending on the specific potline technology employed. For perspective, this represents approximately 15 to 21% of the potential Watana plus Devil Canyon hydropower capacity and 30 to 41% of the hydroprojects average annual energy production.

Although it is impossible at this time to exactly estimate the Railbelt system average cost of power, Upper Susitua power should be in the range of 15 to 20 mills/kWh in todays dollars. Assuming use of the most favorable proven technology, the sale of bulk firm power at these rates would create an annual revenue of $31 million to $41 million.

A direct power sales contract for a large block of Upper Susitna energy could have a beneficial effect on the cost of financing the hydropower project through increasing the quality of the bond rating. The extent of this effect cannot be firmly established at this time as the entire structure of the Upper Susitna power sales contracts must be considered together. However, there is a possibility that the tax exempt status of the Alaska Power Authority could be jeopardized under Section 103 of the Internal Revenue service regulations. If an exempt utility sells more than 25% of its energy to a nonexempt entity the tax status of its bonds may be in question.

A previous analysis of power systems development in the Railbelt region considered both high and low load growth scenarios.(1) The first Upper Susitna unit (Watana) was assumed to be available for the 1991-1992 peak. Under the low load growth scenario full utilization of Watana's capacity would not be achieved unless a substantial portion of the existing and planned thermal capacity were retired. Devil Canyon would similarly not be required until the 2000-2001 period. Under the likely lower range of load growth, the Railbelt annual energy demand, exclusive of the conceptual smelter, is estimated at approximately 9.2×10^9 kwh in 1992. If the conceptual smelter were added to the system, it would amount to 18 to 24% of the total load.

(1) Swift, W.H., et al., "Alaskan Electric Power - An Analysis of Future Requirements and Supply Alternatives for the Railbelt Region", for Division of Energy and Power Development and Alaska Power Authority, March 1978, Battelle-Northwest.

Under the high load growth case, the first Devil Canyon generation would not be called up until the 1996-1997 period--again assuming no refinements of existing thermal plans. All Devil Canyon capacity would be required by 1999-2000.

In 1992 the most likely high Railbelt energy requirement will be 13.5×10^9 kwh. In this instance, the smelter would amount to approximately 15 to 21% of the total load.

The most likely case (regardless of load growth) probably will be the retirement of higher cost thermal generation units and the earliest possible on line dates for both Watana and Devil Canyon generation. Nevertheless, there will be a considerable amount of relatively "young" thermal capacity that may not be retired and an aluminum smelter load may integrate well into the system, particularly under low load growth conditions.

Industrial loads can play an important but frequently misunderstood role in the marketing of power from large generation projects such as the proposed Upper Susitna hydroelectric system. Firstly, the relatively large and constant power demand of an aluminum reduction plant can make the construction of large generating facilities more economically feasible at an earlier date than would otherwise be possible. The industry can purchase large amounts of power not suitable for utility use that otherwise would be wasted. These purchases can contribute revenues to the system reducing the costs of other bulk power purchasers such as the municipal utilities and electric cooperatives. A prime example of this effect has been in the Bonneville Power Administration (BPA) marketing of hydropower from the federal power development of the Columbia River.

Perhaps a more important aspect of a large industrial load that can be partially interrupted is a reduced reserve requirement. In effect, the interruptible portion of the industrial load can be looked upon as a reserve that can be called upon to meet utility needs at peaks or during system emergencies. This aspect is illustrated in the BPA system (25% of the direct service industrial load is interruptible) where a generating capacity reliability margin of approximately 12% is adequate as compared to the more usual standard of 20%.

Energy Intensive Industry for Alaska

VOLUME II

Part 2: Social and Economic Impacts

prepared for

Division of Energy and Power Development
Department of Commerce and Economic Development

by

Institute of Social and Economic Research
Anchorage * Fairbanks * Juneau

June 1978

A. INTRODUCTION

This section of the Energy Intensive Industry Study attempts to provide an indication of some of the social and economic impacts that would be associated with the location of energy intensive industries in Alaska. The approach chosen has been to make the analysis as specific as possible; i.e. to utilize a hypothetical case-study approach. This approach was necessary, it was felt, because of: 1) the wide range of potential industries, 2) the differential impacts of various sizes of facilities, and 3) the multitude of possible locations. In addition, many of the social impacts of industrial development are very local and individual in nature, and a case-study approach serves to emphasize this.

The hypothetical plant chosen was a medium-sized aluminum smelter. Aluminum reduction is the classic energy intensive industry. In addition, it is somewhat easier to analyze than other industries because, unlike petrochemical plants or copper or iron smelters, there are few potential forward or backward linkages in Alaska that would complicate the analysis: alumina would be imported from outside of Alaska and aluminum ingots would be exported with no further processing. Coke would be one input in addition to energy which might be supplied locally.

Two potential sites were chosen, both in the Cook Inlet area: North Foreland-Granite Point and Point MacKenzie. Industrial development in both areas has been discussed for years, and both sites would have access to potential sources of electrical power that have a relatively high probability of development: the Beluga coal fields and the Susitna dam projects.

B. BACKGROUND

B.1. The Plant

The hypothetical plant is modeled after the Alumax aluminum reduction plant proposed for the Hermiston-Umatilla area of Eastern Oregon. It would produce approximately 185,000 short tons of aluminum ingots per year. Total permanent employment for plant operations would be about 800, of whom 185 would be managerial or clerical personnel. Of the remaining 615 production workers, 220 would be maintenance tradesmen.[1] The plant would be much smaller than the Alcan facility located in Kitimat, British Columbia (near Prince Rupert), which employs about 2,500.[2]

In addition to the permanent operations staff, construction of the plant would involve a sizable work force. Construction was estimated to require two years, eight months and involve a work force peaking at 1,400 about ten months before completion. Some operations employment would begin mid-way through construction, gradually reaching the stable level of 800 upon completion of the plant. Total peak employment (construction and operations) is expected to reach 1,520 ten months before completion.[3]

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[1] Bonneville Power Administration (U.S. Department of Interior), The Alumax Environmental Statement-Draft, July 25, 1977.

[2] Ministry of Economic Development, Province of British Columbia, Northwest Report '77, December 1977, p. 213.

[3] Bonneville Power Administration, op. cit., Table IV-33.

Table B.1. ALUMINUM REDUCTION PLANT EMPLOYMENT

Month	Construction Employment	Operation Employment	Total
0	0		0
1	65		65
2	130		130
3	190		190
4	255		255
5	320		320
6	380		380
7	445		445
8	510		510
9	575		575
10	635		635
11	700		700
12	765		765
13	825		825
14	890		890
15	955		955
16	1,020		1,020
17	1,080	0	1,080
18	1,145	50	1,195
19	1,210	70	1,280
20	1,275	85	1,260
21	1,335	105	1,440
22	1,400	120	1,520
23	1,260	230	1,490
24	1,120	335	1,455
25	980	445	1,425
26	840	550	1,390
27	700	600	1,300
28	560	650	1,210
29	420	700	1,120
30	280	740	1,020
31	140	780	920
32	0	800	800

Source: Bonneville Power Administration, The Alumax Environmental Statement-Draft, July 25, 1977, Table IV-33.

Time and labor estimates are based on Oregon conditions; construction of a plant in Alaska would undoubtedly require a longer period and/or larger work force. On the other hand, costs of construction in Alaska could lead to the use of prefabricated components and reduce the Alaskan construction force required.

The hypothetical plant would import alumina that had already been refined from bauxite ores. It would export metal in the form of raw ingots; no local ore mining or metal fabrication activities would be involved. A plant site of about 165 acres would be required. The plant would use 6.9 million gallons (160,000 barrels) of fuel oil a year and approximately 645,000 gallons of water a day. A closed-water cycle would be used, however, and there would be no industrial effluent.[4]

The operation of the plant would require access to a dock capable of accommodating ships of 40,000 dead-weight tons. Such a dock is currently not available on the west side of Cook Inlet and would need to be constructed. The construction and operation of such a dock would involve only a marginal increase to the cost of the plant and to employment associated with it. Facilities capable of offloading 341,000 tons annually of alumina would require one deep-water berth, a wharf face of several hundred feet, and a vacuum unloader. The aluminum ingots could be exported by road, rail, or ship. If the latter mode were employed, it would probably be done in ships with their own loading gear, thus involving no significant additional port facilities. The small requirements

[4] Ibid.

of coke could be handled by barge or truck. A docking facility of this nature would result in operating employment of less than ten.

