Preliminary Railbelt Electric Energy Plans

Volume V

September 1982

Prepared for the Office of the Governor
State of Alaska
Division of Policy Development and Planning
and the Governor's Policy Review Committee
under Contract 2311204417

Battelle
Pacific Northwest Laboratories

LEGAL NOTICE

PRELIMINARY RAILBELT ELECTRIC ENERGY PLANS

Volume V

J. J. Jacobsen
W. H. Swift
J. C. King

September 1982

Prepared for the Office of the Governor
State of Alaska
Division of Policy Development and Planning
and the Governor's Policy Review Committee
under Contract 2311204417

Battelle
Pacific Northwest Laboratories
Richland, Washington 99352

PREFACE

The State of Alaska commissioned Battelle to investigate potential strategies for future electric power development in Alaska's Railbelt region. The results of the study will be used by the Office of the Governor to formulate recommendations for electric power development in the Railbelt.

The primary objective of the study is to develop and analyze several alternative long-range plans for electric energy development in the Railbelt region (see Volume I). Each plan is based on a general energy development strategy representing one or more policies that Alaska may wish to pursue. The analyses of the plans will produce forecasts of electric energy demand, schedules for developing generation and conservation alternatives, estimates of the cost of power, and discussions of the environmental and socioeconomic characteristics for each plan.

This report (Volume V of a series of seventeen reports, listed below), presents a set of preliminary electric energy plans for the Railbelt region. These plans provided, during the course of this study, a common basis for discussion by all parties concerned with electric energy development in the Railbelt region and provided a framework on which to formulate the final electric energy plans presented in Volume I.

RAILBELT ELECTRIC POWER ALTERNATIVES STUDY

Volume I - Railbelt Electric Power Alternatives Study: Evaluation of Railbelt Electric Energy Plans

Volume II - Selection of Electric Energy Generation Alternatives for Consideration in Railbelt Electric Energy Plans

Volume III - Executive Summary - Candidate Electric Energy Technologies for Future Application in the Railbelt Region of Alaska

Volume IV - Candidate Electric Energy Technologies for Future Application in the Railbelt Region of Alaska

Volume V - Preliminary Railbelt Electric Energy Plans

EXECUTIVE SUMMARY

Four preliminary electric energy plans have been developed for the Railbelt area. Each of these plans represents a possible electric energy "future" that presently appears viable for the Railbelt. The plans were developed to encompass the full range of conservation and generation alternatives available to the region as well as to provide a direct comparison of the futures that are currently receiving the greatest interest within the Railbelt. The general supply strategy of each plan is indicated by the plan's title:

Plan 1: Base Case
- A. Without Upper Susitna
- B. With Upper Susitna

Plan 2: High Conservation and Use of Renewable Resources
- A. Without Upper Susitna
- B. With Upper Susitna

Plan 3: Increased Use of Coal

Plan 4: Increased Use of Natural Gas

Key assumptions common to all plans include:

- Utilities' current plans for additions proceed as planned.
- Generating units are retired based on assumed useful lives.
- An interconnection between the Anchorage-Cook Inlet and Fairbanks-Tanana Valley load centers is completed in 1984 and strengthened as necessary to allow economy power exchanges between Fairbanks and Anchorage.
- All load centers maintain sufficient peaking capacity to provide peak requirements in the event of interconnection failure.
- The Glennallen-Valdez load center is included as part of the Anchorage-Cook Inlet load center. Glennallen-Valdez area electrical loads and generating capacity are combined with the electrical loads and generating capacity of the Anchorage area.
- The Bradley Lake hydroelectric project comes on-line in 1988.

PLAN 1: BASE CASE

This plan is based on a transition from existing generating technologies to alternative conventional generating technologies as electrical requirements increase and existing capacity is retired. This plan represents the base or reference case. Two variations of this plan have been identified: Plan 1A is the base case without the Upper Susitna project and Plan 1B is the base case with the addition of the Upper Susitna project. The features of each of these plans are outlined below.

PLAN 1A: BASE CASE WITHOUT UPPER SUSITNA

The primary generating alternatives included in this plan are as follows:

- combustion turbines (gas or distillate)
- combined cycle (gas or distillate)
- hydroelectric (other than Upper Susitna)
- conventional coal steam electric.

The key features of this plan are summarized below:

- The Chakachamna hydroelectric project is built as required to come on-line no sooner than 1994.
- The Grant Lake project is built as required to come on-line no sooner than 1990.
- The Allison hydroelectric project is added as necessary after 1992 (see page 1.2).
- Coal steam turbines are installed after the hydro alternatives, as necessary.
- Oil combustion turbine units are used for peaking in the Fairbanks-Tanana Valley load center until retirement.
- Gas combined cycles are added to provide peaking generation when existing Fairbanks-Tanana Valley oil combustion units are retired.
- Coal-fired steam-electric capacity is added for baseload if less expensive than power from Anchorage-Cook Inlet. If coal-fired generation is not less expensive, all new generation will be gas-fired combined cycle.

PLAN 1B: BASE CASE WITH UPPER SUSITNA

This plan is based upon a continuation of present generating technologies with a transition to Upper Susitna hydropower as required. Any additional capacity required is to be supplied by conventional coal steam turbine or combined-cycle facilities. The key features of this plan are summarized below:

- The Watana I facility of the Upper Susitna project is available as early as 1993.
- If necessary, combustion turbine capacity is added to fill in until Upper Susitna is available.
- Coal Steam turbine units are added after the Upper Susitna project is completed.
- If necessary, oil combustion turbine capacity in Fairbanks-Tanana Valley is added before Upper Susitna is available.
- If necessary, coal steam turbine capacity is added for baseload in Fairbanks-Tanana Valley if less expensive than power from Anchorage-Cook Inlet. If power is less expensive from Anchorage, gas combined-cycle units will be added to provide reserve peaking capacity.

PLAN 2: HIGH CONSERVATION AND USE OF RENEWABLE RESOURCES

This plan emphasizes the use of conservation to reduce electrical energy demand, as well as the use of renewable energy sources such as refuse-derived fuel, wind, and Cook Inlet tidal power. While various levels of conservation are assumed in each of the plans, this plan includes increased levels of conservation. In each of the load centers, conservation alternatives are encouraged through a variety of means such as public education programs, tax incentives, and state and utility load programs. As with Plan 1, this plan also has variations: Plan 2A is without the Upper Susitna project and Plan 2B includes the Upper Susitna project. Features of each of these plans are presented below.

PLAN 2A: HIGH CONSERVATION AND USE OF RENEWABLE RESOURCES WITHOUT UPPER SUSITNA

Under this plan, conservation and alternatives relying on renewable resources, excluding the Upper Susitna project, will be developed to the maximum extent feasible. Additional capacity required will be provided by conventional generating alternatives as in Plan 1. Additional features are presented below:

- The following hydroelectric projects are built as required, but no sooner than the date indicated: Lake Chakachamna, 1992; Keetna, 1992; Snow, 1992; Strandline Lake, 1992; Grant Lake, 1992; and Allison, 1992.
- A 50-MW refuse-derived fuel steam-electric plant is built at Anchorage.
- Cook Inlet tidal power is developed as appropriate in conjunction with hydroelectric facilities since it appears that the tidal options under consideration will not be designed to provide firm power.
- The Browne hydroelectric project is added as necessary after 1992.
- A 20-MW refuse-derived fuel steam-electric plant is built at Fairbanks.
- Wind energy resources in the Isabelle Pass area are developed and intertied.

PLAN 2B: HIGH CONSERVATION AND RENEWABLES WITH UPPER SUSITNA

This plan is similar to Plan 2A except that the Upper Susitna project is built. The key features of this plan are summarized below:

- The Watana I facility of the Upper Susitna project is available as early as 1993.
- A 50-MW refuse-derived fuel steam-electric plant is built at Anchorage.
- Cook Inlet tidal power is developed as appropriate after the Upper Susitna project is completed.

- A 20-MW refuse-derived fuel steam-electric plant is built at Fairbanks.
- Wind energy resources in the Isabelle Pass area are developed and intertied.

PLAN 3: INCREASED USE OF COAL

This plan is based on a transition from existing generating technologies to alternatives that either directly or indirectly use coal as a fuel. Coal is currently available in the Railbelt from the Healy area; it is also expected to be available from the Beluga area in 1988. This plan assumes that coal-fired generation in the Anchorage-Cook Inlet load center will be located in the Beluga area. Baseload generation for the Fairbanks area depends on the costs of facilities located at Beluga compared to costs of facilities located in the Nenana area. The key features of this plan are summarized below:

- All new generation is either coal-fired steam turbines or combined-cycle units using coal-based synthetic fuels.
- With the exception of Bradley Lake, no additional hydroelectric facilities are built.

PLAN 4: INCREASED USE OF NATURAL GAS

This plan is based upon continued use of natural gas for generation in the Cook Inlet area and a conversion to natural gas in the Fairbanks area. The key assumption in this plan is that there will be sufficient gas available in the Cook Inlet area to allow utilities to continue to use it for electrical generation. It is also assumed that natural gas will be available for the Fairbanks area from the North Slope, beginning in 1988. Possible generating alternatives to be included in this plan include fuel cells, combined cycle, combustion turbine, and fuel cell combined cycle. All new generating facilities added in the region are gas fired.

CONTENTS

EXECUTIVE SUMMARY v

1.0 INTRODUCTION 1.1

2.0 BASIS FOR SELECTION OF PRELIMINARY ELECTRIC ENERGY PLANS . . 2.1

2.1 NATURAL RESOURCE BASE 2.1

2.1.1 Coal Resources 2.1

2.1.2 Natural Gas and Petroleum Resources 2.3

2.1.3 Hydroelectric Resources 2.5

2.1.4 Wind Resources 2.6

2.1.5 Geothermal Resources 2.9

2.1.6 Solar Resources 2.11

2.1.7 Peat Resources 2.13

2.1.8 Tidal Resources 2.15

2.1.9 Municipal Refuse-Derived Fuel 2.16

2.2 ESTIMATED AVAILABILITY OF RESOURCES 2.18

2.3 CURRENT GENERATING FACILITIES AND UTILITY PLANS 2.18

2.4 PERFORMANCE CHARACTERISTICS AND AVAILABILITY OF GENERATION ALTERNATIVES SELECTED FOR FURTHER CONSIDERATION 2.23

2.5 CURRENT AND FORECASTED REQUIREMENTS 2.24

2.6 RESULTS OF PUBLIC MEETINGS 2.29

2.7 SELECTION OF PRELIMINARY ELECTRIC ENERGY PLANS 2.33

3.0 DESCRIPTION OF PRELIMINARY ELECTRIC ENERGY PLANS 3.1

3.1 PLAN 1: BASE CASE 3.2

3.1.1 Plan 1A: Base Case Without Upper Susitna . . . 3.2

3.1.2 Plan 1B: Base Case With Upper Susitna . . . 3.5

3.2 PLAN 2: HIGH CONSERVATION AND USE OF RENEWABLE RESOURCES 3.8

3.2.1 Plan 2A: High Conservation and Renewables Without Upper Susitna 3.18

3.2.2 Plan 2B: High Conservation and Renewables With Upper Susitna 3.10

3.3 PLAN 3: INCREASED USE OF COAL 3.13

3.4 PLAN 4: INCREASED USE OF NATURAL GAS 3.14

APPENDIX A.1

FIGURES

2.1 Major Coal Resources of the Railbelt Area 2.2

2.2 Natural Gas and Petroleum Resources of the Railbelt Area . . 2.4

2.3 Hydroelectric Sites Considered for Development in this Study 2.7

2.4 Wind Resources in the Railbelt Area 2.8

2.5 Geothermal Resources in the Railbelt Area 2.10

2.6 Solar Resources for the Railbelt Area 2.12

2.7 Peat Resources of the Railbelt Area 2.14

2.8 Tidal Resources Considered for Development in This Study . . 2.17

2.9 Relative Mix of Electrical Generating Facilities, Anchorage-Cook Inlet Utilities, 1980 . . . . . . 2.20

2.10 Relative Mix of Electrical Generating Facilities, Fairbanks-Tanana Valley Utilities, 1980 . . . . . 2.21

2.11 Relative Mix of Electrical Generating Facilities, Glennallen-Valdez Utilities, 1980 . . . . 2.22

2.12 Projected Peak Demand for Anchorage-Cook Inlet Load Center . . 2.26

2.13 Projected Peak Demands for the Fairbanks-Tanana Valley Load Center 2.26

2.14 Projected Peak Demands for the Glennallen-Valdez Load Center 2.27

2.15 Typical Load Duration Curve for the Railbelt 2.28

3.1 Plan 1A: Base Case Without Upper Susitna for Anchorage-Cook Inlet 3.4

3.2 Plan 1A: Base Case Without Upper Susitna Illustrating Effects of Conservation for Anchorage-Cook Inlet 3.6

3.3 Plan 1A: Base Case Without Upper Susitna for Fairbanks-Tanana Valley 3.6

3.4 Plan 1A: Base Case Without Upper Susitna Illustrating Effects of Conservation for Fairbanks-Tanana Valley 3.6

3.5 Plan 1B: Base Case With Upper Susitna for Anchorage-Cook Inlet 3.19

3.6 Plan 1B: Base Case With Upper Susitna for Fairbanks-Tanana Valley 3.19

3.7 Plan 2A: High Conservation and Use of Renewables Without Upper Susitna for Anchorage - Cook Inlet 3.11

3.8 Plan 2A: High Conservation and Use of Renewables Without Upper Susitna for Fairbanks - Tanana Valley 3.11

3.9 Plan 2B: High Conservation and Use of Renewables with Upper Susitna for Anchorage-Cook Inlet 3.12

3.10 Plan 2B: High Conservation and Use of Renewables with Upper Susitna for Fairbanks-Tanana Valley 3.12

3.11 Plan 3: Increased Use of Coal for Anchorage-Cook Inlet . . . 3.25

3.12 Plan 3: Increased Use of Coal for Fairbanks-Tanana Valley . . . 3.25

3.13 Plan 4: Increased Use of Natural Gas for Anchorage-Cook Inlet 3.26

3.14 Plan 4: Increased Use of Natural Gas for Fairbanks-Tanana Valley 3.26

TABLES

2.1 Operating Parameters for Five Selected Hydroelectric Sites in the Railbelt 2.6

2.2 Operating Parameters for Hydroelectric Sites in Feasibility Study Stage 2.6

2.3 Summary of Cook Inlet Tidal Sites Selected for Further Analysis 2.16

2.4 Estimated Earliest Date of Commercial Availability for Resource Types 2.19

2.5 Estimated Earliest Date of Commercial Operation for Electrical Energy Alternatives 2.25

2.6 Average Score and Rank Order of Responses by Preference--Section A 2.30

2.7 Average Number of Points Given to Each Issue--Section B . . 2.31

2.8 Average Score and Rank Order of Responses by Preference--Section C 2.32

2.9 Average Score and Rank Order of Responses by Preference - Section D 2.33

2.10 Summary of Electrical Energy Alternatives Included as Future Additions in Preliminary Electric Energy Plans 2.36

1.0 INTRODUCTION

The purpose of this paper is to present a set of preliminary electric energy plans for the Railbelt region. Each plan represents a possible electric energy "future" for the Railbelt. The plans were developed both to represent the full range of viable alternatives available to the region and to provide a direct comparison of those futures currently receiving the greatest interest within the Railbelt. In Volume I of this study, the costs of power and the environmental and socioeconomic impacts of these plans are compared to provide information to help the Policy Review Committee, the utilities, and the public to make policy decisions regarding electrical generation expansion in the Railbelt.

A plan is defined by a set of electrical generating alternatives used to meet the peak demand. In this study a set of electrical generation technologies was selected for each of the four alternative electric energy plans. Specific sizes of generating facilities and exact on-line dates are not specified since they depend upon several factors not addressed here. Electrical generation options are specified to meet both cycling and base loads.

Throughout this study conservation alternatives and electric energy substitutes are considered as demand modifiers rather than as supply alternatives; thus, the effects of conservation and electric energy substitutes are represented by a reduction in the electricity required by the consumer. Alternative levels of conservation are evaluated for three of the electric energy plans. One plan (Plan 2), however, includes an aggressive conservation policy that will result in a higher level of conservation than the other plans.

Five major factors were considered when developing these plans:

- natural resources available
- current generating facilities and utility plans
- performance characteristics and availability of alternative generation technologies
- current and forecasted requirements for electricity

- results of public input.

The process used to develop the electric energy plans using these factors was subjective. As pointed out above, the plans were developed to encompass the full range of conservation and generation alternatives available to the region rather than to select the "best" plans based upon a formal selection and evaluation process.

This study considers three load centers (Anchorage-Cook Inlet, Fairbanks-Tanana Valley and Glennallen-Valdez). However, because of the relatively small electrical requirements of the Glennallen-Valdez load center (approximately 2% of the Anchorage-Cook Inlet area), it is not specifically dealt with as an individual load center. For this study, the Glennallen-Valdez load center is considered to be part of the Anchorage-Cook Inlet load center. The electrical demands for the Glennallen-Valdez area are determined as part of this study but are combined with the Anchorage-Cook Inlet loads. Future electrical requirements of the Glennallen-Valdez load center are assumed to be served from the Anchorage area except for the possible addition of the Allison hydroelectric project in some cases.

Each of the load centers has different resource bases, different generating stocks, and different forecasted demand. For example, the Anchorage-Cook Inlet can continue to use natural gas for several years, whereas the Fairbanks-Tanana Valley area does not currently have natural gas available. The Anchorage-Cook Inlet area can use larger generating facilities than the Fairbanks-Tanana Valley area. Because of these differences, each electric energy plan must be adapted for each load center.

The approach and rationale for the selection of the preliminary electric energy plans developed for consideration are discussed in Chapter 2. The plans are described in detail in Chapter 3.

2.0 BASIS FOR SELECTION OF PRELIMINARY ELECTRIC ENERGY PLANS

This chapter discusses the major factors considered when developing the preliminary electric energy plans and explains the reasoning behind the selection of the plans. The plans were selected based on the following five factors: 1) natural resources available; 2) current generating facilities and plans; 3) performance and availability of alternative generating technologies; 4) current and forecasted electrical requirements; and 5) public input.

2.1 NATURAL RESOURCE BASE

The availability of natural resources that can be used for the production of electricity is a primary consideration in both the selection and siting of generation technologies. Each load center within the Railbelt has a different natural resource base. This section summarizes the more important natural resources present in the Railbelt area that can be utilized for electrical power production. Nine major resource types are discussed: 1) coal, 2) natural gas and petroleum, 3) hydroelectric, 4) wind, 5) geothermal, 6) solar radiation, 7) peat, 8) tidal and 9) municipal refuse-derived fuel.

2.1.1 Coal Resources

The Railbelt area has relatively abundant coal resources. The major coal fields are shown in Figure 2.1. Two fields, the Beluga Field and the Nenana Field, have superior potential to support electrical power production. Other sources of coal exist primarily in the Matanuska Valley (Evans-Jones Mines, now abandoned) and on the Kenai Peninsula. The Matanuska source would require more costly underground mining, and the reserves on the Kenai are believed to consist of thin isolated beds suitable for low tonnage local supply but not for central station power generation. Other coal fields (Susitna, Broad Pass, Jarvis Creek and Glennallen Fields) do not appear to have potential to support electrical power production.

