A Review of Electric Power Demand Forecasts and Suggestions for Improving Future Forecasts

Prepared by:

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for

The House Power Alternatives Study Committee
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I. INTRODUCTION

The present report is a preliminary analysis of electric power demand forecasts for areas potentially served by the proposed Susitna dam power project. There are three main tasks undertaken. First, a conceptual discussion of electric power demand forecasts is provided in Part II, based on elementary economic theories of demand for the individual and for the market. This discussion provides a framework for the evaluation of existing power demand forecasts, which is the second task of this analysis. The third objective of the study is to focus specifically on power demand forecasts developed through the use of the Institute of Social and Economic Research (ISER) Man in the Arctic Program (MAP) model. This part of the analysis involves two sub-tasks: a discussion of the properties of the model itself, and a review of the forecasts developed to date using the model. This effort is contained in Part III. The analysis of ISER power demand forecasts developed as part of the overall Susitna Power Alternatives Study is contained in Part IV. A brief summary and conclusions is presented in Part V.

We now turn to a discussion of factors influencing demand. Readers familiar with the economics of demand can skip to Part III.

II. FORECASTING ELECTRIC POWER DEMAND

Power demand forecasts can conceptually be disaggregated into four user defined components: residential, commercial, industrial, and military. Each of these categories will respond to a different set of factors and will be considered separately.

Residential Demand

The analysis of residential demand will first consider factors affecting the individual household, and then treat the aggregation of household demand, i.e., the market residential demand for electric power. The demand schedule for the household can be specified as follows:

$$Q_D = f\,(P,\ P_{sub},\ P_{comp},\ Y,\ \text{Tastes, Random Factors})$$

Verbally, this states that the quantity demanded (Q_D) is some function of (or depends upon) the price of electricity (P), the price of substitutes for electricity (P_{sub}), the price of complementary goods or services (P_{comp}), the disposable income of the household, the tastes or preferences of the household, and various random factors. We will consider each of these variables in turn.

First, the quantity of electricity demanded, over some specified time period, depends on its price. As the price of electricity goes down, assuming all other factors are held constant, then the quantity demanded will increase.

This raises an important question with respect to how sensitive, or responsive, demand will be to changes in price. The economic concept used to measure this is known as elasticity of demand and is defined as the percentage change in quantity demanded divided by the percentage change in the price. It should also be noted that the elasticity will depend on how long we are willing to wait for the effect to take place.

For example, in the short run there may be little that the consumer can do in response to an increase in price, except to lower the thermostat or turn out the lights, etc. Over the longer run, the consumer has the option of substituting other types of space heating, converting to gas hot water, adding insulation, etc. Over an even longer period, changes in building design, use of new technology, etc. becomes possible. In short, the elasticity of demand will tend to increase over time.

The second variable in the demand function is the price of substitute sources of energy. In the case of residential demand, substitute sources of energy for space heating would include, for example, natural gas, oil, solar, and wood. These may be total or partial substitutes.

In general we would expect that as the price of substitutes declined, all other factors remaining the same, the demand for electricity would also decline as consumers substitute relatively cheaper forms of energy. Responsiveness of changes in demand to changes in the price of substitutes can be measured by the cross elasticity of demand, defined as the percentage change in quantity demanded divided by the percentage change in the price of the substitute. Again, the elasticity tends to increase with the length of the period of adjustment.

The price of complementary goods is the third variable in the demand equation. Complementary goods refer to goods used in conjunction with electricity, such as power tools and electric home appliances, etc. As the prices of complementary goods decrease, the quantity of electricity demanded increases, other variables being held constant. Once again, the sensitivity of this relationship can be measured by the cross elasticity of demand, defined in this case as the percentage change in the demand for electricity divided by the percentage change in the price of complementary goods. This elasticity will also increase as the length of the adjustment period increases.