Cook Inlet is subject to problems of icing, tidal currents, and siltation. Nevertheless, these do not appear to be problems severe enough to prevent the construction of a port capable of handling ships of 40,000 dead-weight tons as far up the inlet as Goose Bay.[5]

The Hall-Herout refining process would be used and tremendous amounts of electricity would be consumed, about 6.9 kilowatt hours per pound of aluminum produced. An experimental process developed by Alcoa, the Aluminum Chloride process, is being tested which would use about 35 percent less electricity per pound of aluminum (4.5 kwh/lb.). The process would also be less polluting, since a closed system would be used and cryolite, a fluoride source, would not be employed. Its commercial feasibility, however, is unknown at this time, although it could prove feasible before a plant were built in Alaska. Nevertheless, assuming the Hall-Herout process, the plant would require a supply of about 340 megawatts. To put the amount of power required into perspective, it would be greater than the highest total monthly peak load for 1976 (311 MW) of the utilities that provide most of the power consumed in Southcentral Alaska--Chugach Electric Association and Anchorage

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[5] Personal communication with Keith Collar, Southwest Alaska Pilots Association, Homer, Alaska, by Kent Miller.

Municipal Light and Power.[6] Consumption would be equivalent to that of more than 150,000 "average" Pacific Northwest homes.[7]

The plant would degrade air quality, primarily through emissions of fluoride and sulphur dioxide, but not enough to exceed EPA Class II Significant Deterioration Limits. In many surrounding areas, Class I Significant Deterioration Limits would also be met. Water vapor (steam) plumes from the plant would be visible from as far as two miles away. Water quality in surrounding areas would be adversely affected through long-term fluoride accumulations. Noise levels at the plant would be relatively low, about 45 db (A) at the plant site boundary, or the equivalent of ambient noise in a residential neighborhood.[8]

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[6] Alaska Power Administration (U.S. Department of Interior), Alaska Electric Power Statistics 1960-1976, July 1977.

[7] Bonneville Power Administration, op. cit., p. II-3.

[8] Ibid.

B.2. Site A: North Foreland-Granite Point

The North Foreland - Granite Point area comprises the coastal region adjacent to the Beluga coal fields on the west side of Cook Inlet about 40 air miles southwest of Anchorage. This area appears to be the most logical point for the transshipment of coal, in whatever form, from the field. The only community of any size in the area presently is the Native village of Tyonek.

Tyonek is located in the Kenai Peninsula Borough just south of the Matanuska-Susitna Borough. It was originally located about six miles further south; but in the mid-1950s, the inhabitants relocated to higher ground at the existing site. All new housing has been constructed in recent years and the village has a store, bank, gas station, and small guest house/motel, as well as telephone, water, and electricity (Chugach Electric Association) systems.[9] It also has a Borough-operated school (K-12) and a health center.[10] A sewer system is presently under consideration.[11]

In 1970, the community had a population of 232, of whom 221 were Native.[12] The surrounding area, including Beluga Lake, Granite Point,

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[9] Tratner, Dale (Project Planner), Comprehensive Community Development Plan for Tyonek, Kenai Peninsula Borough Planning Department, September 1972.

[10] Gorsuch, Lee (Project Director), 2(c) Report: Federal Program and Alaska Natives, Robert R. Nathan Associates for the U.S. Department of the Interior.

[11] Kenai Peninsula OEDP Committee, Overall Economic Development Program Kenai Peninsula Borough, revised September 15, 1977.

[12] Ibid.

Kalgin Island, Ladd, Trading Bay, and West Foreland, had a total population of only 33.[13] In 1974, the Native population of Tyonek was 225, although a total of 303 Natives were enrolled to that village under terms of the Alaska Native Claims Settlement Act.[14] There are an estimated 60 men who are 18 years or older in the village.[15]

The primary occupation in the village is fishing. In 1975, about 3 percent of Kenai Borough fishermen lived in Tyonek, which is consistent with the fact that, while Natives made up only 5 percent of the Kenai Borough population, 22 percent of the Borough commercial fishermen and crews were Native. Tyonek fishermen rely primarily on set nets; of the 33 fishermen in the village, 30 had set net permits and only 3 had drift net permits.[16] The traditional fishing grounds are centered around Granite Point, a few miles south of the village; tenders pick up the catch.[17] The importance of the fishing industry to the village is evidenced by the fact that, of the 42 members of the 1976 Kenai OEDP Commercial Fishing Resource Committee, four were Tyonek residents.[18]

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[13] Alaska Department of Labor, Research and Analysis Section, Alaska 1970 Census Atlas, Population by Enumeration Districts from U.S. Bureau of Census Data. No date.

[14] Gorsuch, Lee, op. cit.

[15] Olsen, Marvin E., "Beluga Coal Field Development Scenarios," Battelle Human Affairs Research Centers for Alaska Division of Power and Energy Development, mimeo draft, April 21, 1978; revised draft, May 25, 1978.

[16] Kenai Peninsula OEDP Staff, A Profile of the Commercial Fishing Industry, Kenai Peninsula Borough, February 1978.

[17] Tratner, Dale, op. cit.

[18] Kenai Peninsula OEDP Committee (revised).

The fisheries have been declining in general with a resultant lack of employment opportunities.[19] At least five Tyonek residents had pipeline jobs,[20] and a major $12.5 million chip mill facility was operating near the village. The mill was processing timber received from a bug-kill sale on West Cook Inlet,[21] but the mill closed because of a weakening in the Japanese market and shutdown of the timber salvage sale.[22]

The village has a private airport with runways of 1,427 and 3,350 feet. Charter service is available to Anchorage and Kenai. Another larger airport (5,000 foot runway) at Beluga, owned by Standard Oil of California, is about five miles to the north.[23] The village is served by an occasional barge from Anchorage or Kenai. There is a road that leads from Tyonek to the traditional fishing site at Granite Point and another road (in poor condition) that can be reached after fording the Chuit River to the north. This road runs ten miles up the Chuit River and then through the Beluga airfield and across the Beluga River thirty miles toward Anchorage. This road is the basis of a winter

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[19] Tratner, Dale, op. cit.

[20] Naylor, Larry L. and Gooding, Lawrence A., "Alaska Native Hire on the Trans-Alaska Oil Pipeline Project," Review of Social and Economic Conditions, Institute of Social and Economic Research, University of Alaska, Vol. XV, No. 1, February 1978.

[21] Kenai Peninsula OEDP Committee, Overall Economic Development Program Kenai Peninsula Borough, Annual Report, 1977.

[22] Mr. Kerr, Public Assistance Forester, Alaska Division of Lands, Telephone conversation, February 28, 1978.

[23] Federal Aviation Administration, Alaska Region, Alaska Region Ten-Year Plan, July 1977, pp. 2-60 to 2-158.

route (for two months) to Anchorage.[24] The main barrier to permanent access is the Susitna River.[25]

Chugach Electric Association operates a large gas-fired generating station at Beluga with an installed capacity of 297.7 megawatts; the facility will be upgraded to 362.1 megawatts by 1979.[26] The station employs about nine people full time, but none are local residents. Personnel work ten days on and four days off; housed at the facility while on duty, they commute to Anchorage between duty periods.[27] Chugach operates two 138 KV, 43-mile circuits between Beluga and Point MacKenzie, two 26-mile circuits between Point MacKenzie and Wasilla, and three submarine cables (3-5 miles) between Point MacKenzie and Point Woronzof.[28]

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[24] Tratner, Dale, op. cit.

[25] Matanuska-Susitna Borough Planning Department, Background Report Phase I: Comprehensive Development Plan, Preliminary Draft, 1977.

[26] Battelle Pacific Northwest Laboratories, Alaskan Electric Power, An Analysis of Future Requirements and Supply Alternatives for the Railbelt Region, for Alaska Division of Energy and Power Development and Alaska Power Authority, March 1978.

[27] Mr. Kolzinski, Manager of Production Division, Chugach Electric Association, Telephone conversation, May 30, 1978.

[28] Alaska Power Administration, op. cit.

B.3. Site B: Point MacKenzie

Point MacKenzie is in the Matanuska-Susitna Borough, two miles west of Anchorage across Knik Arm. It lies east of the Susitna and Little Susitna River deltas and south of Wasilla, the small community of Knik, and Goose Bay. The area is undeveloped. A road from Wasilla continues past Knik as far as Goose Bay and the small military base located there. Chugach Electric Association maintains two 138 KV transmission lines from its Beluga powerplant that connect with lines to Wasilla and submarine cables to Point Woronzof in Anchorage.