The only current major coal mining activity in the Railbelt is located near Healy in the Nenana Field (the Usibelli Mine). It supports electrical power generation and direct space heating in the Interior. Coal reserves in that region appear ample for many decades to come.

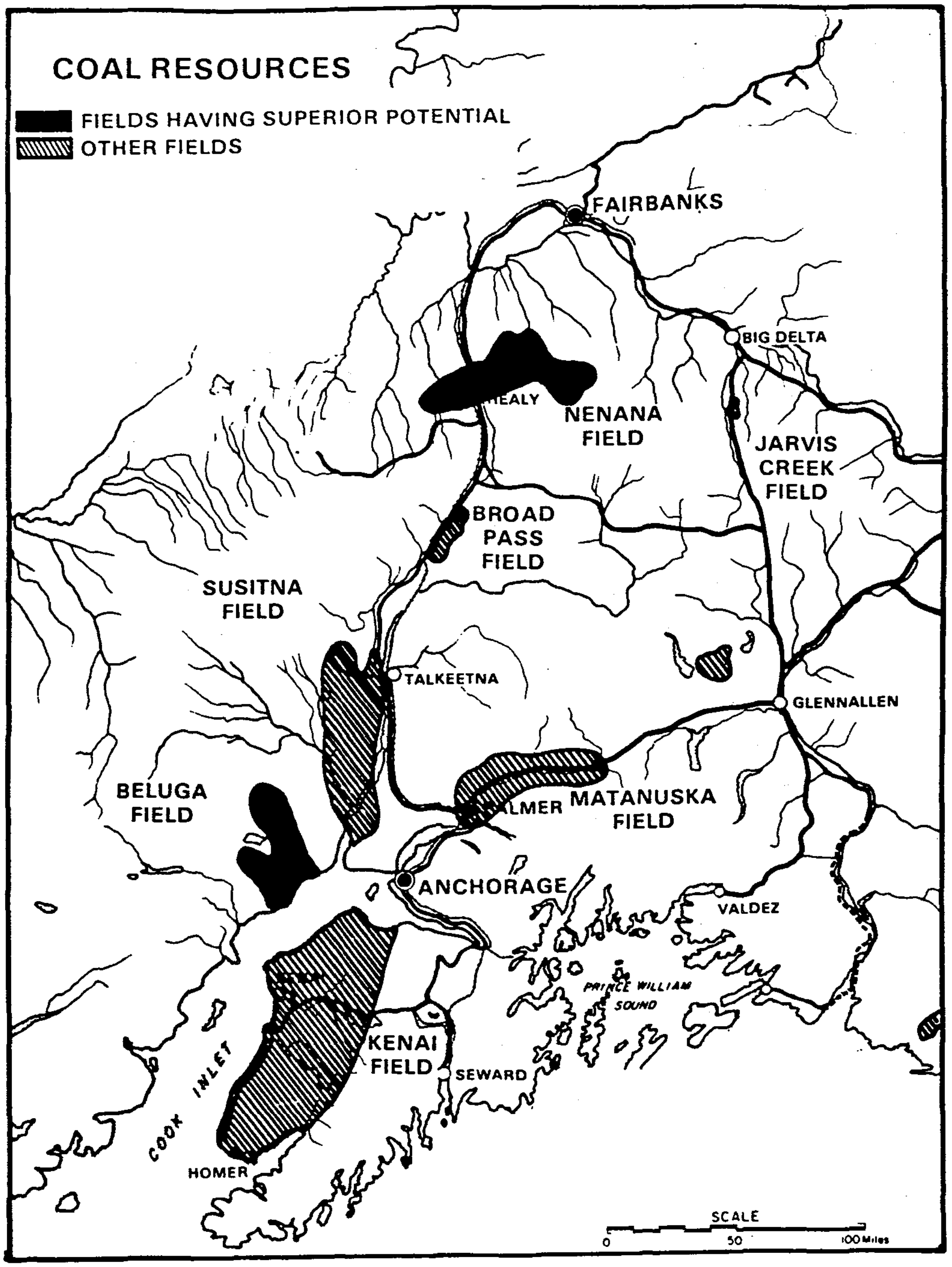

FIGURE 2.1. Major Coal Resources of the Railbelt Area

Little coal is used in the Cook Inlet region. However, research conducted at Battelle-Northwest (Swift et al. 1980) suggests that there is an excellent chance for a "world scale" surface mining operation to develop in the 1980s in the Beluga Field, with the primary impetus being the rapidly growing coal market in East Asia. If an export mine at Beluga is not developed, then coal sufficient to support a generation plant could still be provided to the Cook Inlet region via the Alaska Railroad, but at a substantially higher cost from the Healy area. There appears to be no coal resources available for electrical power production in the Glennallen-Valdez area.

In many ways coal is an attractive fuel for electrical generation in the Railbelt area. It is abundant; good deposits are located close to the major load centers; the technologies for both mining and burning it in an efficient and environmentally safe way are well established; and projections indicate that it will continue to be competitively priced relative to alternative fuels in the future.

2.1.2 Natural Gas and Petroleum Resources

Natural gas from Cook Inlet fields (see Figure 2.2) is currently the predominant non-transportation fuel for both direct end-use and electrical power generation in the Cook Inlet region. The prices in the area are the lowest in the United States, primarily as a result of long-term contracts signed when there was an excess of natural gas and the producers, lacking a major market outlet, faced a "buyer's market."

This price situation is not expected to continue because of expiration of contracts and because of natural gas deregulations. Under the most optimistic (from the consumer's point of view) conditions, rapid increases in natural gas prices may occur about 1990, although it is quite likely that gas prices will increase markedly in the mid-1980s.

Natural gas is not currently available at either the Fairbanks-Tanana Valley or Glenallen-Valdez area load centers. Should North Slope gas become available in the mid to late 1980s, its city gate cost (made up of well head

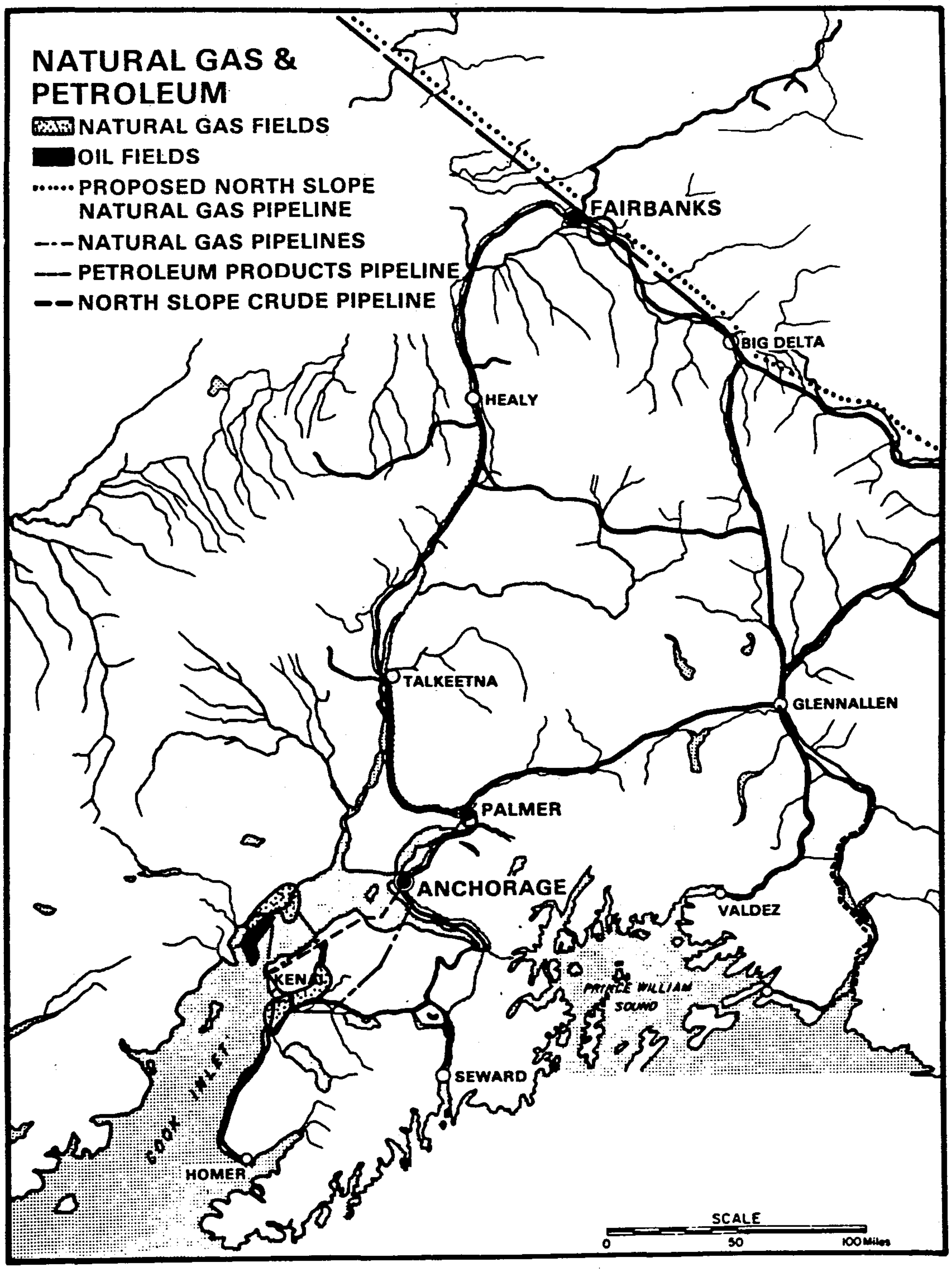

FIGURE 2.2. Natural Gas and Petroleum Resources of the Railbelt Area

price plus conditioning cost plus a share of the transmission tarrif) is expected to be far higher than Cook Inlet gas.

Distillate fuel oils (such as home heating oil, diesel fuel, and combustion turbine fuel) now serve substantial markets in the Railbelt (second to natural gas in total), particularly in isolated communities and in the Fairbanks and Glennallen areas. In the Cook Inlet region, distillate fuels are currently used as a backup supply by the electric utilities for peak loads that natural gas supplies are not able to meet.

Propane and butane low-pressure gas or LPG are products of petroleum refining operations or are extracted from natural gas prior to the latter's transmission through pipeline systems. At the present time LPG is not a major fuel in the Railbelt region.

With the advent of natural gas production on the North Slope, significant quantities of LPG would be produced and separated from the methane and ethane fractions. As of mid-1981, it appears that the LPG would be used locally as fuel to support North Slope oil and gas operations. Thus, the extent of its availability in the Railbelt region is speculative.

2.1.3 Hydroelectric Resources

A number of potential hydroelectric sites have been identified in the Railbelt area. As part of feasibility studies for the Susitna hydroelectric project being conducted by the Alaska Power Authority, Acres-American selected ten sites (not including the Upper Susitna alternatives) as most suitable for development (APA 1981). Based upon further analyses, it now appears that five of the sites (Snow, Keetna, Browne, Strandline Lake, and Chakachamna) are the most attractive for further consideration in this study. In addition, the Allison project is retained for further consideration since its location is convenient to the Glennallen-Valdez load center. Operating parameters for these sites are presented in Table 2.1.

In addition to these six sites are four others in the feasibility study stage. These sites are Bradley Lake, Grant Lake and the Upper Susitna project

TABLE 2.1. Operating Parameters for Six Selected Hydroelectric Sites in the Railbelt

Site	River	Installed Capacity (MW)	Average Annual Energy (GWh)
Snow	Snow	50	220
Keetna	Talkeetna	100	395
Browne	Nenana	100	410
Chakachamna	Chakachamna	480	1925
Strandline Lake	Beluga	20	85
Allison	Allison Creek	8	33

Source: (APA 1981a)

(the Watana and Devil Canyon Dams). The parameters of these sites are presented in Table 2.2. The geographical locations of each of these nine sites are shown in Figure 2.3.

2.1.4 Wind Resources

Battelle-Northwest recently published a Wind Energy Resource Atlas for Alaska (BNW 1980a). This Atlas identified several areas in the Railbelt with relatively high wind power densities (areas with average annual wind power densities of 250 watts/m^2 or more). These areas are shown in Figure 2.4. These areas include wind corridors (Isabelle Pass and Portage Pass), the coastal areas along Prince William Sound, and areas in the Alaska Range including McKinley National Park. The highest wind resources (1000 watts/m^2) appear in the Isabelle Pass area.

TABLE 2.2. Operating Parameters for Hydroelectric Sites in Feasibility Study Stage

Site	River	Installed Capacity (MW)	Average Annual Energy (GWh)
Watana	Upper Susitna	800	3215
Devil Canyon	Upper Susitna	400	2851
Bradley Lake	---	90	347
Grant Lake	---	7	27

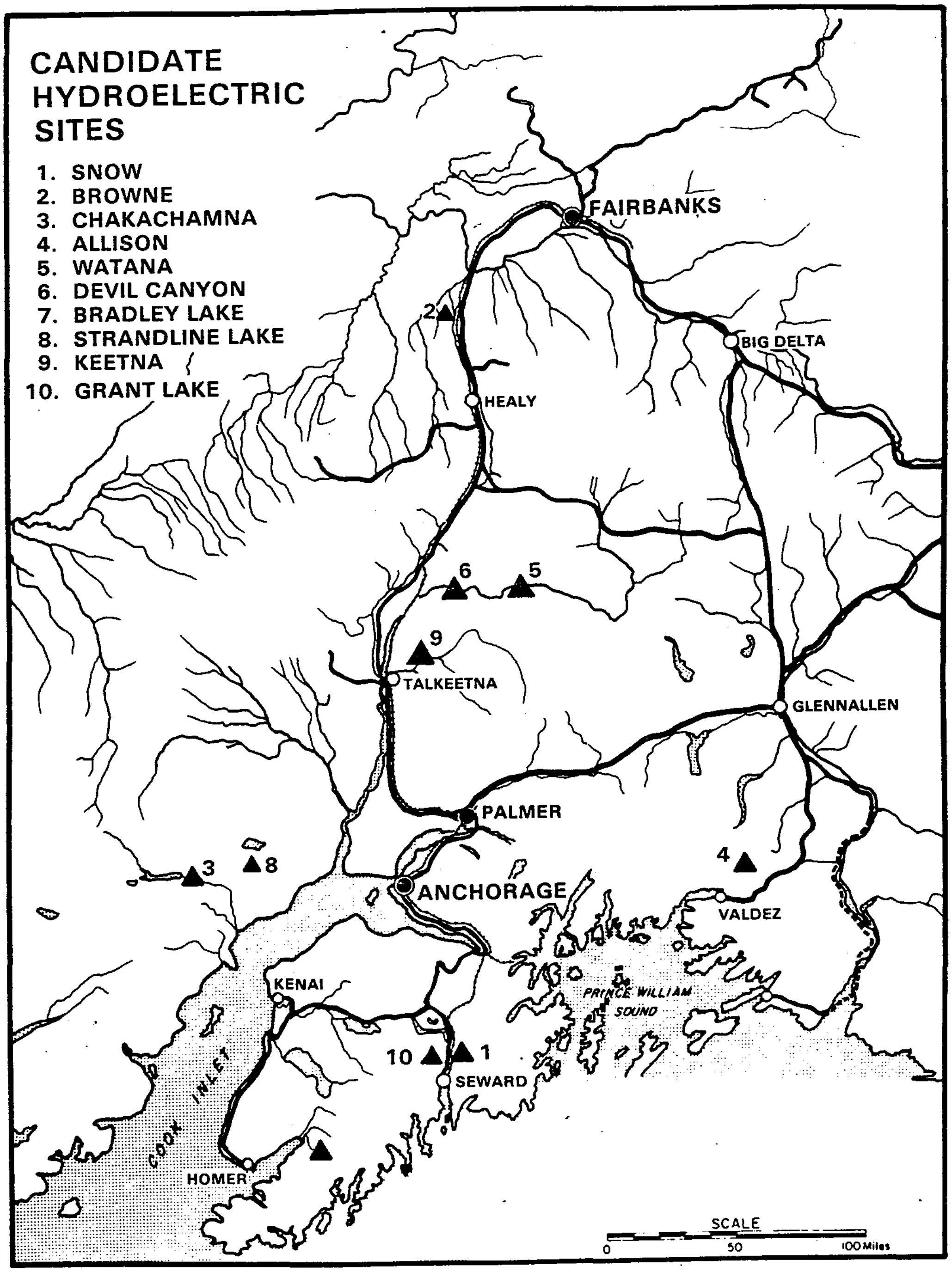

FIGURE 2.3. Hydroelectric Sites Considered for Development in This Study

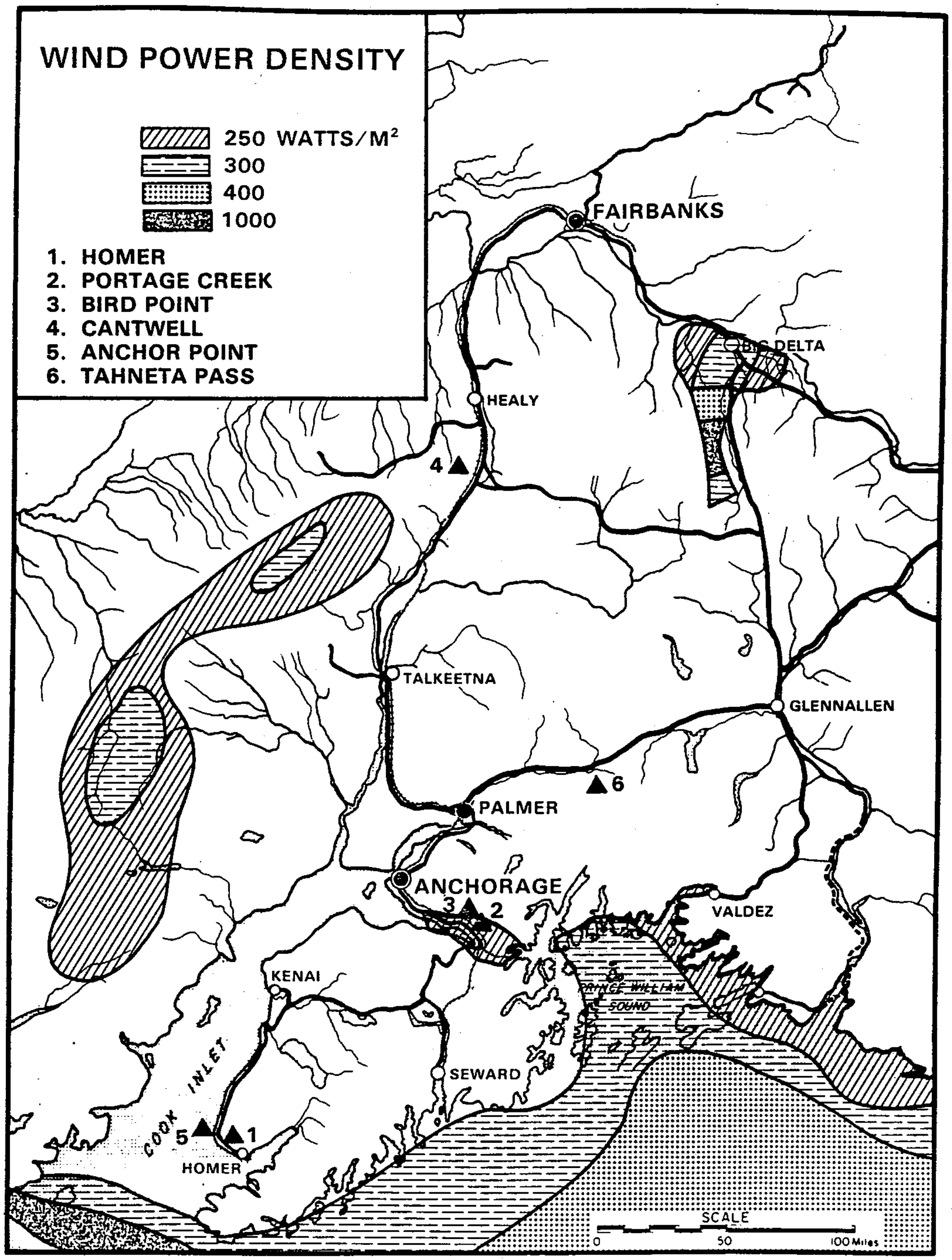

FIGURE 2.4. Wind Resources in the Railbelt Area and Sites Warranting Further Investigation in the Cook Inlet Area

Another study conducted by Battelle-Northwest for the Alaska Power Administration made a preliminary evaluation of the wind energy potential of the Cook Inlet area (BNW 1980b). Six regions (shown in Figure 2.4) were identified as warranting further investigation:

- The hills north of Homer
- Portage Creek Valley - Turnagain Arm
- Bird Point - Turnagain Arm
- Cantwell - Summit - Broad Pass Area
- Anchor Point - Northwest of Homer
- Tahneta Pass - crest of Glennallen Highway

While these areas appear promising, at this time there is no conclusive evidence that large scale generation of electrical energy by megawatt-scale wind turbines is a viable option in the Cook Inlet area (BNW 1980b). The report further recommends that while it is premature to consider embarking on a large-scale wind prospecting program at this time, the quantity and quality of the wind resources at those sites should be determined through measurement programs to gain information regarding the future course of wind energy prospecting in the Cook Inlet area.