Disposable income of the household is also an important variable in explaining the quantity demanded. In most cases (including the demand for electricity) as income increases the quantity of electricity demanded also increases. This is so because as income rises (other factors held constant) households will have larger houses, more appliances, etc. The concept of income elasticity measures the responsiveness of change and is defined as the percentage change in quantity demanded divided by the percentage change in income.

The next variable in the demand function is taste, or preferences. This variable reflects the fact that individual likes or dislikes exert a real effect on household consumption patterns. Generally speaking these tastes are not measurable and the variable is not specified in a quantitative (or empirical) demand function. The justifying assumption is that tastes are relatively stable and can therefore be assumed constant.

This assumption may be more valid than it appears at first glance. Suppose that in response to appeals to "set the thermostat" at 65°, instead of 70°, we observe that households, on the average, have in fact set the thermostat at 65°. Can we conclude that this reflects a change in "tastes" in response to a perceived energy crisis? The answer is no. While it may reflect a change in tastes it may just as well reflect the fact that the price of electricity is increasing.

The final variable in the equation reflects the effects of various factors such as weather (which impacts on heat and light requirements) and the age-size characteristics of the household. More will be said on this later.

Before turning to a discussion of market demand two points should be addressed. The earlier assumption "all other factors held constant" should be commented upon. The purpose of this assumption is to isolate the effect that a change in one variable has on another, not to suggest that other variables do not change. In some instances it will be possible to predict the impact of several variables changing at once on the quantity demanded. For example, the quantity demand varies directly with changes in income and the price of substitutes, and inversely with the price of electricity and the price of complements. Thus, for example, knowledge that both the price of substitutes and income had increased would tell us that Q_D would also increase. However, if the price of substitutes increased but income decreased, we could not say, without additional information, what the impact on demand would be.

A second instance in which we can deal with more than one variable changing relates to relative prices, rather than absolute prices. For example, if the price of electricity increased, by an amount proportionally less than an increase in all other prices, then we might still see an increase in the quantity demanded. In other words, there is a tendency to substitute the good or service that becomes <u>relatively</u> cheaper as the result of price changes, even if the absolute price of the item has increased.

With these comments in mind we can proceed to the discussion of market (as opposed to household) demand. The market demand schedule, at any point in time, is conceptually equal to the sum of individual demand schedules.

However, if we wish to look at the market over time, certain adjustments must be made. For example, the size of the market changes with respect to population growth or decline. A second type of adjustment is appropriate if the market is not homogeneous (i.e., distinct sub-markets exist). For example, heating-degree days are thought to be a significant variable in determining total power demand. If significant geographic variation occurs within the market area (and hence degree-days) then this should be accounted for.

Another example of non-homogeneity is reflected (for the Anchorage Bowl area) by the availability (and perhaps reliability) of public utilities. Some areas are not served by natural gas, and so consumers are more limited in their choice of space heating. Thus, changes in the availability of the utility (or source of energy) over time or growth of residential areas where the range of alternatives is restricted, will have an impact on electric power demand.

A final illustration of factors that affect market demand relates to the housing stock. Over time the housing stock changes, both in terms of its size/composition and in terms of its efficiency with respect to the use of energy. This will impact directly on heating energy requirements and the demand for electricity.

We can summarize the preceding discussion of residential electric power demand as follows. The demand (market) for residential electric power depends upon the price of electricity, the prices of substitutes and complements, income, and various factors influencing the size of the market and specific characteristics of the market or submarkets. Predicting future demand depends upon our ability to measure the effects of the different variables and to forecast future values for these variables.

Our discussion has attempted to provide a general frame of reference for the analysis of electric power demand forecasts and is not intended to be a specific forecasting device. Particular forecasting equations may vary greatly and will depend upon the relative importance of individual variables, and the availability of data with which specific relationships can be determined. However, the discussion is indicative of the types of variables that should be considered in demand forecasting for residential consumption.