The 1970 Census counts for Goose Bay and Point MacKenzie showed six residents in each "community." Separate data for Knik was not tabulated, but that community is included in the large enumeration district surrounding Wasilla, Point MacKenzie, Goose Bay, and Big Lake. Population of the district was 1,312.[29] Eleven Natives were living in Knik in 1974; eighteen others were enrolled to that village but residing elsewhere.[30]

Plans for the development of Point MacKenzie have been considered for a long time. The 1970 comprehensive plan for the Borough envisioned a port and industrial area, a major airport, a Knik Arm crossing to Anchorage, and a community of 20,000 people.[31] When the Matanuska-Susitna Borough was formed in 1966 under terms of the Mandatory Borough

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[29] Alaska Department of Labor, op. cit.

[30] Gorsuch, Lee, op. cit.

[31] Fischer, Victor, Regional Effects of Anchorage Metropolitan Growth, Institute of Social, Economic, and Government Research, University of Alaska, for the Joint Federal-State Land-Use Planning Commission.

Act, special powers for harbor development and operation were assumed for the purpose of developing a port at Point MacKenzie.[32]

The Borough owns much of the land near the point and thus, theoretically at least, could have significant influence on the form of development there.[33] Louisiana-Pacific, which has significant amounts of timber in the area and which now sends its logs to be processed in Seward, has expressed an interest in locating a chip mill in the area but would need a docking facility. Current thinking in the Borough envisions extension of the Goose Bay Road and Alaska Railroad to a port that would initially operate as an export facility. First major users would be the forest products industry; coal (from Beluga) and agricultural products would follow.[34] Export of Beluga coal through Point MacKenzie would require the construction of a road, railroad, and/or slurry pipeline to the Beluga area. Primarily because of this, a recent study recommended a port closer to the Granite Point area.[35]

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[32] Matanuska-Susitna Borough Planning Department, op. cit.

[33] Matanuska-Susitna Borough Planning Department, op. cit.

[34] Matanuska-Susitna Borough Planning Department, Overall Economic Development Plan 1977, 1977.

[35] Stanford Research Institute, Clean Energy from Alaskan Coals, for U.S. Energy Research and Development Administration-Fossil Energy, January 1976.

B.4. Beluga Coal and Hydroelectric Development

The timing and scale of development of the coal and hydroelectric capacity of Southcentral Alaska are subject to considerable uncertainty arising from the economics of energy supply and demand, federal energy policies, and institutional constraints. Thus, it is impossible to develop a unique baseline study of energy availability in the region and overlay the aluminum smelter upon that scenario. In this section, alternative baseline levels of development affecting the economy of the region in which the smelter would be located are discussed.

A minimum level of development of the Beluga coal field would be the result if there were a need for coal-fired electricity generation in the Cook Inlet area or an export market for coal or a coal product developed. Table B-2 shows the population impacts on the immediate region of those types of coal development taken from a recent study of Beluga coal development.[36] Alternative I assumes the construction of two 200 MW coal-fired generating plants before 1985 (using prefabricated modules); Alternative II assumes exports of six million tons of coal per year by 1990; and Alternative IIIa combines the two scenarios. For the first two alternatives, the assumption was that permanent work camps would be constructed. Very few nonemployed dependents would reside in the camp, and no community other than the camp itself would be established. The large number of workers involved in the combined scenario (Alternative IIIa) led to the assumption that once construction

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[36] Olsen, Marvin E., op. cit.

Table B.2. EMPLOYMENT AND POPULATION IMPACTS OF BELUGA COAL DEVELOPMENT (Limited Development Scenarios)

Alternatives	Workers						
	Construction	Mining	Operations	Camp Support	Secondary	Nonemployed Dependents	Total Population
I. Coal Development Sufficient to Fuel Two 200 MW Generators							
(a) Peak 1982	400	--	--	120	--	--	520
(b) Post 1985	--	90	120	60	--	50	320
II. Coal Development for Export of 6 Million Tons/Year							
(a) 1989	240	--	--	60	--	--	300
(b) Post 1989	--	180	30	60	--	50	320
IIIa. Alternatives I and II Combined with Establishment of Permanent Community							
(a) 1989	240	90	120	120	--	130	700
(b) 1990	--	220	150	60	210	260	900
(c) Post 1990	--	220	150	--	370	590	1330
IIIb. Alternatives I and II Combined without Establishment of Permanent Community							
Post 1989	--	220	150	120	--	100	590

Alternatives I, II, IIIa from Marvin E. Olsen, Battelle Human Affairs Research Center, Revised Beluga Coal Field Development Scenarios, June 30, 1978.

Alternative IIIb developed by author using methodology consistent with Alternatives I, II, IIIa.

was completed, a regular community would be established that would require a road link to Anchorage, secondary business establishments (stores, etc.), and ordinary family housing for workers and their dependents. Estimated employment and population impacts are shown on the table.[37] While the study assumes that a permanent community and road link would be necessary for the combined operations scenario, this may not be necessarily true. Despite the large numbers, it would still be feasible to transport workers on a regular basis from Anchorage or Kenai, via plane or ferry. For these reasons, an additional scenario (Alternative IIIb) has been constructed which is identical to IIIa, except that no permanent community is assumed.

Other studies have indicated a potential need for more coal development than described above. One recent report, based on forecasts of electric power demand prepared by the Institute of Social and Economic Research, indicated that at least one and perhaps four more coal-fired 200 MW generating plants would be required before 1991 in addition to the two mentioned in the previous scenarios. These forecasts were based on assumptions of 1) limited economic development in the state, 2) the construction of an Anchorage/Fairbanks electrical transmission inter-tie, and 3) hydroelectric power from the Watana/Devil Canyon projects beginning in 1991-92.[38] Local employment and population impacts for these scenarios were estimated using the same methodology as for the other alternatives and are shown in Table B.3.

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[37] Ibid.

[38] Battelle Pacific Northwest Laboratories, op. cit.

Table B.3. EMPLOYMENT AND POPULATION IMPACTS OF BELUGA COAL DEVELOPMENT
(More Rapid Development Scenarios)

Alternatives	Workers						
	Construction	Mining	Operations	Camp Support	Secondary	Nonemployed Dependents	Total Population
IVa. Slow Growth in Electricity Demand with Work Camps							
(a) Peak 1989	340	220	150	180	--	110	1000
(b) Post 1990	--	250	180	120	--	110	660
IVb. Rapid Growth in Electricity Demand with Work Camps							
(a) Peak 1989	540	280	210	210	--	140	1380
(b) Post 1991	--	340	270	150	--	150	910
Va. Slow Growth in Electricity Demand with Permanent Town							
(a) Peak 1989	340	220	150	180	--	110	1000
(b) Post 1990	--	250	180	--	430	690	1550
Vb. Rapid Growth in Electricity Demand with Permanent Town							
(a) Peak 1989	540	280	210	210	--	140	1380
(b) Post 1991	--	340	270	--	610	980	2200

Based on Methodology used by Marvin E. Olsen, Battelle Human Affairs Research Center.

These scenarios were constructed using the same methodology as employed in constructing the limited development scenarios. As can be seen, the long-term population impact of large-scale Beluga coal development could range between 300 and 900 with peaks of 500-1,400 if permanent work camps were built (Alternatives IVa and IVb). On the other hand, if a regular community developed, it could have a population of somewhere between 1,300 and 2,200 (Alternatives Va and Vb). Since major industrial projects have been specifically excluded from these scenarios, projected requirements would not satisfy the demand arising from an aluminum reduction plant. An additional source (about 340 MW) would be required for the smelter.

The need for thermal generation to satisfy forecast demand is dependent on the timing of the Watana and Devil's Canyon hydroelectric projects as well as the availability of additional natural gas for electricity generation projects. The two hydroelectric projects would have an installed capacity of about 1,500 MW. However, all of that power would be required before the year 2000 with rapid growth in electricity demand, but only about half would be needed under the slow-growth scenario (see table).[39]

Another alternative would be to construct the proposed hydroelectric facility at Chakachamna near Beluga (366 MW).[40] However, as with other

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[39] Ibid.