Based on these reports it appears that wind energy may be a viable source of electric energy in the future. However, the time required to investigate the nature of the wind resource and locate sites with sufficient wind energy, as well as the time required to develop large-scale, commercially available wind machines capable of operation in Alaska, will probably not allow commercial generation in the Railbelt until after 1990.

2.1.5 Geothermal Resources

Two basic types of geothermal resources have been identified in or near the Railbelt region, low-temperature liquid and hot dry rock. Some low-temperature geothermal resources in the Fairbanks area are used for heating swimming pools and for space heating. In southwest Alaska some use is made of geothermal resources for heating greenhouses as well as space heating. Hot dry rock geothermal resources with temperatures that may be high enough to generate electricity have been discovered in the Wrangell and Chigmit Mountains (Figure 2.5). The Wrangell system located east of

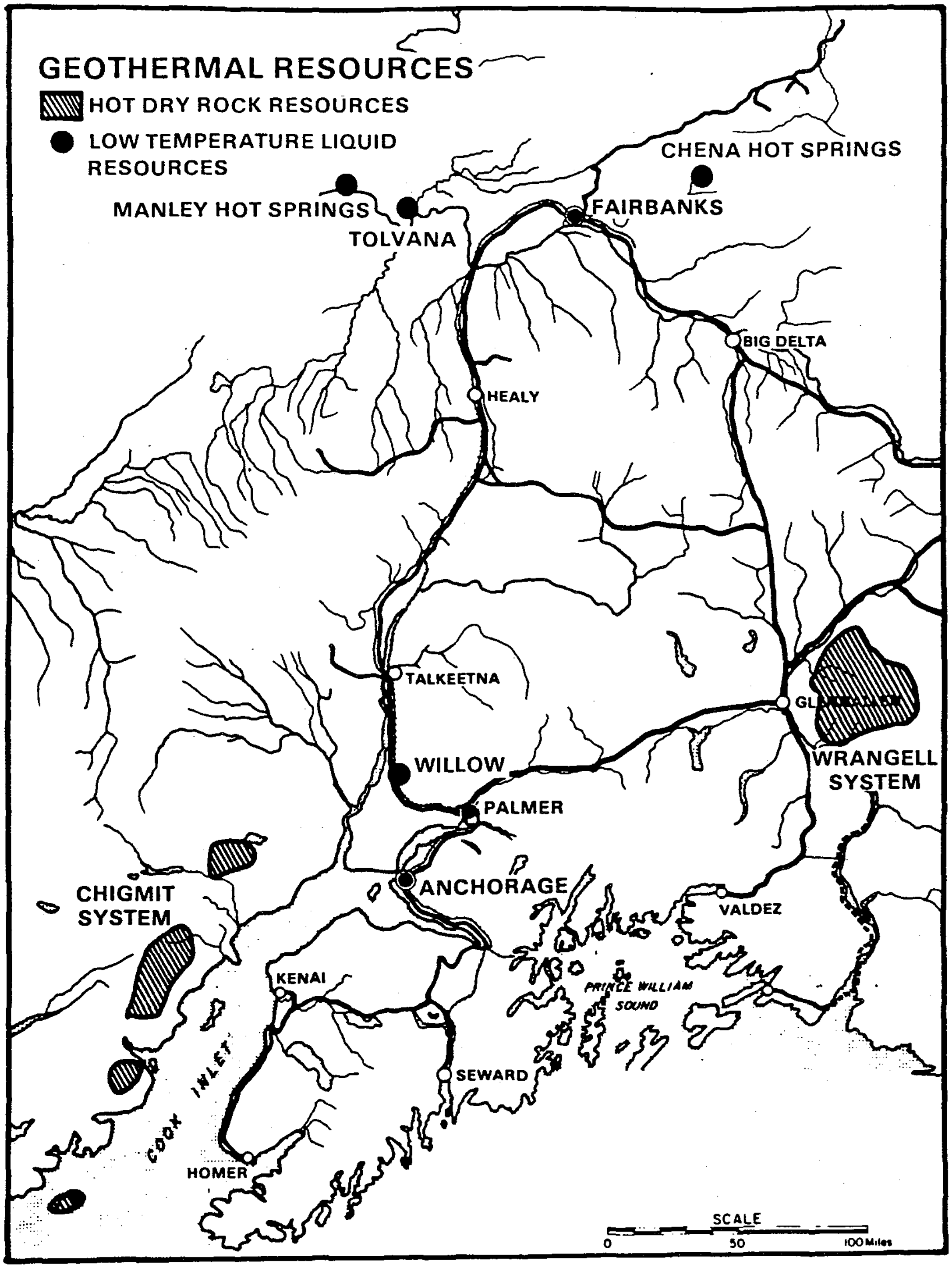

FIGURE 2.5. Geothermal Resources in the Railbelt Area

Glennallen has subsurface temperatures exceeding 1200°F. The Chigmit System is located west of Cook Inlet. Little is known about the geothermal properties of either system.

A geothermal resource in granite rock has been identified in the Willow area (Figure 2.5). A deep exploration well was discovered to have a bottom hole temperature of ~170°F. Exploration data to date indicate that while this resource may prove useful for low-temperature applications, its relatively low temperature makes it an unlikely source for electric generation.

The geothermal areas (with the exception of Mt. Spurn) of both Wrangell and Chigmit Mountains are located in lands designated as National Parks. The federal Geothermal Steam Act prohibits leasing and developing National Park lands. However, if townships within these areas are selected by a native corporation under the Alaskan Native Claims Settlement Act, and if the surface and subsurface estates are conveyed to private ownership, then the federal government jurisdiction would not apply, and development would be possible. The Alaska National Interest Lands Conservation Act of 1980 allows the granting of rights-of-way for pipelines, transmission lines and other facilities across National Interest Lands for access to resources surrounded by National Interest Lands.

2.1.6 Solar Resources

The solar resources of the Railbelt area are summarized in Figure 2.6. The average monthly solar radiation in Btu-day/ft^2 is shown for Homer, Palmer, Summit, Big Delta, and Fairbanks. The solar resources are highly seasonal, averaging less than 200 Btu-day/ft^2 for the winter months and reaching approximately 1500 Btu-day/ft^2 during the summer months of May, June, and July.

As shown in Figure 2.6, the solar resources of the region do not correspond well with the periods of highest electrical demand. During the winter months, which is time of the greatest electrical demand, the solar resources are the lowest. For this reason, it is unlikely that large, centralized solar generating alternatives such as solar photovoltaic and solar central receiver systems will be viable in the Railbelt. Passive solar space

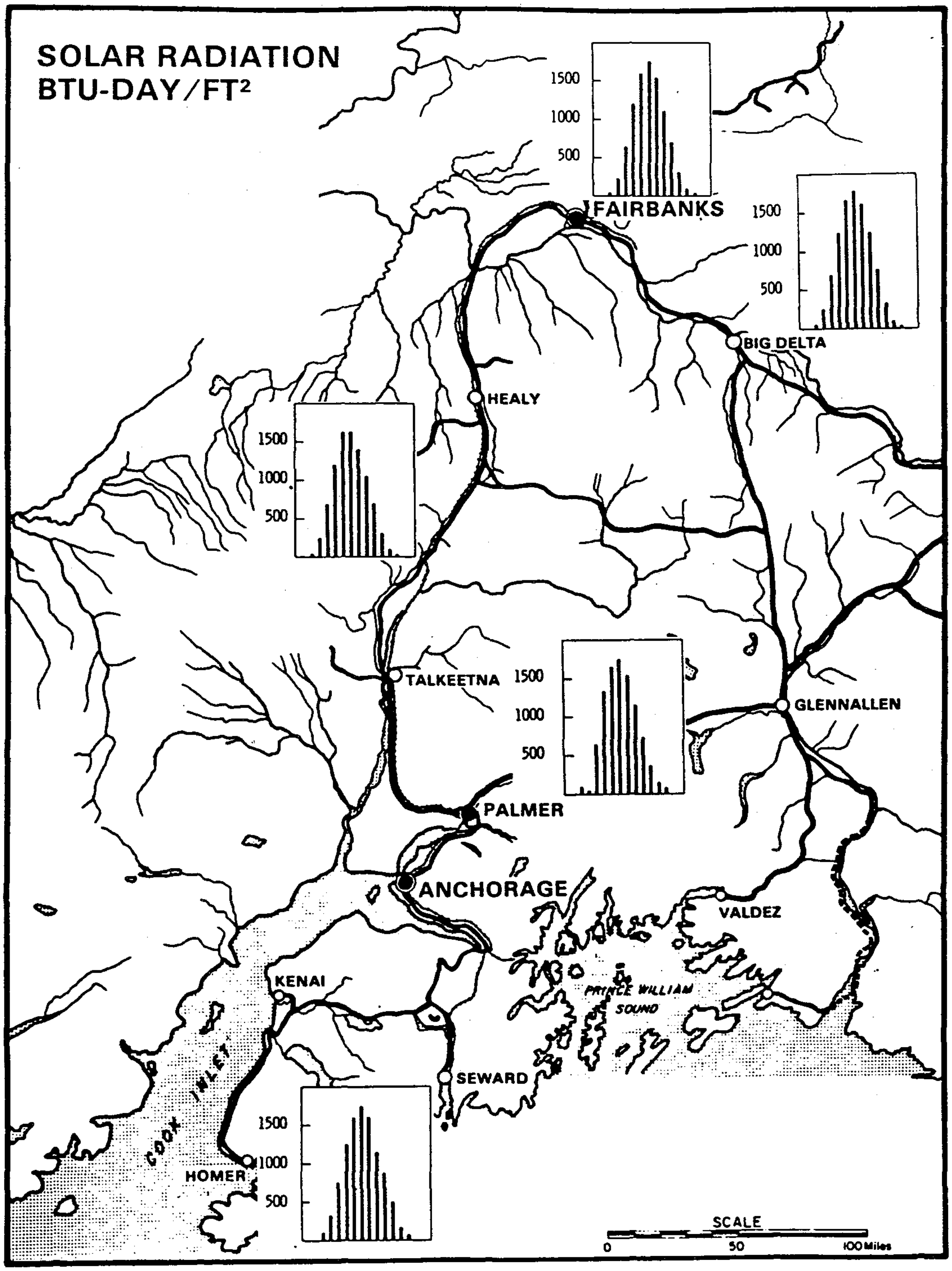

FIGURE 2.6. Solar Resources for the Railbelt Area

heating and dispersed active solar systems may be viable for small, specific applications such as individual industrial and commercial buildings and residences.

2.1.7 Peat Resources

The Railbelt area has wide-ranging peat resources (Figure 2.7). In an effort to refine the information available on peat resources and to select those sites most attractive for power production, the U.S. Department of Energy, Office of Fossil Energy sponsored a State Resource Estimation for Alaska (Huck and Markley 1980). Several bogs were selected as having the greatest development opportunities. These bogs are generally located along the Alaska Railroad west of Palmer. These bogs were selected using the following criteria (Huck and Markley 1980):

1. Distance to a potential major user must not exceed 30 miles by road, or 50 miles by railroad.
2. Distance to a major road with a suitable roadbed must not exceed 5 miles.
3. Bog area must exceed 80 acres (preferably 320 acres).
4. Bog area must be continuous.
5. Bog area must have a minimum peat depth of 5 feet.

Despite this study, the peat resource base in the Railbelt is still poorly understood. Although the bogs identified appear to be significant, no estimates of resources or reserves have been made. As part of the Electric Power Alternatives Study, we concluded that peat is not a reasonable candidate for the Railbelt as a fuel source for electric power generation given other more viable thermal alternatives (e.g., coal). Estimates indicate that peat bog-mouth costs (mined and air dried) will be approximately two times those for coal on a Btu basis. Capital costs for peat-fueled steam-electric plants are also expected to be substantially greater than for coal plants because of the greater materials handling requirements and the larger boiler volume required.

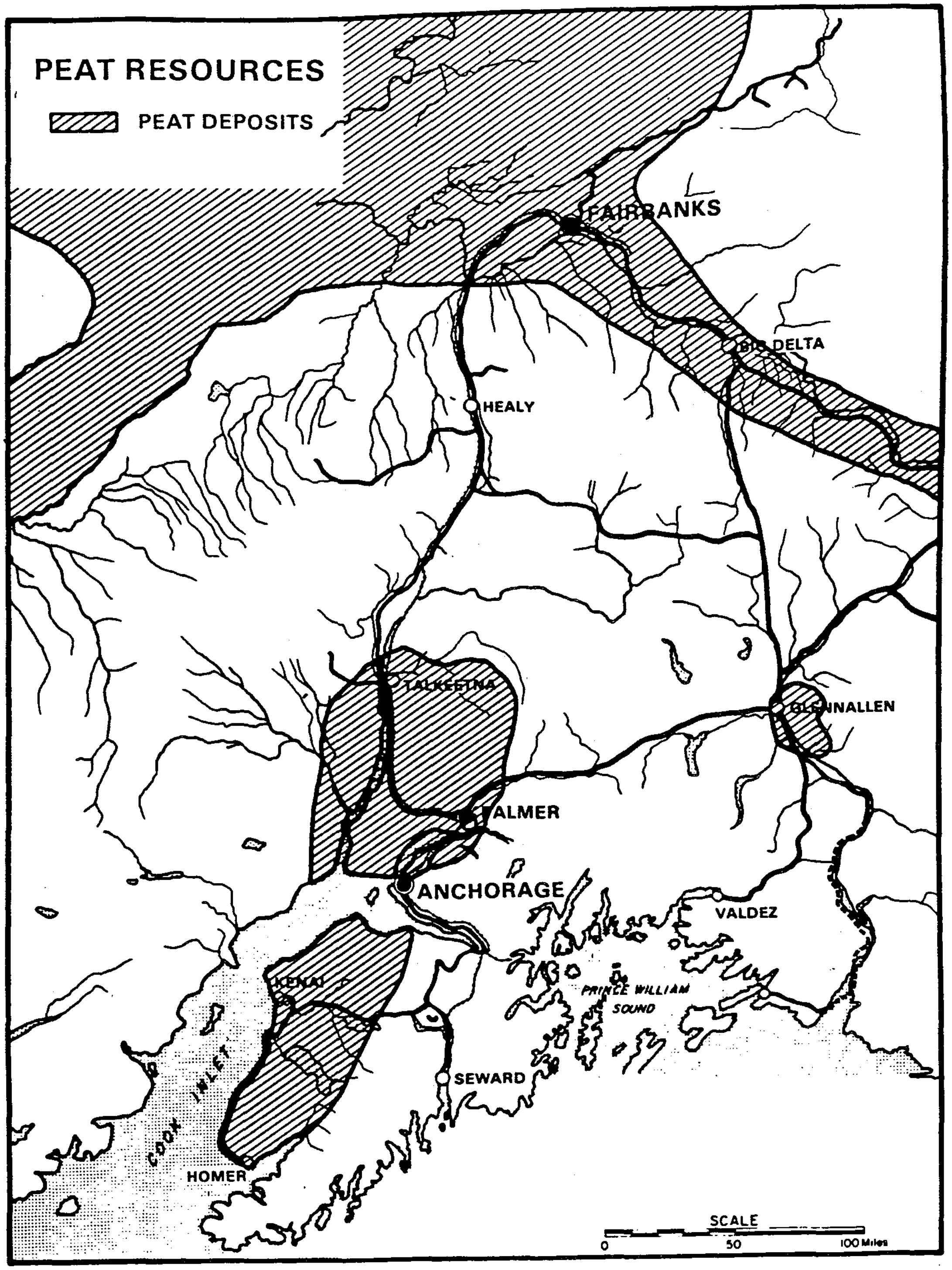

FIGURE 2.7. Peat Resources of the Railbelt Area

Based upon current information and existing steam electric generating technology, the economics of peat-fired generation suggests that this resource not be considered as an alternative within the Railbelt at this time. However, because of the extensive peat resources available within the area it appears to warrant further investigation as technologies to utilize peat are further developed.

2.1.8 Tidal Resources

Cook Inlet tidal power is a potential source of electrical energy for the Railbelt. Acres American Incorporated is conducting a preliminary assessment of the potential of utilizing Cook Inlet tidal power. A preliminary field reconnaissance and site selection has been completed and a report issued (Acres 1981). The technology used to harness tides for the generation of electrical power is summarized below.

> The natural process of ebb and flow in the ocean tides entrains very large amounts of energy and offers a non-polluting, renewable source. Tidal energy is available both in kinetic form in rapidly flowing tidal currents, and as potential energy associated with the tidal waters contained behind man-made barrages. In view of the relatively low density, the cost of extracting kinetic energy from tidal currents is relatively high. There are, around the world, a few special locations where tidal ranges are particularly high, and where it is possible to tap the potential energy for economic power generation.
>
> The fundamental approach to tidal power development involves the creation of an artificial barrier which permits one or more pools to be maintained at elevations which are lower than high tide or higher than low tide. When sufficient head differential is obtained, water at the higher pool level is allowed to flow through hydraulic turbines to the lower pool level, thereby generating power. It will be appreciated that the operating head available within even the highest available tidal ranges falls just within the lowest limit for economic hydroelectric power generation...
>
> ...Cook Inlet is a major tidal estuary located in the South Central Region of Alaska and characterized by its high tidal ranges. It is approximately 180 miles long and ranges in width from 80 miles near its mouth in the Northern Gulf of Alaska to approximately 20 miles not far from Anchorage where the waters divide forming the narrow Knik and Turnagain Arms.
>
> (Acres 1981, pp. 1,2)

As part of the Acres' preliminary assessment 16 sites were considered and an evaluation made of the capacity, energy, and logistical and environmental properties of each site. As a result of the evaluation, three sites were chosen for further analysis. The characteristics of these sites are summarized in Table 2.3. and their location shown in Figure 2.8.