Commercial - Endogenous Industrial Demand

In addition to residential demand we specified commercial and industrial demand for electric power as reflecting distinct components of the total demand for electric power. Commercial demand relates to the consumption of electricity by retail-wholesale trade establishments, office buildings, banks, etc. More generally we are implying consumption by the businesses included in the broad industry classification of wholesale-retail trade; finance, insurance, and real estate; services; government; and elements of transportation, communications, and public utilities. This is roughly analogous to the economic base methodology distinction between basic and nonbasic (or support sector) activity.

Certain industrial demand also is included within the support sector and is classified as endogenous industrial demand. The bulk of this activity is included in manufacturing, such as concrete block products, furniture, apparel, printing and publishing, etc.

By way of contrast, exogenous industrial demand is represented by consumption of power by industry activity classified as exogenous (production for export from the region). In Alaska such activity includes petroleum industry production (except for locally consumed natural gas products), fish processing, pulp and wood products, and similar export oriented production.

The distinction between the two categories is not always precise, but is important for purposes of forecasting. Furthermore, data that distinguish between the two types of activities are not readily available. However, it appears that the bulk of power supplied by utilities at present (not going to residential demand) goes to the commercial-endogenous industrial category of demand. Major exogenous industrial users for the most part supply their own power.[1/]

We can now turn to a discussion of commercial-endogenous industrial demand. There are both micro- and macroeconomic dimensions to the analysis of demand for the commercial/endogenous industrial sector. Basic micro theory assumes that the firm operates so as to maximize profits, defined as total revenue minus total costs. Within the context of the present analysis it is reasonable to assume that the firm's total revenue is largely independent of its use of electric power and hence we can focus on the relationship between total costs and the cost of electricity. Given this assumption the question becomes one of how the firm minimizes its total costs of production for any specific level of output.

As in the case of the household, there are both short run and long run dimensions to the problem, but in either instance the task is to minimize

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[1/] Institute of Social and Economic Research, Electric Power in Alaska, 1976-1995, pp. 3-116 - 3-118.

the total costs of inputs. Basically this means that inputs that become relatively cheaper will be substituted for those that have become relatively more expensive. If the price of electricity increases relative to other factor prices then firms will attempt to reduce the use of electricity relative to other factors to the extent possible. In the short run the range of options is fairly limited, particularly in view of the fact that the bulk of demand is related to space heating and lighting.

Over the longer run the possibilities of substitution increase. For example, as new structures are constructed, alternative sources of energy for space heating are possible. Also, building designs that are more efficient in terms of overall energy utilization can be employed. Greater use of insulation, use of heat from lighting for space heating, and general designs to reduce heat loss or conserve on space requirements are just a few examples. Incorporation of new materials or new technology also expands the range of options.

Just as in the case of residential demand we can also talk about the responsiveness of demand for electricity with respect to factor prices and the prices of factor substitutes. These elasticities tend to be more complicated than those of the consumer demand function, but two generalities can be stated. First, the elasticity will depend on the ratio of electricity costs to total costs of the firm. The greater the ratio, the greater the elasticity. Second, the elasticity will depend on the range of substitutes. The greater the range of substitutes the greater the elasticity. The elasticity will also increase with the period of adjustment.

There is a final point to be made with respect to electricity as an input to production. Its demand is referred to as "derived" demand. In other words, this demand depends upon the demand for some set of final goods and services. This point will be more apparent when we talk about market demand.

In summary, demand for electricity by the firm in the commercial/industrial sector will depend on demand for the product(s) of the firm, the price of electricity itself, the range and price of substitutes for electricity, and the importance of electric costs relative to total costs.

As in the case of residential demand, aggregate, or market demand by the commercial/industrial sector is the sum of individual firm demand schedules. Again, adjustments must be made to reflect changes in market size over time and non-homogeneity of the market. Changes in market size can occur either as a result of an increase of the number of firms or from an increase in the size of firms, or some combination of both. For forecasting purposes, however, it is the total size of the market that is of concern.

The question of homogeneity of the market (over time) must also be considered. In part this is the same question as raised with respect to residential demand. Geographic differences must be considered. Also of concern is the overall composition of commercial/industrial activity as the economy expands (or contracts). The central question is how economic growth affects the types of economic activity within the commercial/industrial sector and whether or not changes in the composition of the sector affect average demand per unit (aside from size of unit considerations).