[40] Alaska Department of Commerce and Economic Development, Division of Energy and Power Development, Alaska Regional Energy Resources Planning Project (Draft Final Report), 1977.

hydroelectric projects with long lead times, construction before 1990 would be difficult, and major new thermal plants would probably be required before then.

C. IMPACTS

C.1. Local

Three potential scenarios of local employment and population impact of the construction and operation of an aluminum smelter as described in Section B are shown in Table C.1. In all cases, the direct employment associated with construction and operation of the plant is identical. During the first two years of the three-year construction period for the plant, employment grows to 1,209 on an annual average basis, 1,126 of which are directly involved in plant construction, while 83 are involved in plant operations. During year three, construction employment falls off and the operation of the plant begins to be phased in over the course of the year. In the fourth year, the construction of the plant has been completed and the operating labor force of 800 is employed. Support employment in all years is assumed to be 120.

The three scenarios depict three different types of response in terms of secondary employment and population to the stimulus of the new plant. At the level of abstraction required in this study, it is impossible to be very specific about the size of the response of the economy to a change in basic employment of the magnitude assumed here. This is because the locations assumed for the plant are virtually undeveloped at present, and the characteristics of the community which would develop around the plant would be a matter of conscious public policy.

Table C.1. LOCAL EMPLOYMENT AND POPULATION GROWTH FROM ALUMINUM REDUCTION PLANT

Year	Construction Employment	Operations Employment	Direct Employment	Support Employment	Secondary Employment	Nonemployed Dependents	Total Population
Permanent Work Camp Environment							
1	414	0	414	120	0	40	574
2	1,126	83	1,209	120	0	130	1,459
3	327	705	1,032	120	0	170	1,322
4	0	800	800	120	0	160	1,080
5+	0	800	800	120	0	160	1,080
Isolated Town Environment[1]							
1	414	0	414	120	135	535	1,204
2	1,126	83	1,209	120	400	1,383	3,112
3	327	705	1,032	120	460	1,290	2,902
4	0	800	800	120	460	1,104	2,484
5+	0	800	800	120	460	1,104	2,484
Developed Community Environment[2]							
1	414	0	414	120	267	1,009	1,810
2	1,126	83	1,209	120	797	2,679	4,805
3	327	705	1,032	120	864	2,540	4,556
4	0	800	800	120	828	2,202	3,950
5+	0	800	800	120	920	2,318	4,164

[1] Secondary employment multiplier year 1 = 1.25, year 2 = 1.3, year 3 = 1.4, thereafter 1.5; population/employment ratio = 1.8.

[2] Secondary employment multiplier year 1 = 1.5, year 2 = 1.6, year 3 = 1.75, year 4 = 1.9, year 5 = 2; population/employment ratio = 2.26.

For example, the first scenario describes the population and employment impact of the plant within a permanent work camp environment. In this case, the plant would be a self-contained unit providing all necessary living accommodations to the employees in the same manner as the Alyeska pipeline and Prudhoe Bay work camps. Spouses and families of workers would not be prohibited but also would not be encouraged to live on the site. No economy would develop around the site, as the employees would live elsewhere and only reside in the camps during those days when employed. The population associated with such a facility would number under 1,000, since a percentage of the total would not be on location at any one time.

Such a scenario seems possible only if the plant site were in an isolated area such as North Forelands-Granite Point. Even in such a case, however, the size of the work force and its permanent nature would seem to justify a more normalized work atmosphere.

The second scenario assumes an isolated town environment surrounding the plant. Such a town would be a real community in the sense that employees of the plant would reside permanently in the town and significant services, both public and private, would be provided locally. As a result, a larger nonemployed population would be present in the community, and total population could be approximately 2,500 in the long run.

Such a community type could be possible at either site discussed previously. The size of secondary response to primary employment change would be dependent to some degree upon access to alternative sources for the provision of goods and services and would also depend upon the extent and proximity of any other developments in the area--specifically the Beluga coal fields. For example, a development in Beluga with regular ferry access to Anchorage or a development at Point MacKenzie with road access to Anchorage would probably result in a somewhat lower level of secondary employment response than a more isolated town on either site. Also, a plant located at a site where development is already occurring might result in higher secondary employment response because of the larger market which results and the potential for import substitution for the provision of goods and services.

The third scenario describes such a situation in which there is a stronger secondary employment and population response. This is based upon employment and population ratios taken from statewide average data. The long-run population impact of such a scenario is approximately 4,200. As with the second scenario, such a case would be possible at either location and would be more likely the larger the underlying base of the economy in place at the time of the construction of the plant, and the stronger the commitment by state and local government to the development of a complete community on the site.

Table C.2 illustrates the range of multipliers in use for the determination of economic impacts for new industrial projects. The range of values, from 1.1 to 3.6, reflects the fact that the value of the multiplier is a function of the location, type of project, time period of

Table C.2. SELECTED TOTAL/DIRECT EMPLOYMENT MULTIPLIERS

[a]Oregon State - Arthur D. Little		3.60
[a]BPA - Alumax Aluminum Reduction Plant (Local Impacts - Oregon)		
	Operations	2.25
	Construction	2.00
[b]Alaska Department of Community and Regional Affairs		
	OCS Operations	1.50
	OCS Construction	1.10
[c]BLM/OCS - Lower Cook Inlet		1.86
[b]Alaska Department of Labor (Klockenteger) (State)		1.46
[d]Beluga Coal Impacts Study (Local-1991)		2.00
[d]Argonne Laboratories (Local Impacts-Lower 48)		2.5-3.5

Sources: [a]Bonneville Power Administration, Alumax Environmental Statement.

[b]Department of Commerce and Regional Affairs, "Economic Forecasts, Lower Cook Inlet Lease Sale."

[c]Bureau of Land Management, Lower Cook Inlet Final EIS.

[d]Olsen, Marvin E. (Battelle), "Beluga Coal Field Development Scenarios."

analysis, and structure of the impacted economy. For all of these reasons, it is incorrect to directly incorporate a multiplier developed for one study or purpose to another situation where conditions may be considerably different. The values employed in this study were not taken from previous work but rather represented "rule of thumb" estimates to portray possible outcomes.

Table C.3 further illustrates the potential misrepresentation which can result from the unsubstantiated use of multipliers. In this table, the ratio of total to basic sector employment is computed for Alaska and several small subdivisions of the state. The location of substantial support sector employment in the Anchorage area is reflected by a ratio which is much higher than the state and remainder of the Southcentral region.

The basic employment assumed for the construction and operation of the plant is subject to some uncertainty. Construction in a remote, rural location may require a larger labor force and a longer time than under more favorable conditions. On the other hand, a modular construction approach might be utilized to minimize construction costs resulting from the high cost of labor in Alaska and the remoteness of the site. Some of the personnel associated with the plant might be located in Anchorage to take advantage of the business services which are available in that community.

Table C.3. TOTAL/BASIC EMPLOYMENT RATIOS: 1976

Total State	2.69
Southcentral Region (Anchorage, Matanuska-Susitna, Kenai, Kodiak, Valdez, Cordova, Seward Census Divisions)	2.93
Anchorage/Matanuska-Susitna	3.60
Remaining Region	2.03

Basic Employment = Agriculture, Fisheries, Forestry; Mining; Manufacturing; Construction; Federal Government (civilian).

Non-Basic Employment = All Other Non-Agricultural Employment.

Source: Alaska Department of Labor

It is unlikely that an aluminum smelter would generate substantial forward and backward linkages in the form of inputs locally supplied or outputs directly utilized. The energy would be supplied locally, of course, and possibly the coke. In addition, there would be some growth in business services providing inputs to the plant operation.

The jobs in which the aluminum reduction plant would result can be divided into several categories. Initially, construction employment would be the primary type. These jobs would last from one to two years. The plant itself would employ a large labor force of 800, about one-fourth of which would be salaried, while the remainder would be paid on an hourly wage. Production employment does not require previous experience in the aluminum industry nor are other special skills required.[41] The secondary employment generated would be in the areas of business services and consumer services and trades.

The project would generate substantial income for those employed. Table C.4 indicates the amount of local income which might be generated (in 1977 dollars) for each of the alternative environments shown in Table C.1. Assuming annual wage rates (in 1977 dollars) of $35,000, $25,000, and $20,000 for the construction, operations, and support sectors, respectively, the long-run impact on income could range between $20 and $40 million annually.