One problem associated with tidal generation facilities is that the timing of the production of energy is controlled by the lunar cycle. To obtain firm power, it is necessary to either retime the production of energy using storage methods or use the tidal power in conjunction with a generation option that can store energy and cycle easily. Acres-American concludes that providing at-site storage to allow retiming of Cook Inlet tidal power will not be cost-effective (Acres 1981). Hydroelectric facilities provide a good generation alternative for use with tidal power since they provide storage and can be cycled easily. For this reason, any tidal power facilities in the Cook Inlet will probably be constructed in conjunction with hydroelectric facilities.

2.1.9 Municipal Refuse-Derived Fuel

Municipal refuse derived fuel (RDF) is available in the Railbelt. However, because of the high cost of collection, consideration of RDF for electric power generation at a significant scale is necessarily limited to metropolitan areas where the sources of refuse are more concentrated. As a result, applications using RDF appear to be limited to the Anchorage and Fairbanks solid waste disposal areas.

TABLE 2.3. Summary of Cook Inlet Tidal Sites Selected for Further Analysis

Name	Installed Capacity (MW)	Net Energy[a] (kWh x 10^6)	Estimated Structure Height (ft)	Barrier Length (ft)
Port MacKenzie	2,350	6,000	126	13,700
Above Eagle Bay	1,400	3,500	65	18,200
Rainbow	1,180	3,000	65	24,300

(a) For comparison, a 400-MW generating plant operating with a 50% annual utilization produces 1,752 x 10^6 kWh of energy.

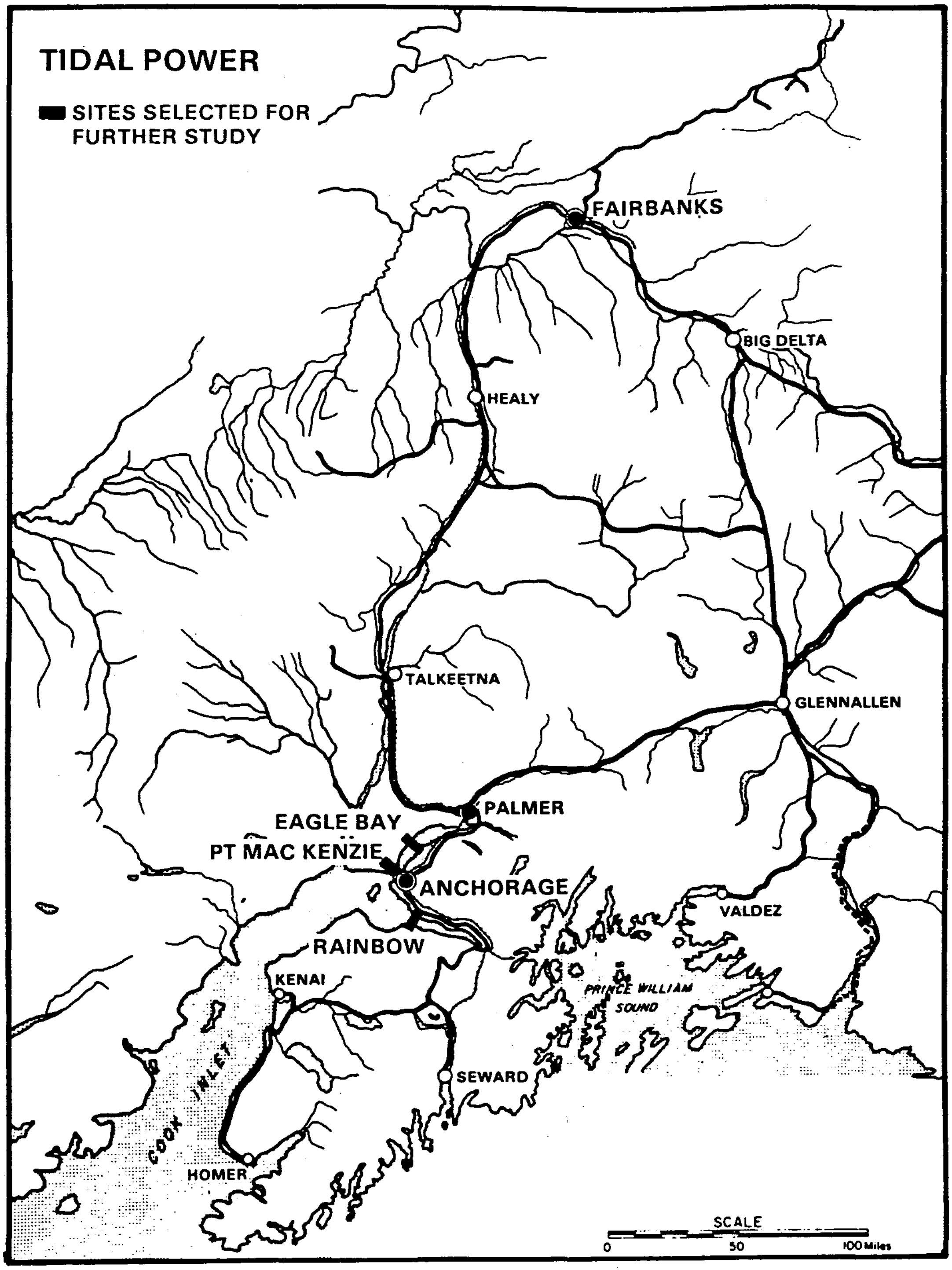

FIGURE 2.8. Tidal Resources Considered for Development in This Study

In this study refuse-derived fuel includes not only refuse but also wood waste and waste oil. Because of the seasonal variation in the amount of refuse produced, it will probably be necessary to supplement the fuel with coal. It is assumed that coal from the Healy area would be transported via the Alaska Railroad to both Anchorage and Fairbanks for this purpose.

2.2 ESTIMATED AVAILABILITY OF RESOURCES

A number of the resources discussed above are not currently used for electrical generation in the Railbelt because they are not yet developed for commercial use. The process of developing a resource for commercial use is typically a complex and time-consuming process, and it is important that the electrical power planners have realistic estimates of when the various resources might be available. We have estimated the availability of the various resources for commercial development. These estimates are presented in Table 2.4.

The years shown in this table are the earliest estimated date for commercial utilization of these resources. Since commercial operation depends on the availability of the technology as well as the development of the resource, some of the dates presented are based on the earliest availability of an appropriate utilization technology rather than on the availability of the resource. (See Section 2.4 for estimates of the earliest date of commercial operation of the various alternatives considered.)

2.3 CURRENT GENERATING FACILITIES AND UTILITY PLANS

Current utility generating stock and plans for expanding that stock form the basis from which any future generating system must evolve. Because of the relatively long life of electrical generating facilities, the existing facilities will be in service for a number of years. This is especially true in the Railbelt area where most of the capacity has been brought on-line since 1970 because of the relatively high growth in load experienced during the 1970s. In some cases, utilities have firm plans for generation expansion that must be taken into account.

TABLE 2.4. Estimated Earliest Date of Commercial Availability for Resources Types

Resources	Year
Resources	
Coal -	
Tanana Field	1988
Beluga Field[a]	1988
Natural gas	
Cook Inlet	1980
Interior	1988
Oil	
All Products	1980
Hydroelectric[b]	
Watana	1993
Devil Canyon	1993
Chakachamna	1994
Browne	1990-1995
Snow	1990-1995
Bradley Lake	1988
Allison	1990-1995
Strandline Lake	1990-1995
Keetna	1990-1995
Grant Lake	1990
Wind[b, c]	
All locations	1990
Geothermal[b, d]	
All locations	2000
Solar[b]	
Solar Photovoltaic Systems	1986
Solar Central Receiver Systems	1990
Passive Solar Space Heating	1980
Dispersed Active Solar Systems	1980
Peat[b, e]	1993
Tidal[b]	2000
Municipal Refuse	
Derived Fuel	1980

(a) Assumes the decision to develop for export is made in 1981.
(b) Commercial utilization of these resources depends on the availability and construction of the generating facilities as well as the development of the resource. The dates shown reflect the earliest estimated date for commercial operation of these resources.
(c) Assumes an initial 2-year wind resource assessment program.
(d) Assumes a 6-year resource assessment with aggressive technology development for hot dry rock resources.
(e) Assumes a 3-year resource assessment.

Each of the electric energy plans must evolve from existing generating systems. Thus, all plans will have a continuation of existing generation modes for 5 to 15 years into the future with a gradual transition to other supply alternatives in the 1985-1995 time period.

The Anchorage-Cook Inlet area is currently almost entirely dependent on natural gas-fired combustion turbine/combined cycle generation. The mix of electrical generating facilities in the Anchorage-Cook Inlet area as of 1980 is shown in Figure 2.9. About 91% of the total capacity was either simple and regenerative cycle combustion turbine or combined cycle combustion turbines. Current plans call for conversion of some of the combustion turbine units to combined cycle operation to increase the generating capacity and to decrease heat rates. The Bradley Lake hydroelectric project appears relatively firm at this point. The most likely configuration for this facility calls for 90 MW of capacity with an annual average energy production of 3476 GWh.

The Fairbanks-Tanana Valley load center depends heavily on coal-fired steam turbine capacity (22% in 1980) and oil-fired combustion turbine capacity

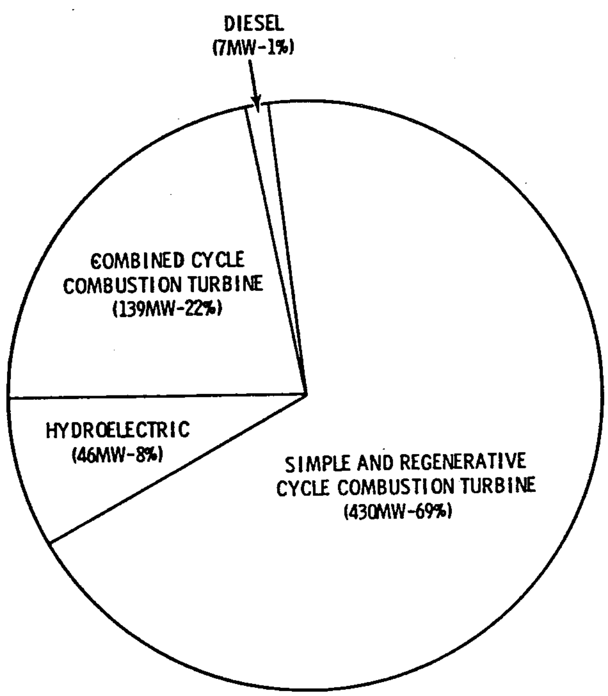

FIGURE 2.9. Relative Mix of Electrical Generating Facilities, Anchorage-Cook Inlet Utilities, 1980

(66% in 1980). Area utilities have excess capacity; unfortunately it consists of expensive oil-fired combustion turbines. At the present time the Fairbanks-Tanana Valley utilities have no firm plans for capacity additions or retirements. The mix of electrical generating facilities in the area as of 1980 is shown in Figure 2.10.

Current plans call for the completion of a transmission line between Willow and Healy that will intertie the Anchorage-Cook Inlet and Fairbanks-Tanana Valley load centers. This line will probably be completed and available in 1984. This line will be designed to operate at 345 kV but will be operated at 138 kV until the Upper Susitna project comes on-line. At 138 kV, maximum power transfer will be about 70 MW.

The completion of this transmission intertie is a key near-term addition for the Fairbanks area. It will allow Fairbanks utilities to purchase relatively inexpensive power (generated with natural gas) from Anchorage. It will also allow both load centers to take advantage of the additional peaking capacity available in the Fairbanks area.

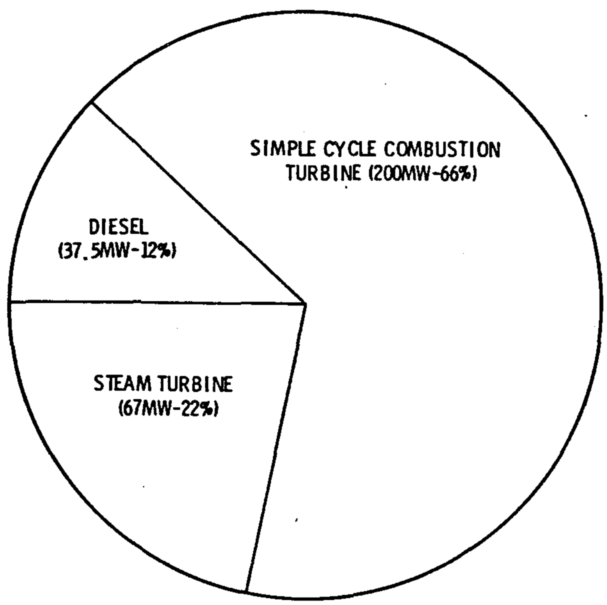

FIGURE 2.10. Relative Mix of Electrical Generating Facilities, Fairbanks-Tanana Valley Utilities, 1980

In general, the Anchorage and Fairbanks area utilities are in a "wait and see" mode regarding Upper Susitna. If the decision is made to build Upper Susitna, utilities will probably add sufficient fossil fuel-fired capacity with low capital costs to serve the load until Upper Susitna comes on-line. This capacity will also serve as reserve capacity after Upper Susitna comes on-line. While the Willow-to-Healy intertie is a key feature of the Upper Susitna project, it will probably be built regardless of the decision made on Upper Susitna.

If the decision is made to not proceed with the Upper Susitna project, then the Anchorage area utilities would probably continue using gas to the maximum extent possible and add coal-fired steam turbine capacity. The Fairbanks area would probably also add coal-fired capacity.

The Glennallen-Valdez load center is largely dependent on diesel generation with a small amount of oil-fired combustion turbine capacity. The relative mix of generating facilities in the Glennallen-Valdez area is shown in Figure 2.11. The Solomon Gulch hydro project will come on-line in 1981 and replace much of the diesel and combustion turbine capacity.

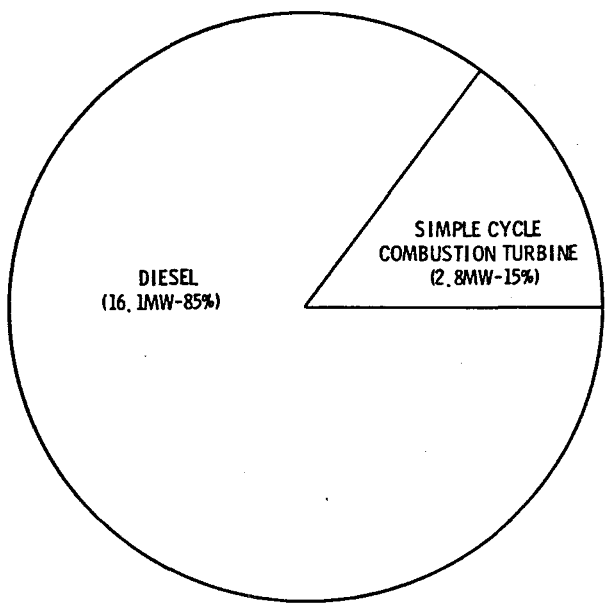

FIGURE 2.11. Relative Mix of Electrical Generating Facilities, Glennallen-Valdez Utilities, 1980

2.4 PERFORMANCE CHARACTERISTICS AND AVAILABILITY OF GENERATION ALTERNATIVES SELECTED FOR FURTHER CONSIDERATION

Individual generating technologies have specific technical and economic characteristics that determine their suitability for certain applications. The major factors discussed in this section are the operating mode of the alternative generation technologies and the dates that they will be available for commercial operation.

A number of currently commercial, emerging, and advanced energy technologies are being evaluated as potential electric energy alternatives to be included in the electric energy plans. A selection of alternatives has been proposed (King 1981). Those alternatives are used in this report. However, since the alternatives presented in King (1981) are pending PRC approval, this selection may not coincide with the final selection, although we anticipate relatively few deletions and additions.

The proposed alternatives can be classified into five categories generally based on their performance characteristics. The five categories include base load generation, cycling generation, fuel saver generation, electric energy substitutes, and electric energy conservation.

Base-loaded power plants operate 65 to 85% of the time and are designed to supply the continuous (base) portion of electric load at low cost. Cycling technologies have more flexible operational characteristics and serve intermediate and peak loads, normally operating approximately 25 to 50% of the time. Fuel saver technologies include those generating devices that are available only on an intermittent basis. Unless provided with storage devices, these technologies normally are not credited as capacity credit since their availability is not assured on a continuous basis. Electric energy substitutes permit the direct substitution of other energy forms for electric power. Conservation technologies reduce the absolute demand for energy, including electric energy.

Five specific electric energy substitute alternatives and one specific conservation alternative have been selected for further consideration. However, the effects of other conservation alternatives such as set back thermostats, cogeneration, district heating, zone lighting and space conditioning in the commercial sector, and more efficient appliances will be evaluated by assuming alternative levels of use.

The effects of increased efficiency of some generating alternatives through the use of bottoming cycles, such as the Organic Rankine cycle (ORC) concept, will be treated as advanced versions of the alternatives with which the bottoming cycle might be used, for example, combustion turbine - ORC.

In some cases a technology may have the potential for playing more than one role in an electric energy supply system. For example, combustion turbines, while commonly used in the "lower 48" as devices to meet cycling load requirements, are currently used in the Railbelt region to provide base load generating capacity partly because of the availability of inexpensive natural gas.

The estimated earliest date of commercial operation in the Railbelt for the proposed alternatives are presented in Table 2.5.

2.5 CURRENT AND FORECASTED REQUIREMENTS

The current and forecasted requirement for electricity influences the size and type of the generating units to be considered in the electric energy plans. For example, the Anchorage-Cook Inlet load center can accommodate larger plants than the Fairbanks-Tanana Valley load center and the Fairbanks-Tanana Valley load center can utilize much larger plants than the Glennallen-Valdez area. The sizes of generating units in the various load centers are partly determined by the characteristics of the demand for electricity in those areas. Figures 2.12 through 2.14 show projected low, medium, and high peak demand for each of the three load centers. These requirements were calculated from annual energy consumption projections made by ISER (Goldsmith and Huskey 1980).

While these projections are tentative, they provide an approximation of future demands that can be used for the purposes of this study.

The data used in these figures and the method of computation are presented in the Appendix.

TABLE 2.5. Estimated Earliest Date of Commercial Operation for Electrical Energy Alternatives

Base Load Alternatives	Earliest Availability
Coal Steam Electric	CA[a]
Refuse-Derived Fuel Steam Electric	CA
Cycling Alternatives	
Coal Gasifier Combined Cycle	1990-95
Natural Gas Fuel Cell Stations	1985-90
Natural Gas Combined Cycle	CA
Natural Gas Combustion Turbine	CA
Natural Gas Fuel Cell Combined Cycle	1990-95
Bradley Lake Hydroelectric	1988
Lake Chakachamna Hydroelectric	1994
Upper Susitna Hydroelectric	1993
Allison Hydroelectric	1990-1995
Snow Hydroelectric	1990-1995
Keetna Hydroelectric	1990-1995
Grant Lake Hydroelectric	1990
Browne Hydroelectric	1990-1995
Strandline Lake Hydroelectric	1990-2995
Fuel Saver (Intermittent) Alternatives	
Large Wind Energy Conversion Systems	1985-90
Cook Inlet Tidal Electric Project	2000
Electric Energy Substitutes[b]	
Micro Hydroelectric	CA
Passive Solar Space Heating	CA
Active Solar Hot Water Heating	CA
Wood-Fired Space Heating	CA
Small Wind Energy Conversion Systems	CA
Electric Energy Conservation	
Building Conservation	CA

(a) CA - Currently Available or Operating
(b) As defined in this study electric energy substitutes include all options that are either dispersed (used by a single consumer or a small community) or not interconnected with utility distribution systems.