The issue of homogeneity also raises the question of efficiency in terms of the use of electricity. For example, the stock of office building space and retail trade space undergoes continual expansion over time. As the composition of this stock ("old vs. newer" structures) changes, is the efficiency of the stock, in terms of electric power consumption, and in terms of electricity as an input, changing? If so, forecasts should reflect this.

A final topic with respect to forecasting demand in the commercial/endogenous industrial sector concerns the overall growth of the sector relative to the growth of the economy as a whole. This issue can be addressed most directly in the context of economic base analysis.

For a given time period (e.g., the year) total economic activity can be divided into two components: exogenous activity, primarily associated with direct government purchases of goods and services, private and public sector investment, and the sale of goods and services for export (i.e., sales to buyers outside of the economic region being considered). Endogenous activity results from the direct and indirect spending of incomes generated by activity within the exogenous sector (plus any set transfer payments into the region).

Roughly speaking, the commercial/endogenous industrial sector that has been under discussion corresponds to the endogenous sector defined above. Thus the question of how the commercial/industrial sector grows is essentially the same as how endogenous economic activity grows relative to total economic activity of the region.

There is substantial reason to believe that endogenous sector growth will occur at a somewhat greater rate than the exogenous sector. This is generally attributed to possibilities for import substitution that occur as the total level of economic activity, or the total market, grows. In other words, goods and services that historically were purchased from other regions can now be produced within the region because markets have become sufficiently large.

The significance of this for purposes of forecasting electric power demand is twofold. Firstly, the size of the commercial/industrial sector may not grow in direct proportion to total economic activity. Secondly, growth of the sector will probably be accompanied by changes in the composition of activity within the sector. This in turn suggests that demand for electric power may not vary directly with the size of the sector. This, of course, is a question that can be answered empirically (assuming that data can be found) and should be considered in demand forecasts.

Our discussion of demand forecasts for the commercial/endogenous industrial sector has suggested that the following factors should ideally be considered in the analysis of demand forecasts. First, at the micro, or individual firm level, sensitivity of demand to the price of electricity itself, the range and price of substitutes for electricity, and the importance of electric power costs relative to overall costs are of interest. At the macro or market level changes in the market itself must be considered, including the size of the market and changes in the composition of firms within the market.

Exogenous Industrial Demand

Exogenous industrial demand relates to potential or existing demand by major industrial firms producing primarily for export (from the economic region). Thus forecasting demand in this category is directly related to forecasting the development of new exogenous industrial activity.

A second issue arises in this instance that also must be considered. Industrial users of the type envisioned here generally have the option of producing their own power. This will be the case if the cost is comparable to purchased power, if significantly greater reliability can be achieved, or if purchased power is simply not available. Thus, the analysis of total demand for utility produced power will have to make an assessment of the competitiveness of that power relative to potential power generated by the industrial user.

Military Demand

Military demand for power is also exogenous demand. Historically the military has produced most of its own power requirements, and essentially has been an independent element in total electric power demand. In the past it is probable that the military has produced its own power for one of two reasons. Either "national security" motives dictated an independent system, or sufficient power was not available from local utilities.

Existing generating capacity appears to be sufficient to meet anticipated demand, at least to 1995, according to the ISER (Electric Power in Alaska: 1976-1995) study. Whether or not utility produced power could substitute for this power deserves to be considered however.

This somewhat detailed discussion of the economic determinants of demand for electric power serves two purposes. First, it provides an introduction to the subject for readers without a working knowledge of basic demand theory. Second, it provides a conceptual framework for the evaluation of existing electric power demand forecasts and for influencing future forecasts. Before turning to a review of existing forecasts we will attempt to summarize the elements of the framework for review.

1. Demand forecasts should be disaggregated to include at least four components, reflecting the different economic behavior of the different types of buyers. The components are: residential, commercial-endogenous industrial, exogenous industrial, and military.