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[41] Bonneville Power Administration, op. cit., p. IV-79.

Table C.4. LOCAL INCOME IMPACT OF ALUMINUM REDUCTION PLANT

(million 1977 dollars)

Year	Construction Income	Operations Income	Support and Secondary Income	Total
Permanent Work Camp Environment				
1	14.5	0	2.4	16.9
2	39.4	2.1	2.4	43.9
3	11.4	17.6	2.4	31.4
4	0	20.0	2.4	22.4
5+	0	20.0	2.4	22.4
Isolated Town Environment				
1	14.5	0	5.1	19.6
2	39.4	2.1	10.4	51.9
3	11.4	17.6	11.6	40.6
4	0	20.0	11.6	31.6
5+	0	20.0	11.6	31.6
Developed Community Environment				
1	14.5	0	7.7	22.2
2	39.4	2.1	18.3	59.8
3	11.4	17.6	19.7	48.7
4	0	20.0	19.0	39.0
5+	0	20.0	20.8	40.8

Assumptions: Average construction wage: $35,000
Average operations wage: $25,000
Average support and secondary wage: $20,000

The aluminum reduction plant would require about 400 MW of peak generating capacity which otherwise would not be necessary. This electric power could be provided either through use of hydroelectric potential of the Southcentral region or the construction of coal-fired generating facilities utilizing Beluga coal. Because this energy requirement would necessarily be met by an increase in local production, the inclusion of the impact of such development on the economy becomes a necessary part of the overall impact analysis. One can analyze the impact of the energy requirement in terms of the requirement for additional coal-fired generation in the Southcentral area. This is based on the assumption that either 1) the aluminum facility would utilize electricity directly generated from Beluga coal or 2) the aluminum facility would utilize hydroelectric power, but the continuation of electricity demand growth in Alaska would necessitate an increment of 400 MW of coal-fired generation at some point in time to "fill the gap" created by the use of hydroelectric power by the smelter. The only difference between the implications of the two assumptions lies in the timing of the impacts. Direct use of coal-fired electricity implies simultaneous construction of coal-fired generating capability. Use of hydroelectric power could postpone the timing of coal-fired additions.

The required coal mining and operating facilities for 400 MW of generating capacity would be incremental in the sense that they would be in addition to the already existing facilities at Beluga which would be at least 400 MW of generating capacity, a coal-exporting operation, or both. Thus, the construction and operation employment requirements of providing this energy would be less than the requirements starting at "ground zero."

Table C.5 shows the local employment and population impacts which would result from the simultaneous construction of the aluminum smelter and a 400 MW incremental coal-fired generating capacity in the Beluga area. The coal-fired generation is assumed to have a secondary impact reflecting an isolated community environment.

The inclusion of the employment and population associated with the coal-fired generating plant in the analysis increases the individual employment categories, but the general size of the impact is approximately the same. The impact of the generating facilities is relatively larger, of course, when the aluminum plant is on a permanent work-camp environment. The location of the impact is, as before, indeterminate from the table except that coal development occurs at Beluga. Aluminum development could occur either there or at Point MacKenzie.

An aluminum smelter at Beluga would provide employment opportunities to the residents of nearby Tyonek, although if it came after coal development there, any excess labor supply would probably already have been eliminated, since there are currently only about 60 men total in the community between the ages of 18 and 60. A Point MacKenzie site would provide employment opportunities to the residents of the Matanuska-Susitna Borough if a road were developed to the site.

Table C.5. LOCAL EMPLOYMENT AND POPULATION GROWTH FROM ALUMINUM REDUCTION PLANT WITH COAL-FIRED ELECTRIC POWER GENERATION

Year	Construction Employment	Operations Employment	Direct Employment	Support Employment	Secondary Employment	Nonemployed Dependents	Total Population
Permanent Work Camp Environment							
1	564	0	564	135	83	106	888
2	1,326	83	1,409	150	115	222	1,896
3	577	705	1,282	150	140	282	1,854
4	150	885	1,035	135	125	260	1,555
5+	0	920	920	135	68	214	1,337
Isolated Town Environment							
1	564	0	564	135	218	601	1,518
2	1,326	83	1,409	150	515	1,475	3,549
3	577	705	1,282	150	600	1,402	3,434
4	150	885	1,035	135	585	1,204	2,959
5+	0	920	920	135	528	1,158	2,741
Developed Community Environment							
1	564	0	564	135	350	1,075	2,124
2	1,326	83	1,409	150	912	2,771	5,242
3	577	705	1,282	150	1,004	2,652	5,088
4	150	885	1,035	135	953	2,302	4,425
5+	0	920	920	135	988	2,372	4,421

Construction at either the North Forelands-Granite Point or Point MacKenzie site would occur within the boundary of an organized borough but outside existing city limits. Thus, the facility would be subject to the property tax but not to other city-administered taxes, unless there were incorporation of a new community. If the plant and secondary development resulted in property value increases of $400 million, property taxes of $4 million annually would be collected at a 10-mill rate. At the same time, if a new community developed, there would be requirements for infrastructure in the form of schools, streets, sewers, etc., as well as ongoing expenditures. As is typical with development of this sort, the receipt of significant revenues lags the demand for expenditures by several years. A method would need to be provided to bridge this gap.

One problem that has been cited for blue-collar employers, in general, and aluminum smelters, in particular, is the fact that they provide few employment opportunities for women. Because they often dominate the local economy, there are also few opportunities outside the plant for women. The labor participation rate for women in Kitimat is the lowest in Northwest British Columbia; that for men is the highest. Many women become bored when forced to stay home alone with no alternatives; general feelings of stress have been noted for many women in the area.[42] A similar situation could potentially arise with construction of a smelter in Alaska, especially one located in a relatively remote area such as Beluga.

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[42]Ministry of Economic Development, op. cit.

C.2. Statewide

Many of the impacts of large projects are felt outside the immediate local area of the project itself, e.g. the effects of the construction of the oil pipeline on economic and population growth in Anchorage and Juneau. This type of growth is generated by several independent mechanisms. As noted above, the project will create a demand for business services. Some of these services would be provided on the plant site, but others would best be handled at existing business service locations such as Anchorage. A second activity would be consumer related and be the result of increased demands for goods and services which the increased incomes of project employees would engender. Some of this activity would best be located near the site of the project, but again some would be located in existing urban centers. A third component of impact outside the immediate location of the plant would be that resulting from increased state government activity. A portion of local government services are provided by the state in Alaska because of the relatively underdeveloped status of local government and the relative fiscal capacities of state and local government. Thus, it would not be unusual to expect an expansion of state government activity in response to a large project of this type. This would be in addition to expansion due to the growth in those functions normally reserved for state government.

An econometric policy analysis model of Alaska developed by the Institute of Social and Economic Research provides some insights into the statewide economic impacts of large-scale developments on the

Alaskan economy.[43] The model does indicate that all of the impacts of development do not occur in the region in which the project is located. Because Anchorage is the trade and service center of the state and includes approximately half of the population, secondary economic growth tends to occur there regardless of the origin of the activity.

The model also highlights the transient nature of the Alaskan population and the central importance that migration has in the growth process. Large-scale developments, epitomized by the oil pipeline, tend to attract people to Alaska because of the potential employment and income opportunities they afford. Thus, large projects not only increase employment opportunities but also people seeking employment. The result is that the unemployment rate is relatively independent of the growth rate of the economy, and if any relationship is apparent, it is that the unemployment rate rises as the rate of growth of the economy increases.

Many of the new employment opportunities associated with a development of this type would be acted upon by resident Alaskans. This would include both individuals employed and unemployed at present. Because of migration, many of the jobs would also go to those not presently in the state, so that all of the income derived from the project wages and salaries would not go to Alaskans.

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[43] Goldsmith, Scott and Huskey, Lee, The Alpetco Petrochemical Proposal: An Economic Impact Analysis. Report to the State Legislature, Institute of Social and Economic Research, University of Alaska, April 1978.

Another factor centers on the project impact on state revenues and expenditures. The primary devices presently available to the state for the generation of tax revenues from a project such as this would be the personal and corporate income taxes. These taxes together provide only a small portion of total revenues, the majority of which are derived from petroleum taxes and royalties. Thus in per capita terms, the marginal tax revenues from new activities are generally less than existing per capita revenues.