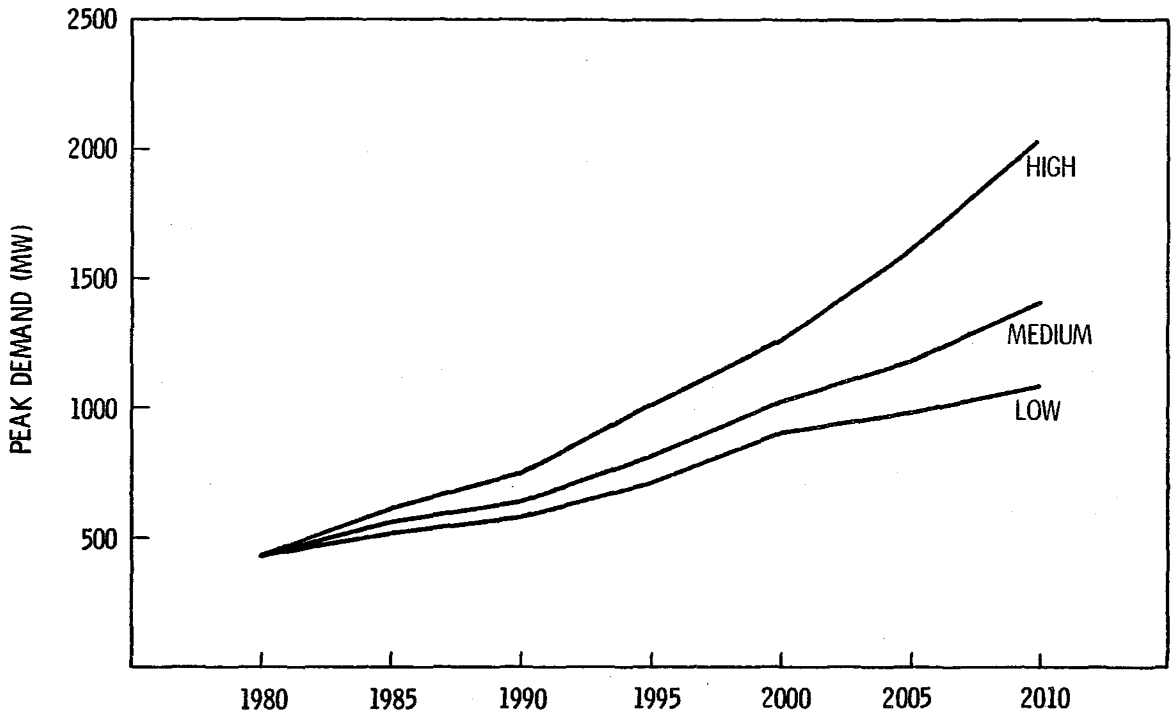

FIGURE 2.12. Projected Peak Demand for Anchorage-Cook Inlet Load Center

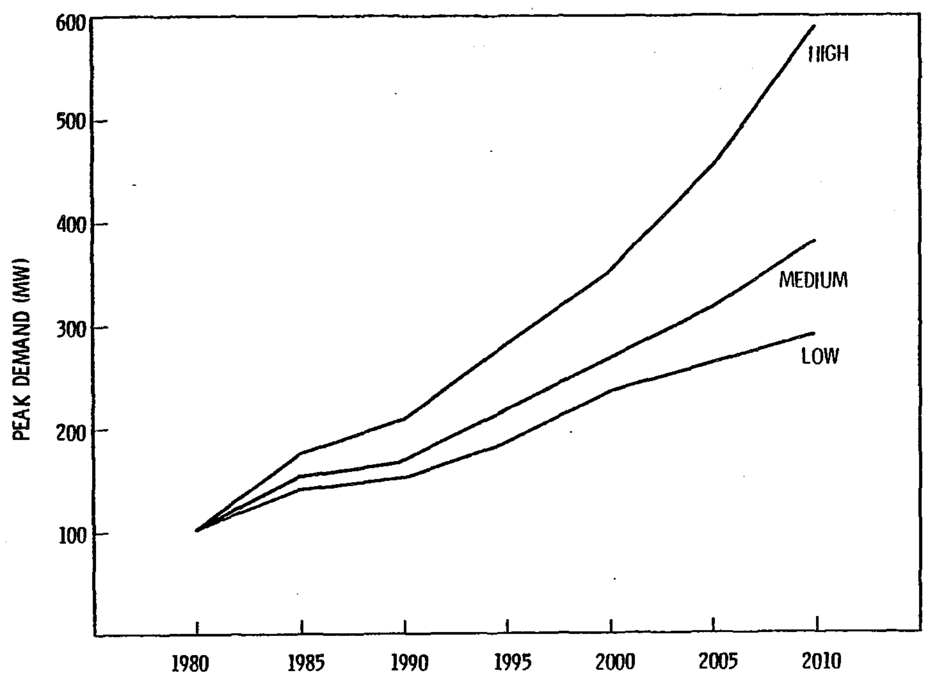

FIGURE 2.13. Projected Peak Demands for the Fairbanks-Tanana Valley Load Center

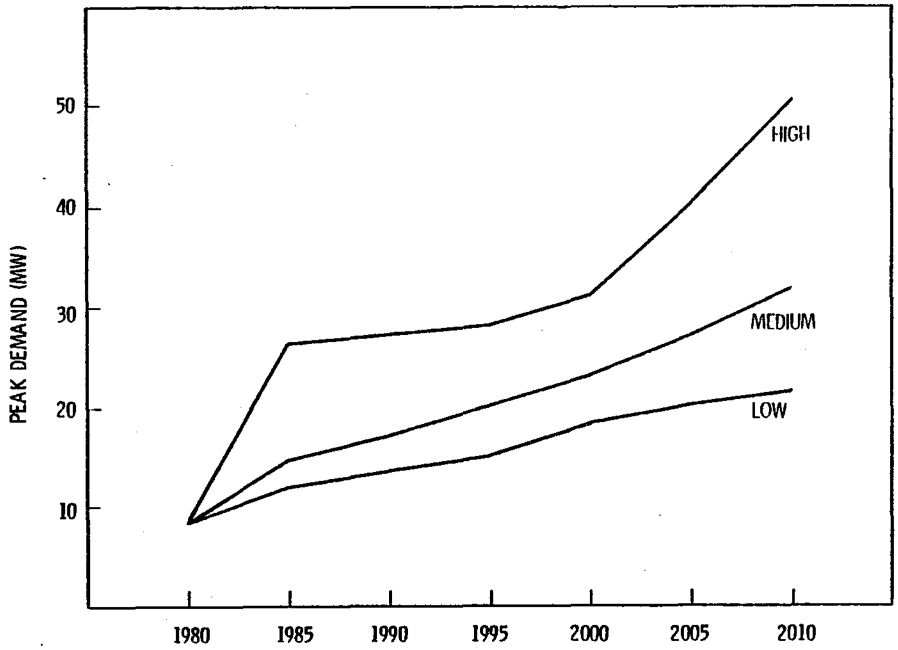

FIGURE 2.14. Projected Peak Demands for the Glennallen-Valdez Load Center

A "typical" annual load duration curve for the Railbelt area is shown in Figure 2.15. An annual load duration curve shows the amount of time that the electrical load is equal to or less than a certain percentage of the annual peak load. Figure 2.15 was derived from load duration curves for three Railbelt utilities. These curves are also shown in the appendix. For convenience, the load duration curve can be divided into three regions. These regions are at load durations of greater than 80% (7007 hours) or more, 20 to 80% (1751-7007 hours) and less than 20% (1751 hours). The resulting regions are commonly referred to as base load, cycling or intermediate load, and peaking load (Energy Modeling 1973).

Using the projections of electrical requirements and the information from the load duration curve, some preliminary estimates can be made for the types and sizes of electrical generating units that best meet the needs of the load centers. Detailed analyses of the most economical types of generation to meet the various types of load are provided in Volume I of this study. However, some general statements can be made regarding the most appropriate capacity for supplying these various loads.

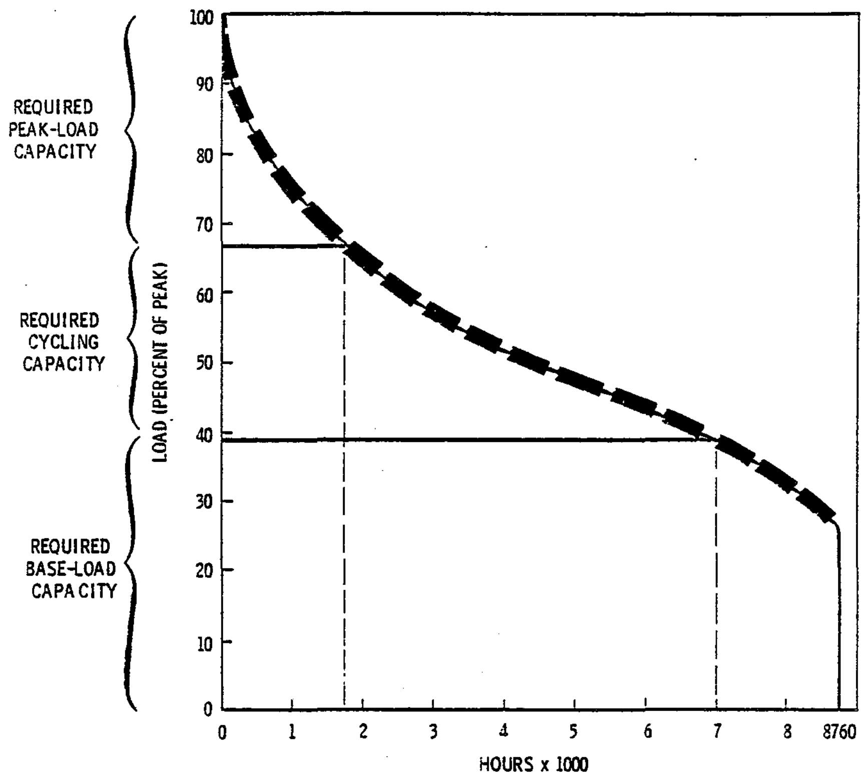

FIGURE 2.15. Typical Load Duration Curve for the Railbelt

As Figure 2.15 shows, base load capacity is limited to about 40% of the peak load; thus, the upper limit on the size of base load generating alternatives should be 40% of the peak load. For reliability, a single unit probably could be limited to about 20-30% of the peak load. This reasoning would limit any new base load capacity in the Anchorage area to about 200 MW in the 1980-1990 time frame, increasing to about 500 MW by 2010. For the Fairbanks area, during 1980-1990 new base load capacity should not exceed about 60 MW and should not exceed 160 MW by 2010. Assuming the two load centers are intertied, base load units up to about 250 MW would be appropriate prior to 1990, increasing to approximately 650 MW by 2010.

Cycling capacity can be used to meet the cycling and peak load. Since cycling capacity is typically added in relatively small sizes, the upper limits on the sizes of generating units are not generally a consideration. Cycling capacity can also be used for base load operation, which allows areas with relatively low peak demands to add all new capacity in the form of cycling technologies such as combustion turbine or hydroelectric facilities.

2.6 RESULTS OF PUBLIC MEETINGS

In recent years, the public and special interest groups have become more involved in the planning process. It is important that the attitudes and desires of the public be considered and included in the planning process. As part of this study a series of public meetings was held, and the results of those meetings were used in developing the electric energy plans. Some of the results of these public meetings are presented in this chapter.

During the week of May 18-22, 1981 a series of public meetings were held in Talkeetna, Anchorage, Fairbanks, and Soldatna. These meetings had two purposes: 1) to present information on the Railbelt Electrical Power Alternatives Study to the public and 2) to solicit information on the public's attitudes regarding electric power development in the Railbelt. An opinion survey containing four sections was used to collect information.

Section A presented 12 statements that addressed electric power planning objectives for the Railbelt. Respondents to the survey were asked to indicate whether they strongly agreed, agreed, were indifferent, disagreed, strongly disagreed, or had no opinion for each statement. The average score of the responses to each statement and the rank order by preference for each statement are presented in Table 2.6. The rank ordering indicates a preference for renewable energy sources and for preservation of the environment. Respondents generally disagreed with creating jobs as a primary objective and encouraging large-scale industrial growth.

Section B of the survey asked people to indicate their level of concern with respect to ten issues associated with the selection of electric power alternatives. In this section they were asked to distribute a total of 100 points among the 10 issues. Issues of more importance to an individual were to receive more points while issues of less concern would receive fewer points. These issues are listed along with the average number of points given to each of the issues in Table 2.7.

The protection of fish and wildlife resources received the greatest average number of points (16.9). Issues of slightly less concern included protecting the scenic quality of the region (12.7), protecting air quality (12.5), avoiding potential catastrophic accidents (10.7), avoiding long-term

TABLE 2.6. Average Score and Rank Order of Responses by Preference--Section A, Electric Power System Planning Objectives

Statement	Average Score[a]	Rank Order
- Alternatives using renewable energy resources (wind, tidal, solar, hydro, geothermal, wood waste and refuse) should be given preferences over alternatives not using renewable resources.	1.56	1
- The protection of the following Alaskan environments should be the primary objective when meeting Railbelt electric power needs:		
a) Forest, meadow, muskeg and tundra	1.16	6
b) Streams, lakes and rivers	1.53	2
c) Saltwater and coastline.	1.20	5
- The protection of fish and wildlife resources should be the primary objective when meeting Railbelt electric power needs.	1.46	3
- Maintenance or improvement of air quality should be the primary objective when meeting Railbelt electric power needs.	1.31	4
- Electric power development should be based on local, small-scale generating alternatives.	0.77	7
- Conservation alternatives should be given preference over electric generating alternatives.	0.75	8
- Minimizing the risk of future inflation in electric power costs should be the primary objective when meeting Railbelt electric power needs.	0.64	9
- Minimizing the cost of power should be the primary objective when meeting Railbelt electric power needs.	0.54	10
- The retention of dollars within Alaska spent on construction, operation and maintenance should be the primary objective when meeting Railbelt electric power needs.	0.43	11
- Increasing the reliability of the electric service should be the primary objective when meeting Railbelt electric power needs.	0.43	11
- Creation of jobs should be the primary objective when meeting Railbelt electric power needs.	-0.67	13
- Encouragement of large-scale industrial growth should be the primary objective when meeting Railbelt electric power needs.	-1.17	14

(a) The average score was based on the number of individuals expressing an opinion on the following scale: strongly agree = 2, agree = 1, indifferent = 0, disagree = -1, strongly disagree = -2.

TABLE 2.7. Average Number of Points Given to Each Issue--Section B, Issues Associated with Selection of Electric Power Alternatives

Issues	Average No of Points	Rank Order
Protecting fish and wildlife resources	16.9	1
Protecting scenic quality of the region	12.7	2
Protecting air quality	12.5	3
Avoiding potential catastrophic accidents	10.7	4
Avoiding long-term health effects	10.6	5
Promoting energy self-reliance	10.5	6
Minimizing energy cost	10.1	7
Avoiding "boom-bust" social impacts	6.8	8
Promoting in-state power-related development	4.6	9
Reducing consumer effort	4.4	10

health effects (10.6), and minimizing energy cost (10.1). The issues receiving the lowest average points included avoiding boom-bust social impacts (6.8), promoting in-state power-related development (4.6), and reducing consumer effort (4.4).

The third section of the survey asked which energy resources should be emphasized when meeting Railbelt electric power needs. As in Section A, the respondents were asked to indicate whether they strongly agreed through strongly disagreed that each of 11 energy resources should be emphasized. The results of this section are summarized in Table 2.8. Conservation and renewable alternatives (solar, geothermal, wind, tidal, and hydro) generally received higher average scores; nuclear and peat and peat-based synthetic fuels received negative scores.

TABLE 2.8. Average Score and Rank Order of Responses by Preference--Section C, Energy Resource Emphasis

Energy Resource	Average Score[a]	Rank Order
Conservation	1.46	1
Solar	1.10	2
Geothermal	1.06	3
Wind	0.99	4
Tidal	0.80	5
Hydro	0.68	6
Refuse and wood waste	0.62	7
Natural Gas	0.53	8
Coal and coal-based synthetic fuels	0.08	9
Peat and peat-based synthetic fuels	-0.42	10
Nuclear	-1.10	11

(a) The average score was based on the number of individuals expressing an opinion on the following scale: strongly agree = 2, agree = 1, indifferent = 0, disagree = -1, strongly disagree = -2.

The final section of the survey asked whether the respondents agreed or disagreed that the state should promote development of certain electric power alternatives by use of incentive programs. The response to this section is presented in Table 2.9. The results of Section D indicate that respondents generally favor incentive programs for small-scale renewable resources, for conservation alternatives, and for large-scale renewable alternatives. They do not favor the use of incentives to promote development of alternatives obtained from Alaskan coal or peat.

TABLE 2.9. Average Score and Rank Order of Responses by Preference - Section D, Use of Incentive Programs

Electric Power Alternative	Average Score[a]	Rank Order
Small scale alternatives using renewable resources (solar, wind, hydro)	1.45	1
Conservation alternatives	1.40	2
Large scale alternatives using renewable resources (solar, wind, hydro, geothermal, tidal, wood waste, refuse)	0.88	3
Alternatives using synthetic fuels obtained from Alaskan coal or peat	-0.23	4

(a) The average score was based on the number of individuals expressing an opinion on the following scale: strongly agree = 2, agree = 1, indifferent = 0, disagree = -1, strongly disagree = -2.

2.7 SELECTION OF PRELIMINARY ELECTRIC ENERGY PLANS

The selection of the preliminary electric energy plans was based primarily on the five factors outlined above. Other general concepts and considerations that influenced the selection of the plans are noted in the description of each plan in Chapter 3.

The underlying purpose of the Railbelt Electric Energy Alternatives Study is to help determine whether the State should develop the Upper Susitna hydroelectric project or if it should pursue other alternatives; thus, two electric energy plans are inherent in the purpose of the project: one plan not including the Upper Susitna project and another plan including the Upper Susitna project. The former provides the conditions for the "base case", that is, the case against which the alternatives will be compared. Plan 1A, Base Case Without Upper Susitna, and Plan 1B, Base Case With Upper Susitna, will provide a direct comparison between continued development of conventional generating resources and development of conventional generating resources with the addition of the Upper Susitna project.

The public meetings, as well as other inputs, point to widespread interest in both conservation and renewable energy resources. Electric energy conservation will take place as a result of price increases in all of the electric energy plans. However, it is desirable to have a specific plan in which conservation alternatives receive greater emphasis than in any other plan. This same plan logically could include renewable energy sources. Thus, Plan 2A, High Conservation and Use of Renewable Resources without Upper Susitna, and Plan 2B, High Conservation and Use of Renewable Resources with Upper Susitna, were selected.