2. Forecasts of residential demand should deal with the price of electricity, the price of substitutes, the price of complementary goods, per capita or household income, and measures of total market size such as total income or population, and the sensitivity, or elasticity of demand with respect to these variables. Because the forecasts are long run forecasts, emphasis on long run elasticities is appropriate. In particular, long run possibilities for energy substitution should be addressed.

3. Commercial-endogenous industrial demand forecasts should deal with the price of electricity and the price of other factors of production, the long run potential for factor substitution in response to changing factor prices and technological change, changing market size, and the composition of commercial and industrial activity within the sector over time.

4. With respect to exogenous industrial demand there appear to be three fundamental questions:

   a. What types of activity and what are the associated electric power requirements,

   b. If such industry locates within the region will they choose to supply their own power or buy from utilities, and

   c. To what extent will the availability and price of utility generated power be a factor in the industrial location decision?

5. Under what conditions would the military become a purchaser of utility power and how much would the military purchase?

In examining this framework for review it is clear that three variables play an important role in future demand. These are the price of electricity itself, the prices (and availability) of substitutes, and market size and composition. While other variables may also be important, it suggests that considerable effort be devoted to the analysis of the three variables cited.

One final issue that needs to be considered relates to the price of electricity itself. Our discussion has implied that there is a single price for electricity, and this clearly is not the case. Rather, there is a complex structure of prices, dependent upon the type of user and the quantity of electricity consumed. This fact introduces two problems related to forecasting future demand.

First, the structure of prices can be instrumental in influencing peak load demand, and hence the amount of generating capacity necessary to meet overall service requirements at given levels of reliability. This is essentially a question of the timing of demand over the short run.

Second, the level of aggregate demand will also be responsive to the structure of prices. In other words, price is a function of the quantity demanded. The result of this is that, conceptually, we do not have the single equation demand model as discussed above, but rather two simultaneously determined equations. From an empirical standpoint there may not be much that can be accomplished in attempting to deal with this problem, but it is a point that should be considered in the qualitative assessment of demand forecasts.

III. A Review of Electric Power Demand Forecasts

In this section several forecasts of electric power demand will be reviewed in the context of the discussion set forth in Part II. Before considering specific forecasts a few comments are necessary. First, regional comparability of the forecasts is not exact, but in general the aggregate region under consideration is the railbelt area. For present purposes this includes the Fairbanks area, the railbelt, Anchorage, and Southcentral Alaska. While the specific studies have different geographical boundaries, the dominant centers of population and demand are comparable. Second, the forecast periods are not always directly comparable, although in most cases the 1980-2000 period is covered.

A third point to note is that the various forecasts are not independent. Rather, what is observed are two "families" of forecasts, the first of which is an outgrowth of the 1974 Alaska Power Administration Alaska Power Survey study. The second group are based on economic forecasts prepared utilizing the Institute of Social and Economic Research (ISER) Man in the Arctic Program (MAP) econometric models. At least one recent forecast reflects a blend of the two approaches. We will first look at the APA family.

The first study considered is the 1974 Alaska Power Survey - Future Power Requirements: Report of the Technical Advisory Committee on Economic Analysis and Local Projections (Alaska Power Administration). The study will be referred to as the 1974 APS study for short.

Total annual demand estimates are developed for three components: utility, industrial (exogenous) and national defense, at both the statewide and regional levels. The two regions of interest in the present case are the Southcentral and the Yukon (interior) planning regions as delineated by the Alaska Power Administration (APA). While these regions extend beyond areas likely to be served by the Susitna project, the bulk of potential demand within the planning region is contained within the area of probable Susitna impact.

Exogenous industrial demand includes hypothetical major new industrial activity, related to resource extraction and processing, new energy-intensive industries, or heavy manufacturing. Low, mid-range, and high development scenarios are constructed, based upon a study prepared by the Alaska Department of Economic Development entitled "Power Demand Estimators, Summary and Assumptions for the Alaska Situation", by E. O. Bracken (1973). The derived power requirements, by year and industry type, are shown in Table III-1. It should be noted that these are statewide figures. However, the regional industrial annual demand for power (Table III-2) indicates that the bulk of the activity will be located in the Southcentral and Southeast regions. The high range estimate for Southcentral includes a uranium enrichment plant for 1990 and 2000 which accounts for about 65% of the total industrial power requirements.