The demands for state services generated by the project will be positively affected by several factors. First, many services are provided in Alaska at the state level rather than at the local level as in many other states. Education is an important example. Second, the migration to the state will cause population to increase, and this will increase the demand for public expenditures. It is possible that impact revenues would be less than impact expenditures at the state level.

C.3. National and Pacific Northwest

The world demand for aluminum is expected to grow somewhere around 4 percent[44] to 5 percent[45] per year. The output of the aluminum reduction plant considered here would amount to about 2 percent of total U.S. production or about 0.5 percent of world production. The United States

[44] Bonneville Power Administration, op. cit.
[45] Ministry of Economic Development, op. cit.

is a net importer of aluminum; an estimated 14-24 percent of U.S. demand between 1980 and 2000 will have to be supplied by imports, according to one study. Production of the plant could reduce expected annual imports by 5-8 percent between 1985 and 2000.[46]

In recent United States history, the prime location for aluminum plants has been in Washington and Oregon where power supplied by the Bonneville Power Administration (BPA) has been extremely inexpensive. For instance, the original contract for the proposed Alumax plant in Oregon provided for power at a cost of about 2 mills per kilowatt at the smelter.[47] However, the BPA no longer has large amounts of excess power; rates are being raised as contracts are renewed, and plants have been given incentives to find other sources of power.[48] Partially because of the lack of cheap power in Washington and Oregon, no new smelters are currently being proposed in the continental United States.

The Alcan plant in Kitimat is planning an expansion of its facilities sometime between 1983 and 1999. It tentatively plans a massive "Kemano II" hydroelectric project (1,200 MW) to power the expanded facility.[49] Construction of a plant in Alaska could conceivably delay or inhibit the implementation of that project.

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[46] Bonneville Power Administration, op. cit.

[47] Ibid.

[48] Bonneville Power Administration, op. cit.

[49] Ministry of Economic Development, op. cit.

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Energy Intensive Industry for Alaska

Volume II

Part 3: State Management Options

prepared for

Division of Energy and Power Development
Department of Commerce and Economic Development

by

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June 1978

A. INTRODUCTION

This concluding segment of the Energy Intensive Industry Study, like the preceding section, addresses itself to the aluminum industry.

As outlined in Part I, the specific aluminum industry project considered herein is a reduction plant, or smelter, which would produce 185,000 tons per year of aluminum ingot for interstate shipment or export from Alaska. The hypothetical plant location is West Cook Inlet, near Tyonek or Point MacKenzie. This plant would be constructed over a 32 month period, requiring a peak on-site construction labor force of 1400 persons. When completed, the plant's permanent resident labor force would total 800 persons. Major annual raw materials requirements for the plant would consist of approximately 360,000 tons of improted alumina, 75,000 tons of calcined petroleum coke, and 120,000 barrels of residual oil --residual oil is used as a binder for petroleum coke in forming carbon anodes. Annual process energy requirements would consist primarily of 2.6 billion kilowatt hours of electricity, and 940 million cubic feet of natural gas, or the equivalent in liquid fuels. Infrastructure requirements for the plant, and related community of 4700-6900 population assumes concurrent development of the Beluga coalfield and mine-mouth power plant and would include public sector development of a deep water port, airport, highway, electricity and natural gas transmissions systems, local utilities, streets and roads, shcools and other public facilities, along with private sector development (perhaps publicly assisted) of housing and commercial facilities.

State management options affecting aluminum industry development in Alaska, based on the above criteria, would be chosen under the following set of initial circumstances:

1. Of the major raw materials and process energy sources required by the aluminum reduction plant, only natural gas and alternative liquid fuels are today available in Alaska. However, resources are present in Alaska for the generation of sufficient electric power for an aluminum reduction plant, and for the manufacture of a sufficient supply of petroleum coke.

2. Infrastructure in the hypothetical location areas for the reduction plant and associated community is almost totally undeveloped, although the selected locations are near the extensively developed Railbelt.

3. Alaska construction costs, and manufacturing labor costs, are substantially higher than elsewhere in the U.S., a major deterrent to the relatively capital and labor intensive aluminum industry.

4. An aluminum reduction plant located in Alaska would be more remote from domestic markets for primary aluminum than alternative locations in the Lower 48, but would be closer to markets in Japan and the Far East.

5. Alaska's present relatively heavy state and local tax burden, and its long-term financial outlook, reflecting possible declines in state revenues from the petroleum industry, may not be attractive to the aluminum industry.

6. As noted in Part 2, Alaskan residents have indicated a positive attitude toward industrial development in the state's future, and have expressed encouragement for such development. They have expressed a decided preference for development of renewable resource industries, reflecting a concern for permanent and stable -- or steadily growing -- industries.

7. State institutions such as the Alaska Power Authority, Alaska State Housing Authority are available at the present time to fund specific revenue-producing public sector projects complementary to development of an aluminum industry. The existing Alaska Departments of Transportation and Public Facilities, and Education are considered capable of an adequate response to non-revenue producing infrastructure requirements. Administrative and regulatory agencies of the Alaska Departments of Commerce and Economic Development, Revenue, Natural Resources, and Environmental Conservation are considered adequate for the purpose of controlling development and operation of a major new industry.

8. Development and application of state policy in respect to industrial development in the past decade generally has favored industrial projects which would maximize value added to Alaskan resources prior to their export from the state. The recent decisions of the Alaska Legislature, and administration approving sales of royalty crude oil to the El Paso natural gas pipeline consortium and the Alpetco petrochemical consortium, as well as the approval of financial assistance to the Northwest Alaskan pipeline developers have precedented a relatively high level of state involvement in inducing industrial development considered beneficial to the state.

This segement of the Energy Intensive Industries Study will review state management options with respect to possible development of an aluminum reduction plant in Alaska with reference to the present circumstances outlined above.

State management options will be considered based on three alternative levels of state involvement, as follows:

1. Low state involvement, a case in which the state would have the relatively passive role of ensuring compliance of any independently proposed development with applicable law and regulation.

2. Moderate state involvement, a case in which the state, in addition to the functions outlined above would formulate a general policy to facilitate development of an aluminum industry, by means of regional land use planning, incorporation of non-revenue producing infrastructure in transportation and other agencies long-term plans, and would respond to the industrial developer's proposals regarding state development of electric power supply and other revenue-producing public sector projects.

3. High state involvement, a case in which the state would actively promote development of the aluminum industry by soliciting private firm's proposals for such development and by offering maximum state participation in the infrastructure development outlined under Item 2 above, coordinated with the developer's requirements. This high level of state invovlement could also include long-term commitments of royalty crude oil and natural gas, as well as direct loans and/or loan guarantees to the aluminum industry developer.

It is assumed that the state's choice of a particular level of involvement in aluminum industry development would follow a judgment as to the attractiveness of this industry as an addition to Alaska's economic base, as well as a general judgment regarding the benefits of new industry to the Alaskan public interest as a whole.

B. STATE INVOLVEMENT

The State has the option of three possible levels of involvement in aluminum industry development, low involvement would be an essentially passive or regulatory role, moderate involvement would incorporate a planning function generally related to the industry, while high involvement would entail maximum state promotion of and assistance to the industry project.

State policy formation regarding industrial development, and its application during the past decade, has been preoccupied with the petroleum industry as a major growth factor in the state's economy. A major state policy initiative in respect to this industry has been support for projects which would maximize value added to crude petroleum prior to export. Commitment of state royalty crude oil to the Tesoro-Alaska refinery and the proposed Alpetco petrochemical plant are key examples of this support.

It is believed that state incentives to development of the aluminum industry would be consistent with state policy precedents regarding the petroleum industry. If hydroelectric power were its energy source, aluminum production would be among the few industries which could incorporate large quantities of this resource into exportable products with related major gains in employment and capital investment within Alaska. Alternatively, for coal used in generation of electric power, and for the relatively small volumes of crude oil and natural gas required as raw materials and process fuels, the aluminum reduction plant would add greater value to the state's gross product than raw materials exports.

These gains to the state economy would be very similar to those resulting from establishment of a petroleum refinery or petrochemical plant, except that the aluminum reduction plant would probably not supply any significant portion of its production to markets within Alaska. It is believed that offsetting the disincentives to new industrial development in Alaska, in the form of higher construction and operating labor costs, probable relatively high power cost and taxes, and remoteness from U.S. markets would require a high level of state involvement. This involvement probably must include active promotion of aluminium producers' interest in Alaska, comprehensive planning of land use, the industrial site and related community development, development of community infrastructure and industrial park facilities, and assistance in developing housing and community facilities. It is possible also that the state must consider making royalty oil available to a coke maufacturer on a favorable long-term contract.