As pointed out earlier (Section 2.1.1), coal is an attractive fuel for electrical generation in the Railbelt area for a number of reasons. It is abundant, there are good, easily mined deposits close to the load centers; the technologies for both mining and burning it are well established; and projections indicate that it will continue to be competitively priced relative to alternative fuels. It also appears likely that an export mine will be developed at Beluga providing the Cook Inlet area with a good source of coal. A third plan based upon increased emphasis on coal is included: Plan 3, Increased Use Of Coal Case.

Natural gas is currently the mainstay fuel for generation in the Cook Inlet area and may become available in the interior if and when production and transmission of North Slope natural gas occurs. The major favorable attributes associated with natural gas are its relatively low environmental impact compared to other fossil fuels, the lower capital cost per unit of generating capacity, and the short lead time involved in making capacity additions. In short, natural gas based generation is clean, flexible, and adapted to conditions of uncertain future demand.

Considerable known reserves of natural gas exist in the Cook Inlet region; about 3,900 billion cubic feet (BCF). Some of this gas is committed (or dedicated) under contract to the gas and electric utilities (620 BCF); some is committed to industrial applications (ammonia and urea production) and for export (approximately 730 BCF); and some (about 830 BCF) is at least tentatively committed to the proposed (and currently uncertain) Pacific Alaska LNG project for exports to the "lower 48 states".

A significant amount (about 1600 BCF) of the known reserves appears totally free of current commitments. However, current industrial and export users will probably compete with the gas and electric utilities for commitment of this gas to their operations.

For gas reserves not currently committed under contract, the future price is subject to considerable uncertainty as it becomes deregulated in 1985. Thus, it is conceivable that the price to an electric utility could approach that of distillate fuel oil on a heat equivalency basis. Whether or not this occurs is largely dependent upon the competitive nature of the future market. Thus, the advantages of natural gas must be traded off against the uncertainty in price.

At this point, however, the possible advantages of increased use of natural gas warrant further evaluation. These considerations resulted in the fourth preliminary electric energy plan: Plan 4, Increased Use Of Natural Gas.

The electrical energy alternatives included in each of the four electric energy plans are summarized in Table 2.10. These alternatives are taken from Table 2.5 which includes the proposed selection of alternatives to be included in the electric energy plans.

Each of these plans is discussed in greater detail in the next Chapter.

TABLE 2.10. Summary of Electrical Energy Alternatives Included as Future Additions in Preliminary Electric Energy Plans

	Electric Energy Plan[a]					
	1A	1B	2A	2B	3	4
BASE LOAD ALTERNATIVES						
Coal Steam Electric	X	X	X	X	X	
Refuse-Derived Fuel Steam Electric			X	X		
CYCLING ALTERNATIVES						
Coal Gasifier-Combined Cycle					X	
Natural Gas Fuel Cell Stations						X
Natural Gas Combined Cycle	X	X	X	X		X
Natural Gas Combustion Turbine	X	X	X	X	X	X
Natural Gas Fuel Cell Combined Cycle						X
Bradley Lake Hydroelectric	X	X	X	X	X	X
Grant Lake Hydroelectric	X		X			
Lake Chakachamna Hydroelectric	X		X			
Upper Susitna Hydroelectric		X		X		
Allison Hydroelectric	X		X			
Browne Hydroelectric			X			
Keetna Hydroelectric			X			
Snow Hydroelectric			X			
Strandline Lake Hydroelectric			X			
FUEL SAVER (INTERMITTENT) ALTERNATIVES						
Large Wind Energy Conversion System			X	X		
Cook Inlet Tidal Electric Project			X	X		
ELECTRIC ENERGY SUBSTITUTES[b]						
Micro Hydroelectric			X	X		
Small Wind Energy Conversion Systems			X	X		
Passive Solar Space Heating	X	X	X	X	X	X
Active Solar Hot Water Heating	X	X	X	X	X	X
Wood-Fired Space Heating	X	X	X	X	X	X
ELECTRIC ENERGY CONSERVATION						
Building Conservation	X	X	X	X	X	X

(a) Plan 1: Base case
A. Without Upper Susitna
B. With Upper Susitna
Plan 2: High conservation and use of renewables
A. Without Upper Susitna
B. With Upper Susitna
Plan 3: Increase use of coal
Plan 4: Increase use of natural gas

(b) As defined in this study electric energy substitutes include all options that are either dispersed (used by a single consumer or a small community) or not interconnected with utility distribution systems.

3.0 DESCRIPTION OF PRELIMINARY ELECTRIC ENERGY PLANS

This chapter describes the features of the four preliminary electric energy plans. Information about each plan is presented in two general forms: 1) an outline of the key features of each plan for each load center and 2) a figure showing a representative mix of generating capacity for that plan over the 1980-2010 period.

The figures illustrating the evolution of the generating capacity over time illustrate the nature of each of the electric energy plans; they are not meant to present the exact capacities or timing of the capacity additions. However, to ensure that the figures are relatively realistic, an effort was made to use representative data in their development. In many cases, these data were not developed as part of this study but are sufficiently accurate for illustrative purposes.

A number of assumptions were made that are common to all four plans. They are:

- Current utility plans for additions proceed as planned.
- Generating units are retired based on assumed lifetimes.
- An interconnection between the Anchorage-Cook Inlet and Fairbanks-Tanana Valley load centers is completed in 1984 and strengthened as necessary to allow economy power exchanges between Fairbanks and Anchorage.
- The Glennallen-Valdez load center electrical loads and generating capacity are combined with Anchorage-Cook Inlet loads and generating capacity.
- All load centers maintain sufficient peaking capacity to provide peak requirements in the event of interconnection failure.
- The Bradley Lake hydroelectric project is completed and comes on-line in 1988.

3.1 PLAN 1: BASE CASE

This plan is based on a transition from existing generating technologies to alternative conventional generating technologies as electrical requirements increase and existing capacity is retired. This plan represents the base or reference case. Two variations to this plan have been identified: Plan 1A, without the Upper Susitna project, and Plan 1B, with the Upper Susitna project. The assumptions made in each of these plans are presented below.

3.1.1 Plan 1A: Base Case Without Upper Susitna

The primary generating alternatives included in this plan are:

- combustion turbines (gas or distillate)
- combined cycle (gas or distillate)
- hydroelectric (other than Upper Susitna)
- conventional coal steam electric.

The key features of this plan for each of the load centers are summarized below.

Anchorage-Cook Inlet

- The Chakachamna hydroelectric project is built as required to come on line no sooner than 1994.
- The Grant Lake project is built as required to come on line no sooner than 1990.
- The Allison hydroelectric project is added as necessary after 1992.
- Coal steam turbines are installed after the hydro alternatives, as necessary.

Fairbanks-Tanana Valley

- Oil combustion turbine units are used for peaking until retirement.
- Gas combined cycles are added to provide peaking generation when existing oil combustion units are retired.
- Coal-fired steam electric capacity is added for base load if less expensive than power from Anchorage-Cook Inlet. If coal-fired generation is not less expensive, all new generation will be gas-fired combined cycle.

This plan is illustrated in Figure 3.1 for the Anchorage-Cook Inlet load center. As with all the figures included in this chapter, the horizontal axis represents the time horizon of the study--1980 through 2010. The heavier curve in the figure is the peak demand (net consumption) for that load center multiplied by 1.4. The peak demands were calculated from the medium annual energy consumption projections made by ISER in Electric Power Consumption for the Railbelt: A Projection of Requirements (Goldsmith and Huskey 1980). While these projections were not developed as part of this project, they provide an approximation of future requirements that can be used for the purposes of this report. (Consumption forecasts are being made as part of this study but have not been completed at this time.) The peak demands (PEAK) were computed from the annual energy (AE) projected in the ISER report assuming a yearly load factor (YLF) of 0.50 using the formula:

$$\text{PEAK (MW)} = \frac{\text{AE (GWh)}}{\text{YLF} * 8.760 \text{ (hours/year)}}$$

The assumed yearly load factor of 0.50 is approximately the yearly load factor experienced by area utilities during the 1970s. This calculated peak demand is then multiplied by 1.08 to adjust for transmission and distribution losses. This converts the demand projection from net consumption to gross generation by allowing for transmission and distribution losses. This value is then multiplied by 1.3 to allow for a 30% reserve margin. Both the estimate for transmission and distribution losses (8%) and for reserve margin (30%) were selected only to be representative of Railbelt area utilities and are not necessarily based upon historical data. Overall, adjusting for transmission and distribution losses and for the reserve margin results in an increase of approximately 40% in peak generation required above peak consumption. For example, in Figure 3.1 the gross generating capacity required in the year 2000 for the Anchorage-Cook Inlet area is approximately 1400 MW.

While the same peak demand requirement is used for illustrative purposes in all plans in this report, the peak demands (and annual energy requirements) developed when evaluating the plans will depend upon the cost of power

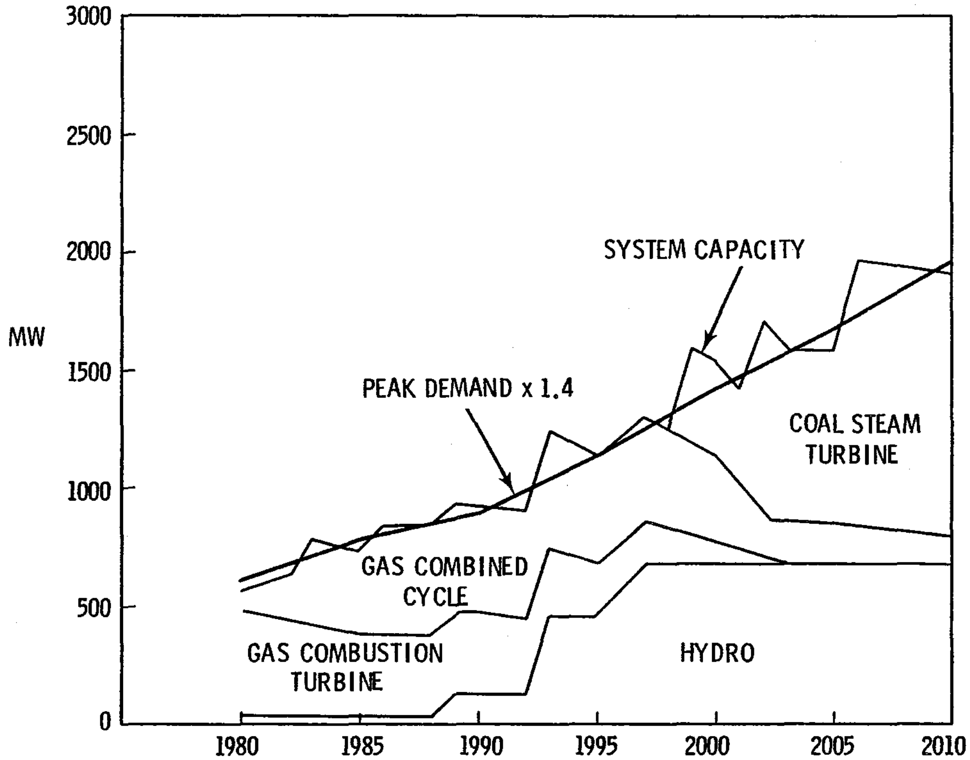

FIGURE 3.1. Plan 1A: Base Case Without Upper Susitna for Anchorage-Cook Inlet

produced in each of the plans. For example, a plan that results in a relatively high cost of power will have a relatively low demand for electricity while plans with lower costs of power will have higher demands.

Also shown on each figure is a general representation of the mix of generating capacity to meet the projected gross generation requirement. Figure 3.1 shows that under Plan 1 the Anchorage-Cook Inlet area load center would supply the 1400 MW of generating capacity required in the year 2000 using about 650 MW of hydroelectric capacity, 100 MW of gas combustion turbine, 400 MW of gas combined cycle and about 500 MW of coal steam turbine.

The Railbelt Electric Power Alternatives Study treats conservation and electric energy substitutes as demand modifiers rather than as supply alternatives. (Those alternatives defined as conservation or electric energy substitutes are shown in Tables 2.5 and 2.10.) Thus, when evaluating these alternatives, their effects will be represented by a reduction in the electricity required by the consumer. As pointed out earlier, different levels of conservation and electric energy substitute penetration are evaluated as part of each electric energy plan. Figure 3.2 illustrates the effects of increased conservation on the gross generating capacity required and on the relative mix of generating capacity required in Plan 1. At this point in the study, the effects of conservation on the required peak consumption have not been evaluated. The levels of conservation used for illustrative purposes in the figures are based on sample calculations and should not be interpreted as representing the final contribution of conservation in any plan. As shown, conservation reduces the gross generating capacity required. The mix of generating alternatives is relatively unchanged. The primary effect of conservation in this case is to delay the date that generating plants are required to be on-line.

Figures 3.3 and 3.4 illustrate the future mix of generating capacity for the Fairbanks-Tanana Valley load center for Plan 1 without and with additional conservation included, respectively. These figures show that under this plan existing diesel and oil combustion turbine capacity is retired and replaced with coal steam turbine and gas combined cycle generation. The coal steam turbine capacity would be used for base load while the gas combined cycle capacity would be used to meet cycling load. Figures 3.3 and 3.4 assume that coal steam turbine plants located in the Fairbanks area (Nenana) can produce power at a lower cost than power produced at Beluga and transmitted to Fairbanks. If power produced at Beluga is less expensive in Fairbanks than power generated at Fairbanks, then Fairbanks would add only gas combined cycle units to provide reserve capacity to meet peak demand and would import power from Anchorage.

3.1.2 Plan 1B: Base Case With Upper Susitna

This plan is based upon a continuation of present generating technologies with a transition to Upper Susitna hydropower as required. Any additional required capacity is to be supplied by coal steam turbine or combined cycle facilities. The capacity from the Upper Susitna project is allocated to the three load centers based upon their relative peak demand in 1990.

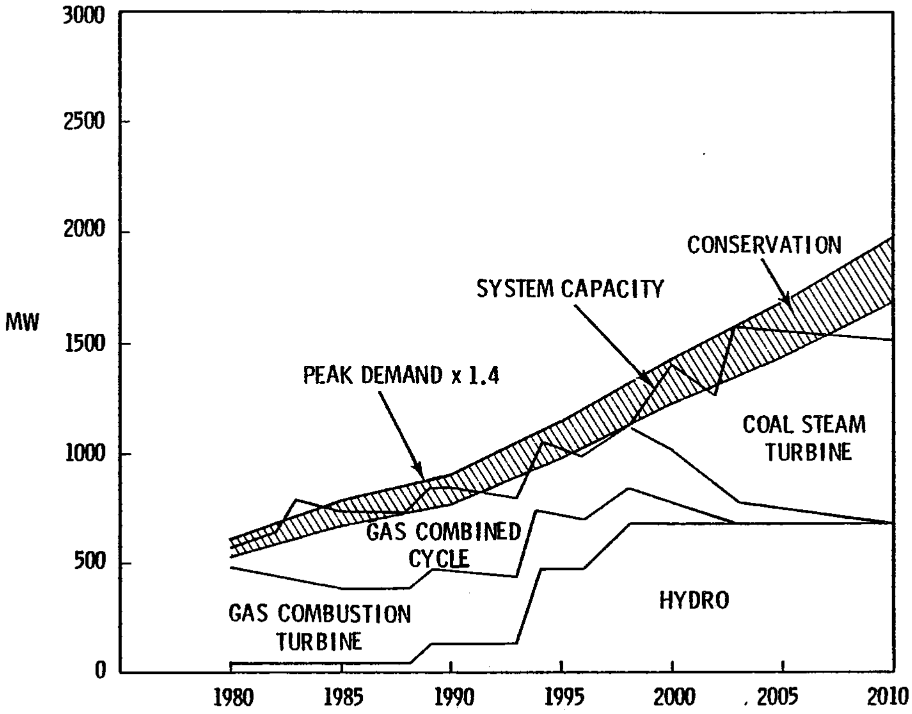

FIGURE 3.2. Plan 1A: Base Case Without Upper Susitna Illustrating the Effects of Conservation for Anchorage-Cook Inlet

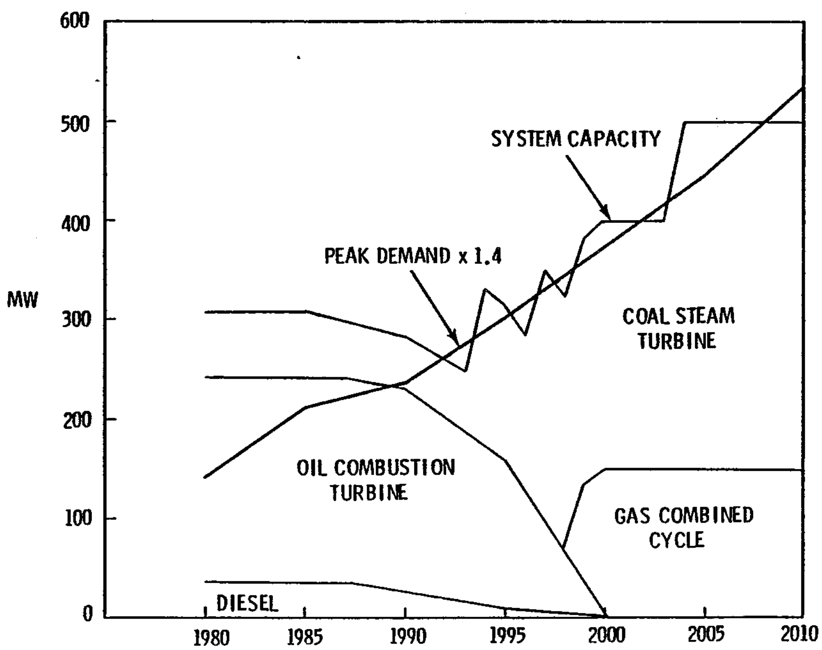

FIGURE 3.3. Plan 1A: Base Case Without Upper Susitna for Fairbanks-Tanana Valley

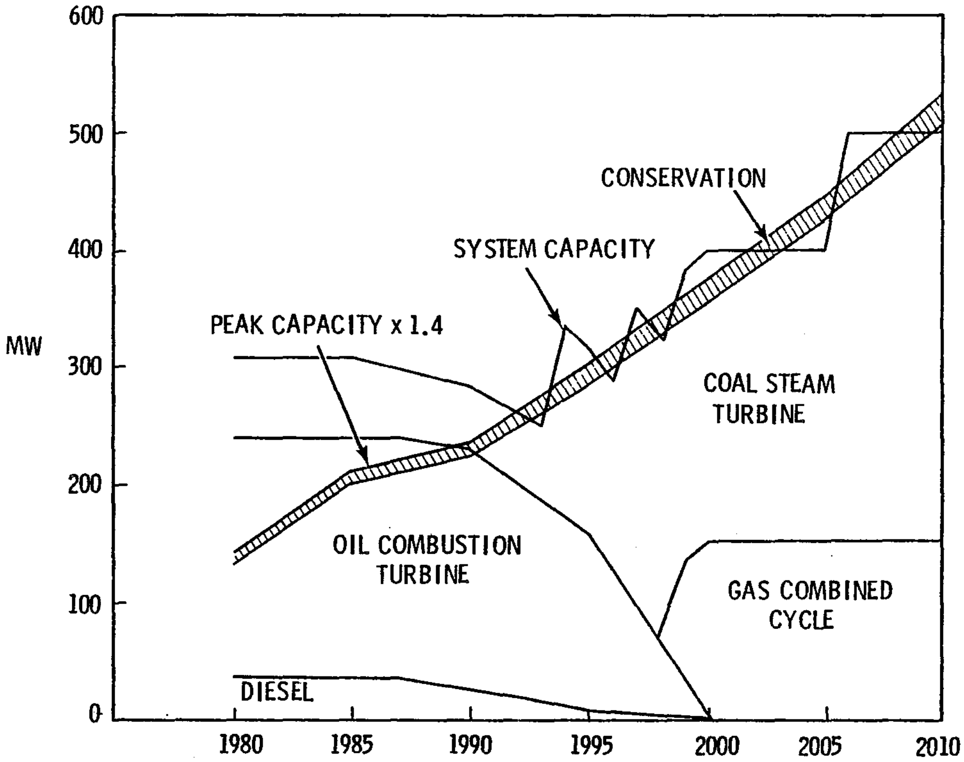

FIGURE 3.4. Plan 1A: Base Case Without Upper Susitna, Illustrating Effects of Conservation for Fairbanks-Tanana Valley

Anchorage-Cook Inlet

- The Watana I facility of the Upper Susitna project is available as early as 1993.
- If necessary, combustion turbine capacity is added to fill in until Upper Susitna is available.
- Coal steam turbine units are added after the Upper Susitna project is completed.