Thus, for the year 2000, industrial demand has a range of 22,990 million KWH (MKWH) which, from a planning standpoint, is little or no help at all. Elimination of the enrichment facility (which many would agree is warranted) narrows the range to 5,470 MKWH. To put the figures in perspective, achievement of the high industrial demand figure for 2000, net of the uranium enrichment plant, implies an annual growth rate of over 12.7% per year from 1972.

Whether or not the implied rates of industrialization in the different scenarios will be achieved is at best a matter of speculation. Certainly

TABLE III-1

Assumed New Industrial Power Requirements, 1972-2000

Industry	Actual Requirements 1972 1000 KW	Estimated Future Requirements 1980 1000 KW	1990 1000 KW	2000 1000 KW
		Higher Range Estimate		
Timber	46	110	160	250
Mineral		360	3,870	3,990
Petroleum	58	160	260	560
Total	104	620	4,290	4,800
		Mid Range Estimate		
Timber		80	110	160
Mineral		120	360	1,300
Petroleum		130	160	260
Total		330	620	1,720
		Lower Range Estimate		
Timber		50	80	110
Mineral		60	120	360
Petroleum		100	130	160
Total		210	330	620

Note: Adapted from "Power Demand Estimators, Summary and Assumptions for Alaskan Situation," E. O. Braken, Alaska Department of Economic Development, April 1973.

"Petroleum" includes all petroleum and petrochemical industries.

Source: APS 1974, p. 84.

TABLE III-2

1974 ALASKA POWER SURVEY POWER DEMAND FORECASTS
1972-2000, in Million KWH

REGION	1972 (ACTUAL)	1980 LOW[2]	1980 MID	1980 HIGH	1990 LOW	1990 MID	1990 HIGH	2000 LOW	2000 MID	2000 HIGH
SOUTHCENTRAL										
Utility	1037	2340	2670	2990	4290	5350	7190	6430	9710	15740
Industrial	254	490	910	1820	910	1820	23340[3]	1820	5330	24810
National Def.	174	209	209	209	243	243	243	260	260	260
Total	1465	3039	3789	5019	5443	7413	30773	8510	15300	40810
YUKON (Interior)										
Utility	307	680	780	870	1200	1500	2020	1730	2610	4230
Industrial	-0-	210	280	490	280	490	1680	490	1680	2450
National Def.	235	253	253	253	284	284	284	317	317	317
Total	542	1143	1313	1613	1764	2274	3984	2537	4607	6997
"RAILBELT"[1]										
Utility	1344	3020	3450	3860	5490	6850	9210	8160	12320	19970
Industrial	254	700	1190	2310	1190	2310	25020	2310	7010	27260
National Def.	409	462	462	462	527	527	527	577	577	577
Total	2007	4182	5102	6632	7207	9687	34757	11047	19907	47807

Source: Computed from Tables 20, 21 and 23; 1974 APS.

Notes:
1. Railbelt is the sum of the Yukon (interior) and Southcentral planning regions of APA.
2. Low, Mid, and High refer to the lower, mid range and higher rates of growth cases as set forth in the 1974 APS study and described in the text.
3. This is not a typographical error. Rather it reflects a nuclear enrichment plant with an annual power demand of 17,520 million KWH, for 1990 and 2000.

the "high" case is closer to a wish list than to a projection. Even the low and mid-range cases are not assured. Industrial location decisions are extremely complex under the best of circumstances and there is no attempt at such analysis represented in the 1974 APS study. While some of the projects speculated about may occur there is no basis in the report to even guess as to which would occur. In particular, there is no consideration given to the role that the price of electricity (or other power) would play in the location decision.