The above items, with the exception of planning, and development of non-revenue producing infrastructure would be largely funded by revenue bond sales, and would be self-amortizing. The possible use of a non-profit corporation which could sell tax-exempt bonds for production plant construction could also be explored jointly by the state and/or aluminum manufacturer. Such a plan was recently proposed for petroleum refinery development by the Alaska Petrofining consortium, however, the legality of this financing mechanism for a production plant has not been firmly established. This device like the other revenue bond-financed programs outlined above would also be self-amortizing, that is the aluminum producer would fully reimburse the related interest charges and debt payment.

Other incentives by the state under a high level of involvement may include direct loans and/or loan guarantees by the state. These loans or guarantees could provide, or enable the private developer to obtain from other sources lower interest rates and longer term than would normally be available to a private borrower. They could also enable the developer to proceed if, due to expected high costs of construction and operation, his project were not expected to show financial results attractive to private lenders. Although the state's use of loans and loan guarantees as development incentives could be one of its most effective incentives, this device could require they share the risks of a financially marginal project. The precedent for use of direct loans and loan guarantees to facilitate a large industrial project is the Legislature's recent approval of these for the developers of the North Slope natural gas pipeline. However, this project will result in direct annual revenues to the state exceeding $200 million annually, a sum equal to approximately 20% of the direct loans authorized. The aluminum industry's fiscal contribution to the state would not be comparable to this case. Nevertheless, this type of incentive to renewable resource industries has been quite strongly endorsed by Alaskans, and as indicated above the aluminum industry's role in the Alaskan economy would be quite similar to that of a bona fide industry of this type. Therefore, it is not inconceivable that if a strong justification were made for the aluminum industry, public support for such involvement by the state could be present.

C. RAW MATERIALS AND PROCESS ENERGY

An aluminum plant's total annual consumption of Alaskan energy resources would approximate 6.5 million barrels of oil equivalent (b.o.e) or about 14,500 b.o.e. per day. Of this total, about 68%, or 4.4 million b.o.e. would be in the form of 2.6 billion kilowatt hours of hydroelectric or coal-fired electric power required by the electrolytic reduction process. Of the remainder, 1,550,000 barrels of residual oil would be required annually as feedstock for manufacture of petroleum coke, with an additional 40,000 barrels required for the coker's process heat. The aluminum reduction plant would require 120,000 barrels of residual oil for process use in forming carbon anodes. An additional 160,000 b.o.e., consisting of 120,000 barrels of residual fuel oil, or alternatively 740 million cubic feet of natural gas, and approximately 80 million cubic feet of propane gas would be required for carbon baking.

It is expected that sufficient petroleum refining capacity, and related production of residual oil and liquefied propane gas will be available on the Kenai Peninsula by the early 1980's to supply an aluminum reduction plant's requirements. It is also expected that sufficient natural gas will be available in the West Cook Inlet area to enable substitution of natural gas for residual oil as fuel for the carbon baking process.

The quantities of residual oil and natural gas required for plant fuels and process uses other than petroleum coke feedstock are relatively small, therefore it is expected that the aluminum manufacturer would be able to procure them in normal markets, and that the state would not be called upon to commit royalty crude oil or natural gas in order to ensure this supply.

It is however improbable that the volume of petroleum coke to be purchased by a single aluminum reduction plant would be sufficient in itself to induce establishment of a coker, and further improbable that a coker producing the required 75,000 tons per year would be capable of selling its product at an attractive price. It is possible that the aluminum plant's requirements would induce the establishment of a larger coker, with 50-75% of its production intended for export, provided that a long-term supply of residual oil for coke feedstock were made available on attractive terms. Therefore, it is possible that the state's commitment of royalty crude to a petroleum coke manufacturer could be solicitied if an Alaskan aluminum reduction plant were projected; the coke manufacturer's annual requirement for 150-300,000 tons per year of coke production would be approximately three to six million barrels of residual oil (8-16,000 b.d).

The cost of electric power is sufficiently important in minimizing cost of primary aluminum production to have warranted large concentrations of the U.S. aluminum industry in areas such as the Pacific Northwest, where large blocks of very low-cost power have been available in the past. This factor has also, in the past two decades, induced U.S. aluminum producer's interest in foreign plant locations, in Africa, Indonesia, and other nations, where few other production and transportation cost advantages have been available to the industry. The prospect of low-cost power for aluminum manufature in Alaska has during the past 20 years been the objective of three proposals for hydroelectric power development. The Aluminum

Company of America (Alcoa) proposed development of the Yukon-Aaiya project in the late 1950's, Harvey Aluminum, inc. (now Martin Marietta) researched the Wood Canyon project on the Copper River in the 1960's, and an affiliate of Kaiser Aluminum and Chemical Corporation investigated the Upper Susitna projects in the mid-1970's. Other less specific aluminum industry interest has also been shown in both Alaska and the neighboring Yukon Territory. The aluminum industry normally has sought federal or state development of a large low-cost hydroelectric power project which could be facilitated on the one hand by the aluminum producer's long-term contract for power, and which would at the same time provide a long-term power supply for community use. Among the Alaskan hydroelectric projects considered, Yukon-Taiya and Wood Canyon both were considered too remote from the Railbelt, which contains Alaska's only major electrical load centers, to be of use in supplying community power requirements, however, both of these projects were probably too large, as conceived, to be paid for primarily by aluminum industry power purchases. The Susitna projects on the other hand were recognized by Kaiser as merely sufficient to satisfy Railbelt needs through the late 1990's leaving no long-term power surplus for an aluminum reduction plant.

At the present time Alaska's major electrical load center, the Anchorage area, is almost totally dependent on natural gas-fired electrical generation. It is considered probable that by the early 1980's, three major factors will induce new coal-fired generating capacity to be developed for this market:

1. Depletion of existing North Cook Inlet natural gas reserves may make it difficult to procure long-term supplies of natural gas for power fuel beyond those researves which are committed to utilities at the present time.

2. Natural gas prices are expected to increase at a more rapid pace than prices of other fuels, causing natural gas to become less competitive for electricity generation.

3. Federal regulation may prohibit use of natural gas for base-loading electricity generation by the early 1980's.

As a result, near-term capacity planning of Anchorage areas utilities may be forced to include alternative energy sources by the early 1980's. Because current planning for the Susitna hydroelectric projects does not envision a first stage completion before 1990, it is considered probable that a major coal-fired generation project will be required to satisfy Railbelt area utilities growing demand before hydroelectric power becomes available. In this context, state management options, and possible related incentives to aluminum industry development probably must be concerned with the development of a coal-fired power source for an aluminum reduction plant, whether or not eventual development of Susitna hydro, wholly or partially under state auspices is considered.

In Volume III of this report, the Railbelt area's annual requirement for coal in 1985, primarily for electricity generation, total 1.9 million tons. Assuming the Susitna hydroelectric project were completed in 1992, the Railbelt's annual coal requirement would increase to 4.2 million tons in 2000. Of this total, all but 600,000 tons would consist of coal reserves probably including some at the existing Healy mine which would be opened to production after 1980. If Susitna is not developed, the Railbelt's annual coal requirements would increase to 3.9 million tons in 1980, 5.5 million in 1985, and 8.8 million in 2000. These production forecasts assume that coal would satisfy virtually all of the Railbelt's electrical load growth through 2000.

The proposed developer of the Beluga coalfield has indicated that this coal reserve may be economically opened to large scale production for export when a total market for five to six million tons per year is developed. A smaller scale mining effort for local supply will require less new infrastructure and could be economical. Thus, it is probable that the Beluga coalfield could be opened solely to supply the Alaskan market in the mid-1980's.

The introduction of an aluminum reduction plant into the Railbelt area power market would create an annual market for 1.5 million tons of coal. The addition of this to local utility market would make it possible for the Beluga coalfield to be opened by 1985. It is possible that in this way the introduction of an aluminum reduction plant could assist in making available a lower-priced source of coal for Anchorage area utilities than if a smaller scale mine opened solely to supply these utilities.

The addition of an aluminum reduction plant to the Railbelt power market could also enable some economies of scale to be realized in the capital and operating costs of coal-fired electrical generation. However, economies of this type are difficult to forecast due to potential diseconomies of scale in containment and disposal of cooling water, ash, and possible residues from coal washing and beneficiation.