Fairbanks-Tanana Valley

- If necessary, oil combustion turbine capacity is added before Upper Susitna is available.

- If necessary, coal steam turbine capacity is added for base load if less expensive than power from Anchorage-Cook Inlet. If power is less expensive from Anchorage, gas-combined cycle units will be added to provide reserve peaking capacity.

Figures 3.5 through 3.6 illustrate this plan for the two load centers. In this plan, the first 400 MW of Watana is added in 1993-94 with the second 400 MW added in 1994-95. Devil Canyon is added in 1999-2000. For the Anchorage and Fairbanks load centers, any additional capacity required is added in the form of coal steam turbine units.

3.2 PLAN 2: HIGH CONSERVATION AND USE OF RENEWABLE RESOURCES

This plan would emphasize the use of conservation to reduce electrical energy demand as well as the use of renewable energy sources such as wind and Cook Inlet tidal power. While various levels of conservation are evaluated in each of the plans, this plan emphasizes conservation. In each of the load centers, conservation alternatives are encouraged through a variety of means such as public education programs, tax incentives, and state and utility loan programs. Renewable energy sources such as tidal, wind, and refuse-derived fuel will be included. Any generation capacity required in addition to renewable sources will be supplied with conventional generating facilities similar to Plan 1. As with Plan 1, this plan has two variations: Plan 2A, without Upper Susitna, and Plan 2B, with Upper Susitna. Features of these plans are presented below.

3.2.1 Plan 2A: High Conservation and Renewables Without Upper Susitna

Under this plan conservation and renewable resources, excluding the Upper Susitna project, will be developed to the maximum extent feasible. Additional capacity required will be provided by conventional generating alternatives as in Plan 1. Additional features specific to each load center are presented below.

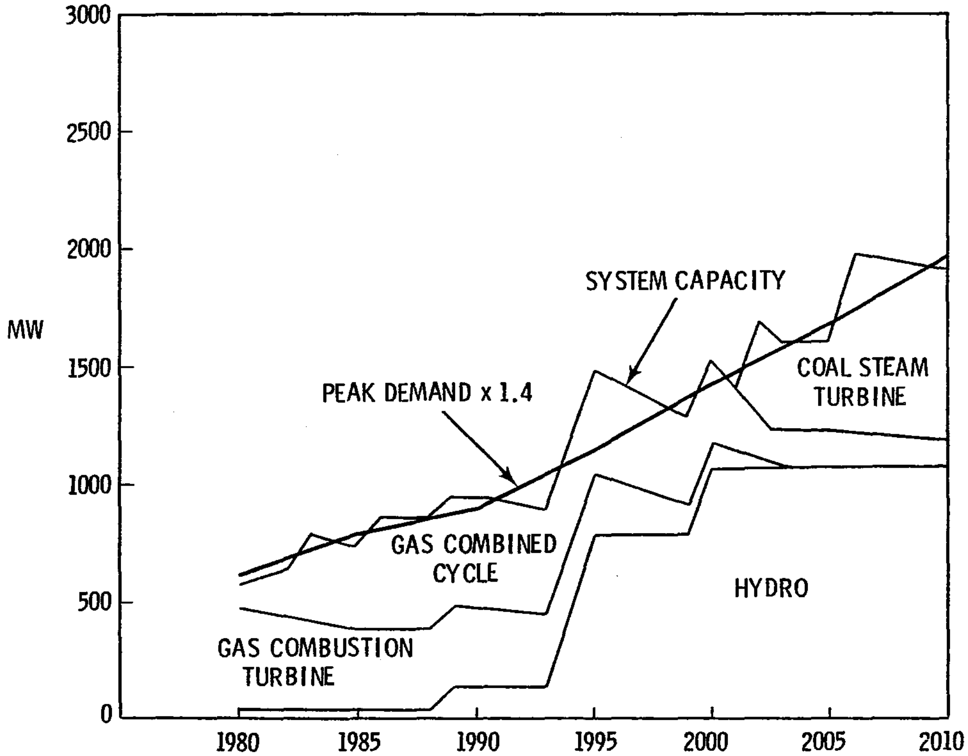

FIGURE 3.5. Plan 1B: Base Case with Upper Susitna for Anchorage-Cook Inlet

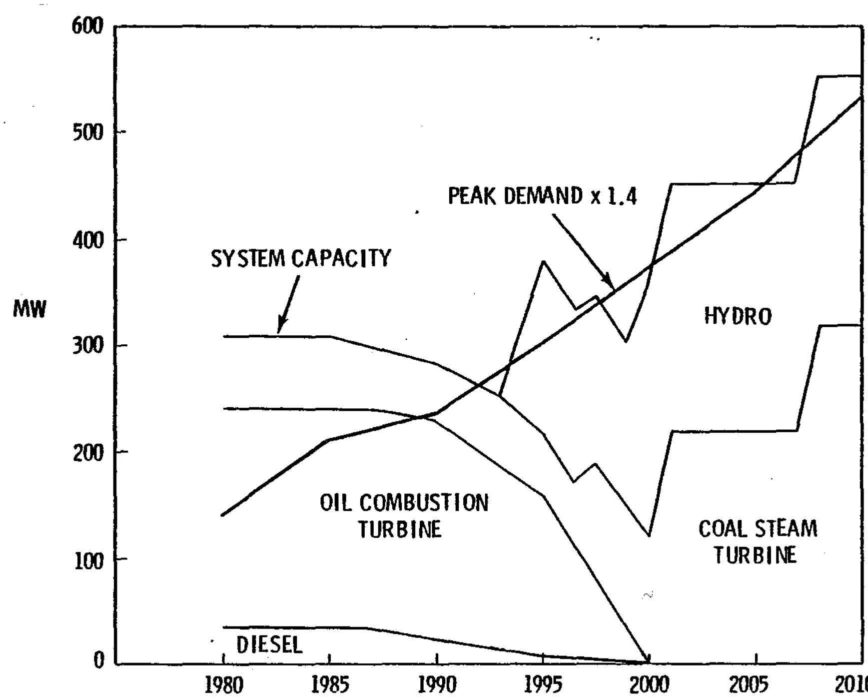

FIGURE 3.6. Plan 1B: Base Case with Upper Susitna for Fairbanks-Tanana Valley

Anchorage-Cook Inlet

- The following hydroelectric projects are built as required but no sooner than 1992: Lake Chakachamna, Keetna, Snow, Strandline Lake, Grant Lake, and Allison.
- A 50-MW refuse-derived fuel steam-electric plant is built.
- Cook Inlet tidal power is developed as appropriate in conjunction with hydroelectric facilities since it appears that the tidal options under consideration will be designed to provide firm power.

Fairbanks-Tanana Valley

- The Browne hydroelectric project is added as necessary after 1992.
- A 20-MW refuse-derived fuel steam-electric plant is built.
- Wind energy resources in the Isabelle Pass area are developed and intertied.

Figures 3.7 and 3.8 illustrate this plan for each load center.

3.2.2 Plan 2B: High Conservation and Renewables with Upper Susitna

This plan is similar to Plan 2A except that the Upper Susitna project is built.

Anchorage-Cook Inlet

- The Watana I facility of the Upper Susitna project is available as early as 1993.
- A 50-MW refuse-derived fuel steam-electric plant is built.
- Cook Inlet tidal power is developed as appropriate following the Upper Susitna Project.

Fairbanks-Tanana Valley

- A 20-MW refuse-derived fuel steam-electric plant is built.
- Wind energy resources in the Isabelle Pass area are developed and intertied.

Figures 3.9 and 3.10 present this plan for each load center.

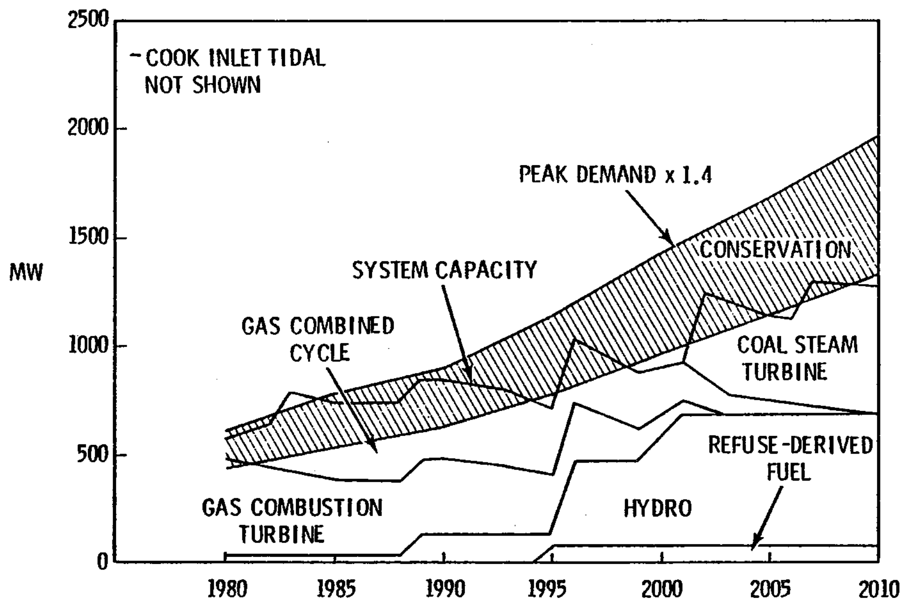

FIGURE 3.7. Plan 2A: High Conservation and Use of Renewables Without Upper Susitna for Anchorage-Cook Inlet

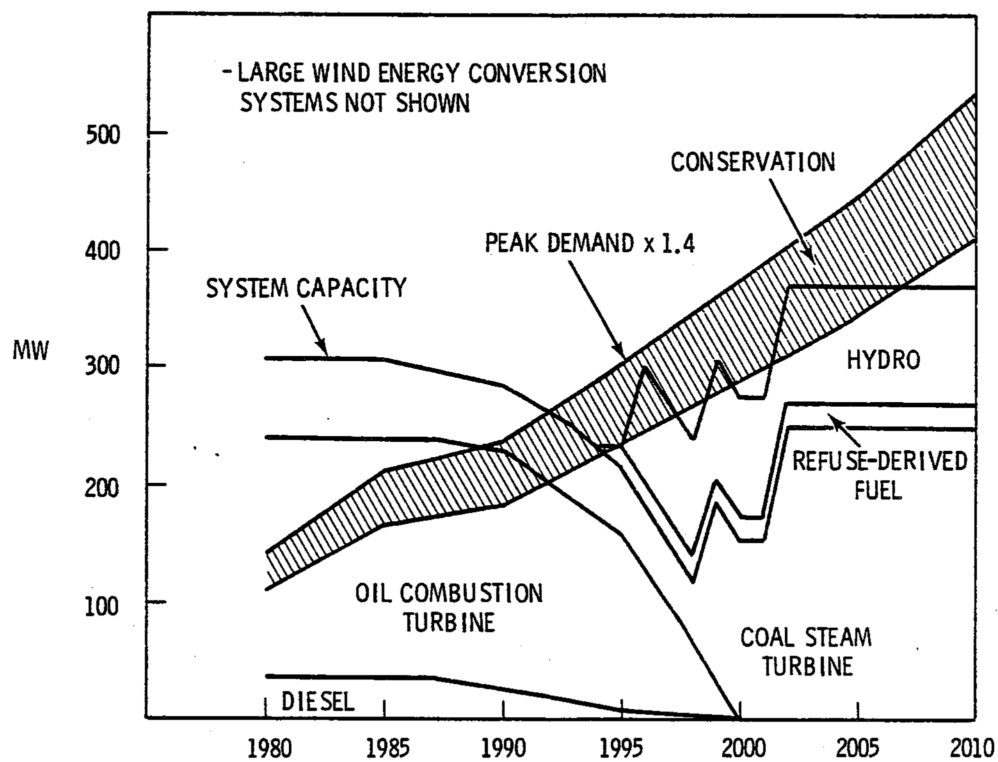

FIGURE 3.8. Plan 2A: High Conservation and Use of Renewables Without Upper Susitna for Fairbanks-Tanana Valley

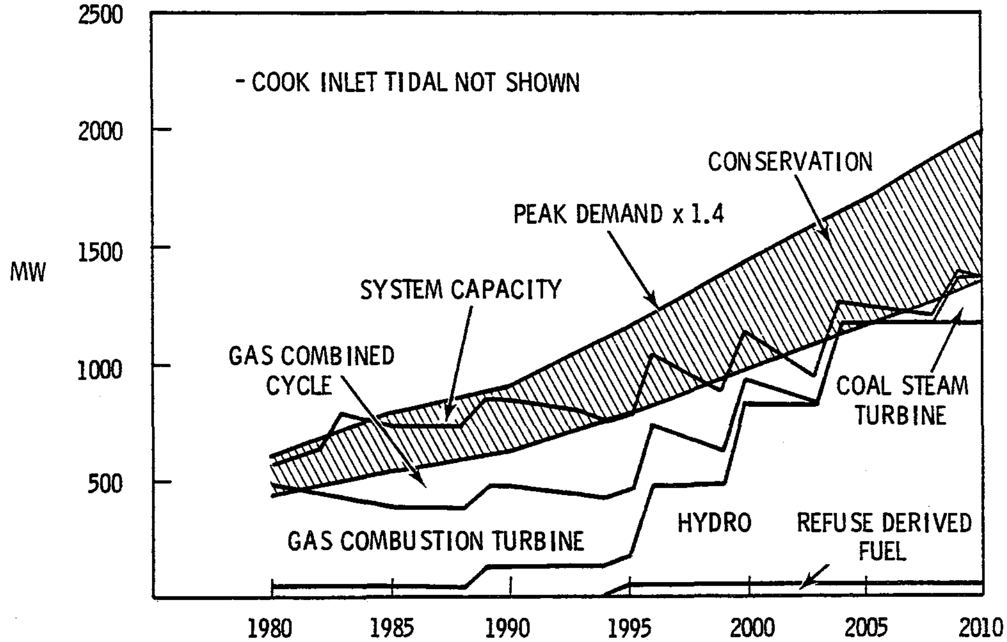

FIGURE 3.9. Plan 2B: High Conservation and Use of Renewables with Upper Susitna for Anchorage-Cook Inlet

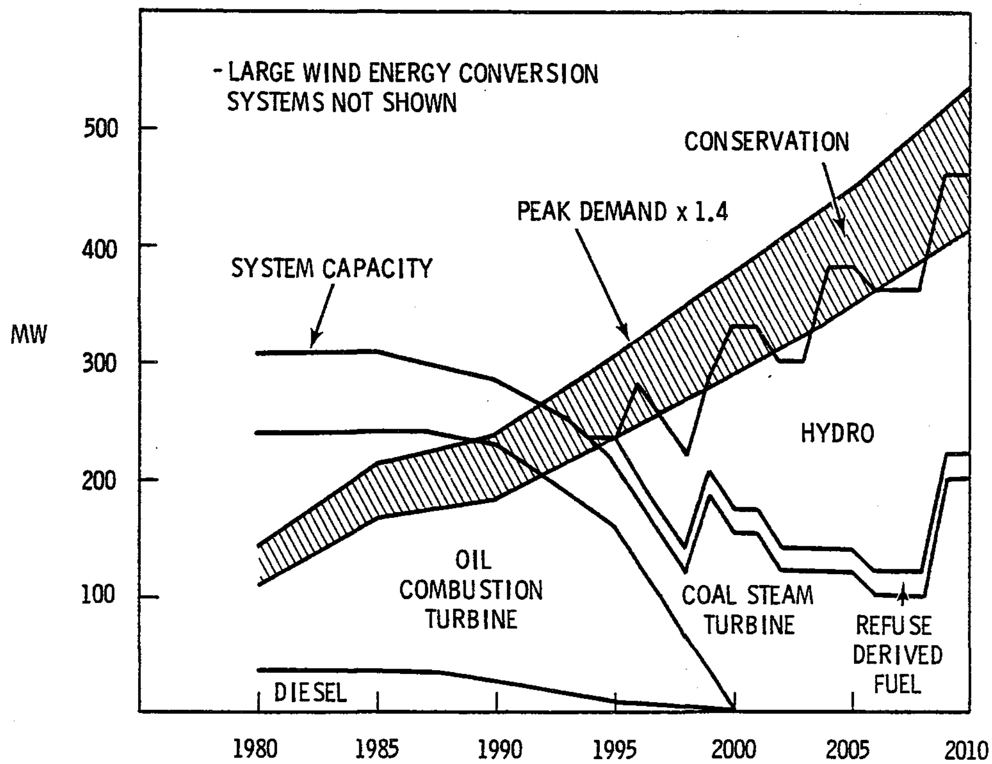

FIGURE 3.10. Plan 2B: High Conservation and Use of Renewables with Upper Susitna for Fairbanks-Tanana Valley

Figures 3.7 through 3.10 show that each load center has a greater reduction in demand due to conservation than shown for Plan 1 in Figures 3.2 and 3.4. The contribution of conservation to the reduction of demand has not yet been quantified. The relative amount of conservation shown in these figures is based on tentative calculations and do not represent results of this project. Plan 2 assumes that an aggressive conservation policy is pursued in the Railbelt.

It is important to note that the figures presented in this chapter show firm generating capacity in the load centers. Certain generation alternatives can contribute electrical energy (i.e., kilowatt hours), but cannot be depended upon at any given time to contribute to the firm capacity of the system. Since in most cases neither wind nor tidal generation can be relied upon for firm power, they are not shown in these figures. Wind energy can begin to obtain a capacity credit if it is a significant (~15%) part of the total installed capacity and is geographically dispersed to meteorologically varied regions.

3.3 PLAN 3: INCREASED USE OF COAL

This plan is based upon a transition from existing generating technologies to alternatives that either directly or indirectly utilize coal as a fuel. As discussed earlier, coal is currently available in the Railbelt from the Healy area. Coal from the Beluga area is expected to be available in 1988. This plan assumes that coal-fired generation in the Anchorage-Cook Inlet load center would be located in the Beluga area. Base load generation for the Fairbanks area would depend on the relative costs of facilities located at Beluga to facilities located in the Nenana area.

Anchorage-Cook Inlet

- All new generation is either coal-fired steam turbines or combined cycle units using coal-based synthetic fuels.
- With the exception of Bradley Lake in 1988, no additional hydroelectric facilities are built.