Another concern that might be expressed with these estimates is that (implicitly) no adjustment has been made for changing efficiency of industrial use of electricity. To the extent that gains in efficiency are possible then the demand estimates will be overstated. Finally, if the concern of the forecasting effort is in part aimed at planning for future utility generated power requirements, then the study misses an important link. Specifically, what part of new industrial power demand would be served by the utilities?

Forecasts of demand for utility generated power were developed from forecasts prepared for each of the utilities. These individual forecasts fall in three categories: individual utility prepared forecasts; APA forecasts based on 1972 generation and assumed rates of growth; and utility estimates based on REA power requirements studies, and various consultants' studies. Individual utility forecasts generally covered the 1972-1982 period, but reflect a wide range of assumptions about future growth rates, future industrial development, etc. In other words, there is no homogeneity of assumptions common to each of the individual utility forecasts.

These forecasts were then aggregated to obtain a 1980 statewide mid-range estimate of demand that served as the basis for all other projections. The 1980 mid-range estimate of 4,100 MKWH implies a growth rate from 1972 of 12.3%. The 1980 higher rate of growth figure is 4,600 MKWH, which supposedly reflects the assumption that the high growth rate is 20% above the mid-range growth rate of 12.3%, or 14.8%, for the 1972-1980 period. However, the figures presented indicate a growth rate of 13.9%, or a high growth scenario 13% above the mid-range, not 20% as indicated. A similar discrepancy exists with the lower rate of growth, which appears to be 17% below the mid-range growth rate, not 20% as suggested in the report.

In any event, the 1980 demand estimates for each scenario were then projected to 1990 and 2000 using assumed future rates of growth, as summarized in Table III-3.

TABLE III-3

ASSUMED GROWTH RATES, UTILITY DEMAND:
1980-1990, and 1920-2000, 1974 APS STUDY

	1972-1980	1980-1990	1990-2000
High Range	14.8%	9%	8%
Mid-Range	12.3%	7%	6%
Low Range	9.8%	6%	4%

Source: 1974 APS, p. 71.

There is no pretention that these growth rates are anything more than "educated guesses". The fact that the rates drop substantially below the 1972-80 rates was in part due to an assumption of greater efficiency and conservation of electricity in the future. However, also buried in these figures are implicit assumptions about future population growth, future energy prices, saturation rates, etc., that make it impossible to make any real quantitative assessment of the forecasts. Statewide estimates were then disaggregated to the regional level. The disaggregation was accomplished by reference to historic trends in regional power markets over the 1960-72 period. No explicit account of any regional economic growth indicators is suggested, except as implied by historic electric power demand changes. See Table III-2 for relevant region forecasts.

In summary, there is no way to judge the "goodness" of the forecast in respect to any underlying economic considerations. While the 1980 base mid-range figure does reflect the collective judgment of the utility industry, and hence may be a reasonably accurate estimate, the rest of the "forecast" is pure assumption on an aggregate level and there is no way to assess the assumptions without more assumptions. While one of the forecasts may turn out to be reasonably accurate it will largely be a matter of chance.

The third component of demand is national defense demand. These forecasts were provided by the military, and reflect military produced power. (See Table III-2.) It is clear that military demand drops significantly as a proportion of total demand, even in the low growth rate case, and is not a significant factor in future demand.

Aggregate electric power demand for the regions in question is also indicated in Table III-2, and some general summary comments regarding the forecasts are necessary. First, there is no way to judge the quantitative validity of the forecasts based on material contained within the study. No links to future values of economic variables are established in the utility demand analysis. The industrial demand component of the analysis is really based on nothing more than a wish list of hypothetically possible future industrial development. Again, there is no analysis of the economic probability of such events occurring.

A further complication is that there is no way of determining from the study what proportion of future industrial demand might potentially be served by utility supplied power. In other words, what industrial projects will be so remote as to be unable to purchase power at competitive rates.