It is expected that costs of coal-fired power, generated on a large scale at or near Beluga would range from 3.0¢-3.5¢ per kilowatt hour at the busbar of an aluminum reduction plant or utility purchaser. These costs are based on probable installed costs of $1200-1600 per kilowatt for coal-fired generation near Beluga with approximately 20-30 miles of double circuit high voltage transmission, and fuel cost at $1.00 per million BTU at the power plant. This cost is substantially higher than the rates known to be paid for power by any aluminum reduction plant in the U.S. but comparable to those in Japan.

At the present time, Railbelt area power markets are served by six utilities. In the Anchorage-Kenai-Matanuska/Susitna area, Chugach Electric Association, Inc. (CEA), Homer Electric Association, Inc. (HEA) and Matanuska Electric Association, Inc. (MEA) are organized as cooperativs and are financed by the Rural Electrification Administration (REA), while Anchorage Municipal Light and Power (AMLP) is a municipally-owned utility organized as an administrative department of the Municipality of Anchorage. These utilities are primarily dependent on gas-fired generation by CEA, which is interconnected with HEA and MEA and AMLP. CEA also receives power from its small Cooper Lake hydroelectric plant, and both CEA and AMLP receive allocations of power from the Alaska Power Administration's small Eklutna hydroelectric plant, a federal power project. It is these utilities which are expected to make up the local market for Beluga coal in the mid-1980's. Fairbanks' area utilities, the REA-sponsored Golden Valley Electric Association, Inc. and the city-owned Fairbanks Municipal Utilities System, at present only primarily on coal mined at Healy for base-loading generation; it is expected that their needs through the mid-1990's can be met by expansion of the Healy mine and nearby power plant. Therefore, it is the Anchorage/ Kenai-Matanuska/Susitna utilities alone which would fall into the same power market for Beluga coal with a possible aluminum reduction plant in the West Cook Inlet area.

Up to the present time new fuel supply and generation planning and new project financing and development for the Anchorage-Kenai-Matanuska/Susitna area has been done by CEA and AMPL. However, the introduction of the Alaska Power Authority under legislation passed in the 1975 Legilature now enables the state to sponsor more comprehensive regional power system planning and development than could be accomplished by these two utilities. It is probable that the Alaska Power Authority could more readily finance a relatively capital-intensive large-scale coal-fired generation project than the individual utilities. It is also considered probable that the Alaska Power Authority is the only existing agency which could undertake a generation project large enough to supply both the local utilities and an aluminum reduction plant.

Based on the above, it is anticipated that an intensive involvement by the Alaska Power Authority would be essential in providing the incentive of a secure long-term power supply to the aluminum industry. The Power

Authority's role would include proposing long-term coal purchase contracts capable of inducing the opening of the Beluga coalfield, obtaining power purchase commitments from local utilities and the developer of the aluminum plant; and planning power supply for the related community.

Under its organizing statutes, the Alaska Power Authority is a semi-autonomous agency of the state. Its potential sources of funds include legislative appropriations, but its intended source of major project financing is the sale of revenue bonds. Therefore, the Power Authority is capable of developing self-supporting power supply projects for both the community and for industry. The Power Authority may not subsidize projects, however, although it may administer funds appropriated by the Legislature for this purpose.

The Alaska Power Authority is capable of serving as lead agency in providing power supply to an aluminum reduction plant and related communities under any level of involvement by the state. The Power Authority is perhaps uniquely capable of developing a power supply project which would serve both a new industry and the Anchorage-Kenai-Matanuska/Susitna area, or the Railbelt as a whole. Although it has not yet been clearly established whether the Power Authority will have a contributing role in planning, developing and operating the Susitna hydroelectric project, it is possible that in such a role the Authority could coordinate development staging for both new coal-fired and hydroelectric generation in the Railbelt. Co-ordination of this type could contribute to long-term power cost minimization in the region. As indicated above, it is believed that the addition of a large industrial load could be helpful in enabling this, by facilitating the near term development of large scale coal-fired generation.

It is, however, by no means clear that the cost of power which could be supplied by the Authorith would be attractive to the aluminum industry. A cost of 3¢ per kilowatt hour is approximately the level projected for new large scale nuclear power projects in the Lower 48. If replacement cost power pricing does not become a general practice in areas such as the Pacific Northwest, and if environmental and community pressures do not threaten to deter new industrial development, it is possible that continued rolled-in cost-based power pricing will continue to offer incentives for industrial expansion in areas outside Alaska.

D. DEVELOPMENT OF INFRASTRUCTURE

State development of infrastructure for an aluminum reduction plant would take two forms: First, non-revenue producing or non-self-supporting public works must be developed in the form of highways, deep water port, airport and related facilities, and community facilities typically assisted by the state, such as water and sewer utilities, streets and roads, and schools. These facilities could be developed as federally assisted state projects under the Department of Transportation and Public Facilities and the Department of Education. Second, revenue-producing or typically financially self-supporting infrastructure must be developed, such as power supply systems, industrial park facilities, and housing and community facilities. In addition to the Alaska Power Authority, the Alaska Industrial Development Authority (AIDA) and the Alaska State Housing Authority have the statutory authorization to develop this type of project.

Development of infrastructure in the West Cook Inlet area cannot rely on existing facilities other than power supply to any significant degree. However, this area is not remote from Anchorage, and links to that area's well-developed facilities would be relatively short.

E. ALASKA'S TAX BURDEN AND LONG-TERM FINANCIAL OUTLOOK

Assuming that Alaska's recent high rates of expenditure for public services reach maturation and declines on a per capita basis a new industry and associated population should result a positive net fiscal impact on the state. A large share of the cost of state facilities and services is currently funded by the petroleum industry relative to its total employment and value of product than is provided by other industries. Granted that the major sources of state revenues from the petroleum industry are royalties and severance taxes, justified by that industry's extraction of a vital resource, the greater part of these revenues is nevertheless used to fund current operating expenditures of the state government, at a level presently several times as large, on a per capital basis, as the national average state expenditure. Petroleum industry revenues now funded by the state and local tax contributions of other industries and individual residents. In spite of this, state and local taxes, are not relatively low, compared to those in other states. From the point of view of a new industry investigating an Alaskan plant location, the present method of funding Alaskan government expenditures has some serious disadvantages. First, as previously noted, corporate income and other taxes are not low; at the present time, second, and more important, it can be expected that if depletion of petroleum reserves begins to reduce state royalty and severance tax revenues in the mid-1990's, as it will without major new oil discoveries, a larger share of the total tax burden for the accustomed level of state services will fall on non-petroleum industries. Because the domestic and foreign markets for primary aluminum do not permit the industry to pass on production costs to consumers as readily as the petroleum industry, it is probable that a state attempt to maintain its total revenues in the face of declining oil production would have a very severe impact on an Alaskan aluminum industry's profitability. This situation probably creates an additional disincentive to location of an aluminum reduction plant in Alaska. Clearly, if the state wishes to encourage new industrial development in Alaska, policy development must include long-term planning for maintenance of a reasonable level of services and concurrent fiscal self-sufficiency.

F. COMMUNITY OBJECTIVES

As noted in Phase I-A the substantial number of Alaskans polled in recent years regarding community development goals (and the role of the state in achieving them) generally favor new industrial development. They also favor state incentives to such development including loans but not direct subsidies. Renewable resource industries and development of hydroelectric power are widely favored for development by Alaskans, with secondary emphasis on other industries.

It is believed that while the aluminum industry as a whole is not a renewable resource industry, it could in Alaska fulfill the role expected of such industries by residents. The aluminum industry would rely only to a very minor extent on Alaskan resources other than energy; if this energy were provided by hydroelectric power, the Alaskan resource used would, in fact, be renewable. If coal were the electric power source, the reduction plant's annual consumption of power, requiring extraction of 1.5 million tons of coal per year, would result in an annual depletion rate of only one tenth of one percent (0.1%) of the estimated 1.5 billion ton recoverable reserves at the Beluga field alone.

It is probable that if the state were to propose a high level of involvement in developing an aluminum industry the initial public opion response would clarify whether or not such development is seen as consistent with community objectives. The state's initiative in doing this should reflect a judgment as to whether the aluminum industry would in fact offer benefits sought by the community, in the form of improved long-term employment and improved outlook for stable economic growth.