Fairbanks-Tanana Valley

- All new generation is either coal-fired steam turbines or combined cycle units using coal-based synthetic fuels.

Figures 3.11 and 3.12 present this plan for the Anchorage and Fairbanks load centers, respectively. In both cases the existing diesel, combustion turbine, and combined cycle facilities are retired and replaced with coal fired steam turbine units for base load and with a generating technology capable of providing cycling power that uses a coal-based synthetic fuel. Examples of technologies considered in this category include fuel cells and combined cycle units. Neither the specific technologies nor fuels to be included in this plan have yet been selected.

3.4 PLAN 4: INCREASED USE OF NATURAL GAS

This plan is based upon continued use of natural gas for generation in the Cook Inlet area and a conversion to natural gas in the Fairbanks area. The key assumption made in this plan is that there will be sufficient gas available in the Cook Inlet area to allow utilities to continue to utilize it for electrical generation. Also for the Fairbanks area it is assumed that natural gas will be available from the North Slope beginning in 1988. Possible natural gas-fired generating alternatives to be included in this plan are fuel cells, combined cycle, combustion turbines, and fuel cell combined cycle.

Anchorage-Cook Inlet

- All new generating facilities added in the region will be gas fired.

Fairbanks-Tanana Valley

- All new generation will be gas fired.

Figures 3.13 and 3.14 illustrate this plan for the Anchorage and Fairbanks load centers, respectively. The diesel and simple cycle combustion turbine generating units are allowed to retire. All additional capacity additions are either conventional or emerging natural gas-fired alternatives. In some cases fuel cells might provide an alternative to the combined cycle units.

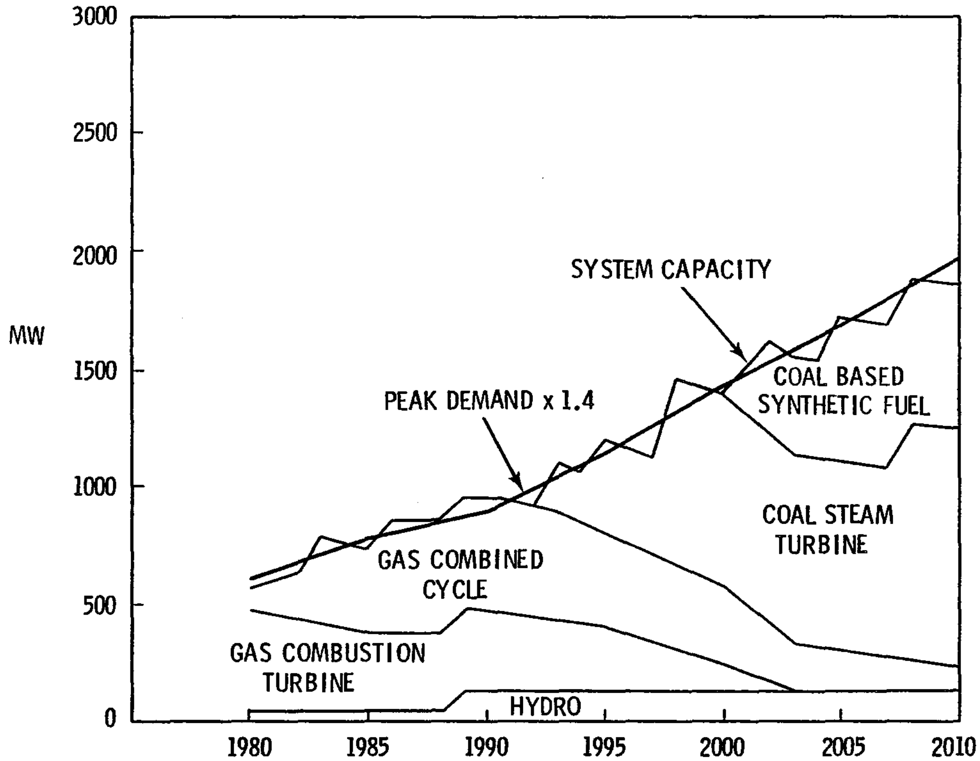

FIGURE 3.11. Plan 3: Increased Use of Coal for Anchorage-Cook Inlet

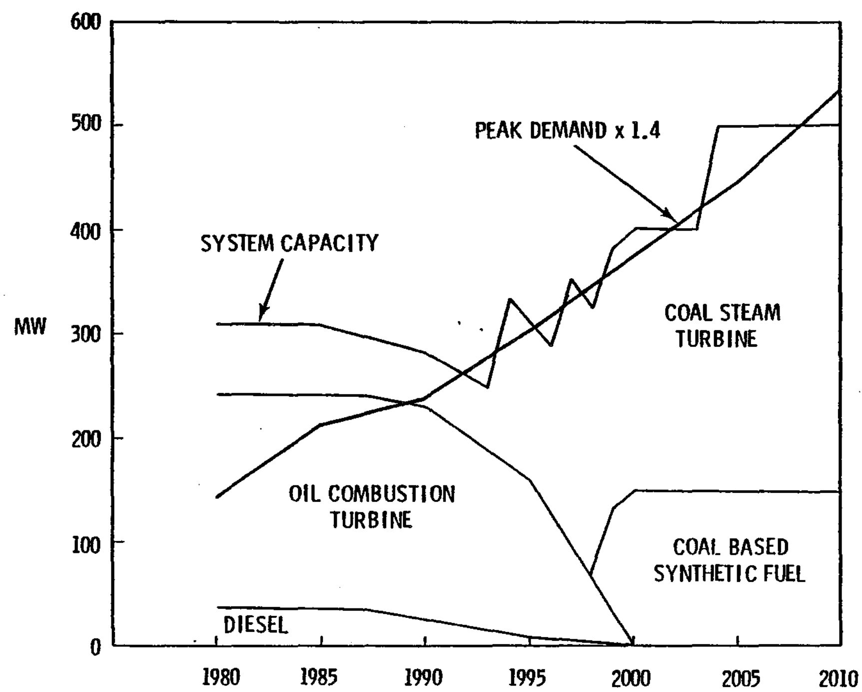

FIGURE 3.12. Plan 3: Increased Use of Coal for Fairbanks-Tanana Valley

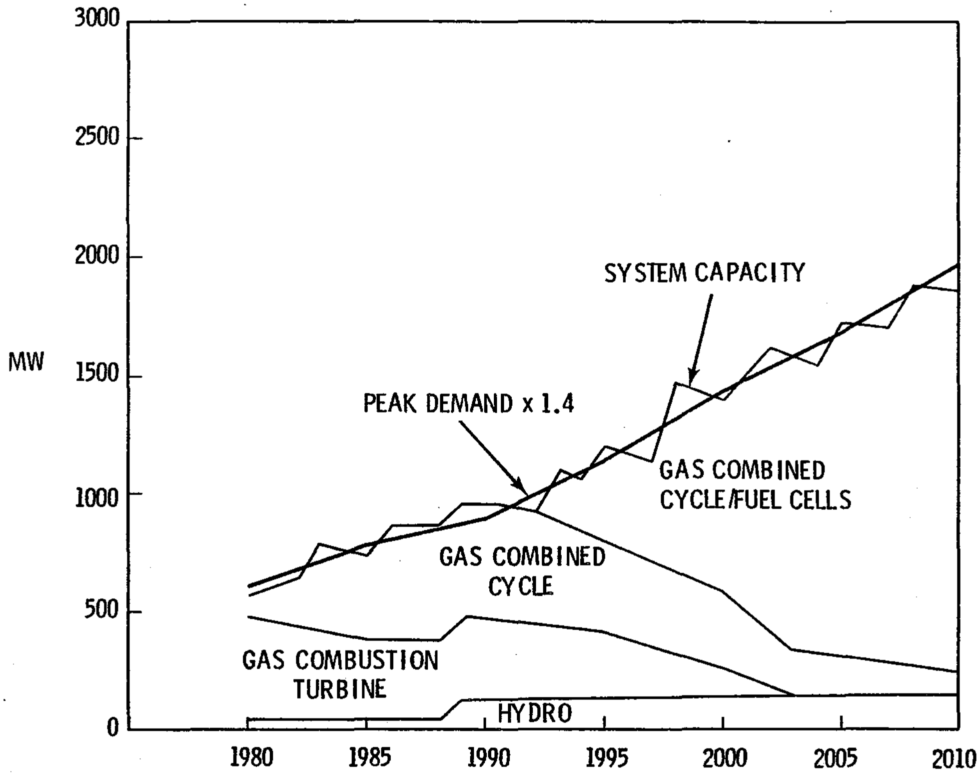

FIGURE 3.13. Plan 4: Increased Use of Natural Gas for Anchorage-Cook Inlet

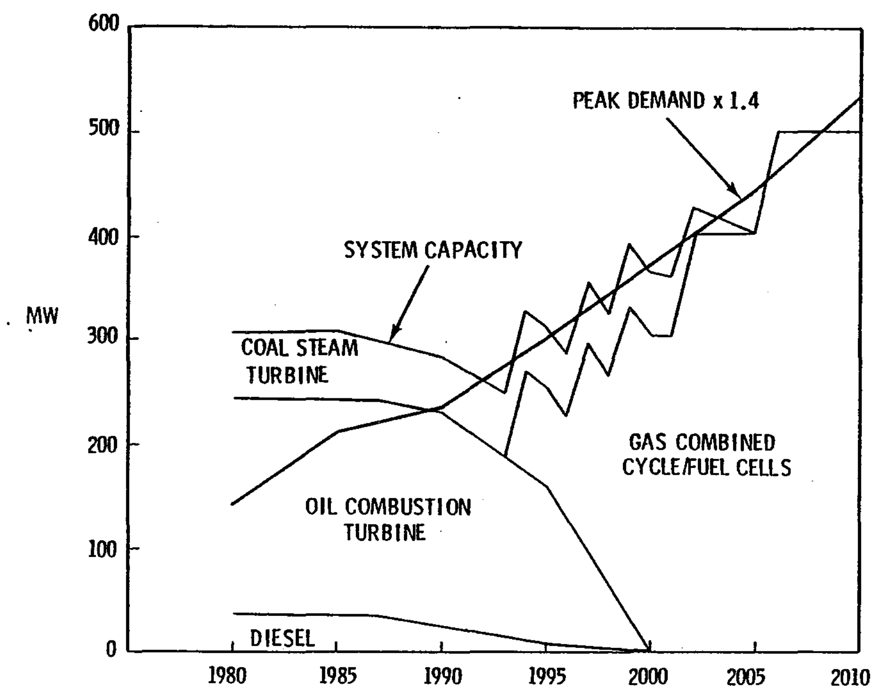

FIGURE 3.14. Plan 4: Increased Use of Natural Gas for Fairbanks-Tanana Valley

REFERENCES

Acres-American, Inc. 1981. Preliminary Assessment of Cook Inlet Tidal Power, Task 1 Report--Preliminary Field Reconnaissance and Site Selection.

Alaska Power Authority. 1981. Susitna Hydroelectric Project, Development Selection Report-Appendices A through I. Prepared by Acres American Incorporated, Buffalo, New York.

Energy Modeling. 1973. A Model for Energy-Environment Systems Analysis: Structure and Uses. Papers presented at a special workshop organized by the U.S. National Science Foundation and the Energy Research Unit, Queen Mary College, London, IPC Science and Technology Press Ltd, Surrey, England.

Goldsmith, Scott and L. Huskey. 1980. Electric Power Consumption for the Railbelt: A Projection of Requirements. Institute of Social and Economic Research. Anchorage, Alaska

Huck, R. W. and D. Markley. 1980. "State Resource Estimation: Alaska". In Procedures of U.S. Department of Energy First Technical Contractors' Conference on Peat, TR-80/031-001, pp. 107-122. McLean, Virginia.

King, J. C. 1981. Selection of Electric Energy Generation Alternatives for Consideration in Railbelt Electric Energy Plans. Comment Draft Working Paper No. 3.3. Pacific Northwest Laboratory, Richland, Washington.

Metcalf and Eddy Engineers. 1979. Feasibility of Resource Recovery from Solid Waste, A Report to the Municipality of Anchorage, Alaska. Boston, Massachusetts.

Pacific Northwest Laboratory. 1980a. Wind Energy Resource Atlas: Vol. 10--Alaska. PNL-3195 WERA-10b. Pacific Northwest Laboratory, Richland, Washington

Pacific Northwest Laboratory. 1980b. Preliminary Evaluation of Wind Energy Potential - Cook Inlet Area, Alaska. PNL-3408, Pacific Northwest Laboratory, Richland, Washington

Swift, W. H. 1981. Municipal Refuse Derived Fuel. Draft Working Paper No. 1.4. Pacific Northwest Laboratory, Richland, Washington.

Swift, W. et al. 1980. Beluga Coal Market Study. Final Report. Pacific Northwest Laboratory, Richland Washington.

APPENDIX

PEAK DEMAND AND ANNUAL ENERGY PROJECTIONS-
LOAD DURATION CURVES

TABLE A.1 Peak Demand and Annual Energy Projections for the Anchorage-Cook Inlet Load Center

Year	Low		Medium		High	
	Peak (MW)	Ene (GWH)	Peak (MW)	Ene (GWH)	Peak (MW)	Ene (GWH)
1980	435	1907	435	1907	435	1907
1985	513	2249	556	2438	610	2676
1990	573	2510	635	2782	741	3249
1995	707	3097	813	3564	1013	4438
2000	908	3981	1016	4451	1260	5519
2005	998	4375	1193	5226	1601	7013
2010	1097	4807	1402	6141	2038	8927

SOURCE: Goldsmith, Scott and L. Huskey. 1980. Electric Power Consumption for the Railbelt: a Projection of Requirements. Institute of Social and Economic Research.

Peak demand computed from annual energy (AE) assuming a yearly load factor (YLF) of 0.50. (PEAK = AE/(YLF x 8.760).

TABLE A.2 Peak Demand and Annual Energy Projections for the Fairbanks-Tanana Valley Load Center

	Low		Medium		High	
Year	Peak (MW)	Ene (GWH)	Peak (MW)	Ene (GWH)	Peak (MW)	Ene (GWH)
1980	101	446	101	446	101	446
1985	141	619	152	669	175	769
1990	152	666	169	742	208	914
1995	185	813	216	949	280	1227
2000	237	1040	268	1177	350	1537
2005	263	1154	318	1397	453	1988
2010	291	1277	381	1671	590	2586

SOURCE: Goldsmith, Scott and L. Huskey. 1980. Electric Power Consumption for the Railbelt: a Projection of Requirements. Institute of Social and Economic Research.

Peak demand computed from annual energy (AE) assuming a yearly load factor (YLF) of 0.50. (PEAK = AE/(YLF x 8.760).

TABLE A.3 Peak Demand and Annual Energy Projections for the Glennallen-Valdez Load Center

Year	Low Peak (MW)	Low Ene (GWH)	Medium Peak (MW)	Medium Ene (GWH)	High Peak (MW)	High Ene (GWH)
1980	8.4	37	8.4	37	8.4	37
1985	12.1	53	14.6	64	26.5	116
1990	13.7	60	17.1	75	27.2	119
1995	15.1	66	20.1	88	28.3	124
2000	18.3	80	23.3	102	31.1	136
2005	20.1	88	27.2	119	40.2	176
2010	21.7	95	32.0	140	50.9	223

SOURCE: Goldsmith, Scott and L. Huskey. 1980. Electric Power Consumption for the Railbelt: a Projection of Requirements. Institute of Social and Economic Research.

Peak demand computed from annual energy (AE) assuming a yearly load factor (YLF) of 0.50. (PEAK = AE/(YLF x 8.760).

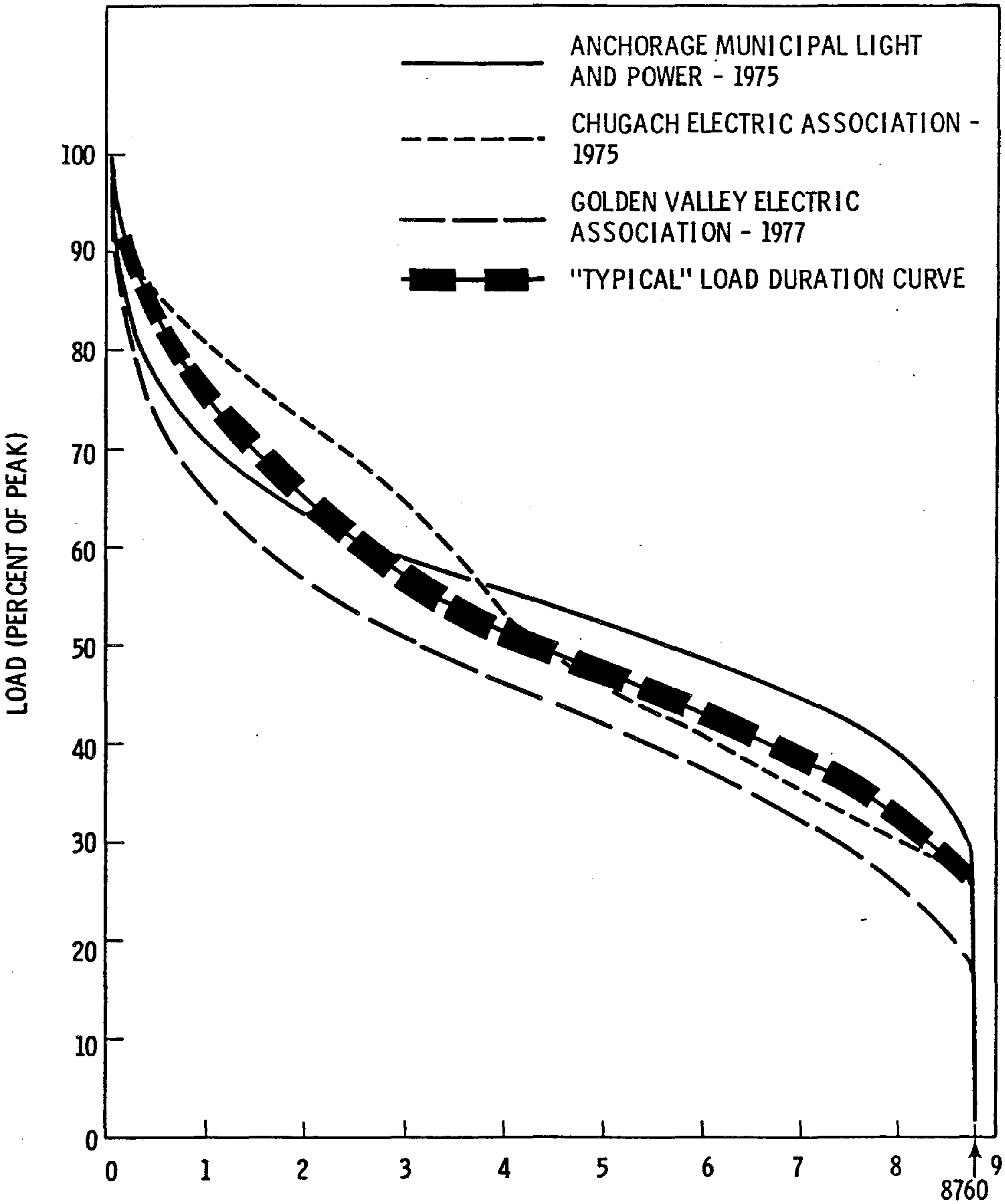

FIGURE A.1. Load Duration Curves for Railbelt Utilities (Hours x 1000)