The 1974 APS study served as the basis for the next demand forecasts considered, contained in the Interim Feasibility Report: Southcentral Railbelt Area Alaska Upper Susitna River Basin, Appendix 1, Part 2 (Army Corps of Engineers, Dec. 1975) Section G - Marketability Analysis. This study will be referred to as the 1975 MA study.

The principal distinction between the two studies relates to the treatment of industrial demand, and remedies one of the deficiencies of the 1974 APS study. (See the Appendix for a history of industry assumptions.) In particular, future industrial demand was adjusted to include only those assumed projects that would be reasonably served by an interconnected railbelt power system. Minor adjustments to utility and military demand were also made to reflect 1973 and 1974 data not available at the time of the 1974 APS study. The results of these adjustments are summarized in Table III-4. The list of industrial projects and associated power demand is contained in the Appendix. Utility demand that would not be part of an interconnected railbelt system has also been eliminated. This adjustment eliminates remote cities and villages.

TABLE III-4

1975 INTERIM FEASIBILITY REPORT - MARKETABILITY ANALYSIS:
RAILBELT ELECTRIC POWER DEMAND FORECASTS 1974-2000, IN MILLION KWH

AREA	1974 (ACTUAL)	1980 LOW	1980 MID	1980 HIGH	1990 LOW	1990 MID	1990 HIGH	2000 LOW	2000 MID	2000 HIGH
ANCHORAGE										
Utility	1305	2410	2580	2850	4420	5210	6880	6570	9420	15020
Industrial	45	140	350	710	350	710	20390	710	2870	20460
National Def.	155	170	170	170	190	190	190	220	220	220
Total	1505	2720	3100	3730	4960	6110	27460	7500	12510	35700
FAIRBANKS										
Utility	330	610	660	700	1050	1270	1660	1530	2230	3500
Industrial	-	-	-	-	-	-	-	-	-	-
National Def.	197	220	220	220	240	240	240	260	260	260
Total	527	830	880	920	1290	1510	1900	1790	2490	3760
RAILBELT										
Utility	1635	3020	3240	3550	5470	6480	8540	8100	11650	18520
Industrial	45	140	350	710	350	710	20390	710	2870	20460
National Def.	352	390	390	390	430	430	430	480	480	480
Total	2302	3550	3980	4650	6250	7620	29360	9290	15000	39460

Source: 1973 Interim Feasibility Report, Marketability Analysis.

The effect of these adjustments is to reduce the range of forecasts by 6,590 million KWH of annual demand, but the range of the forecast is still extremely large (30,170 million KWH). If the assumption of the uranium enrichment plant is dropped then the range of forecasts narrows considerably. In the year 2000 the range would become 12,650 million KWH, and the total high demand figure becomes 21,940 million KWH.

While the 1975 MA study does adjust for utility and industrial demand that would not be served by a railbelt interconnected system, the principal deficiencies of the 1974 APS study remain. Utility demand growth is based upon assumed rates of demand growth and industrial demand is nothing more than a summation of hypothetical projects that may or may not occur. In short, there is no empirical link between the generalized discussion of possible future economic activity and the demand forecasts. Furthermore, the discussion of future economic condition is of such a general nature that widely different forecasts would be quite consistent with the same economic scenarios.

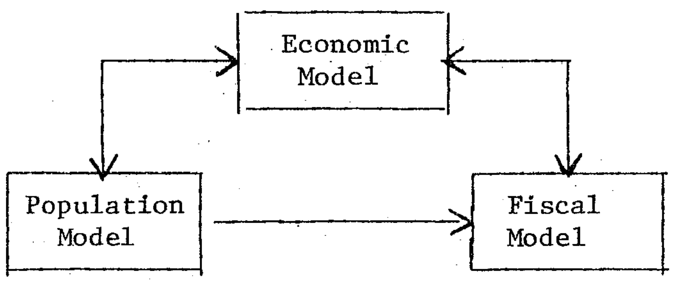
We now shift from APA forecasts to a consideration of forecasts developed using the MAP models of ISER. The initial study of concern is Electric Power in Alaska, 1976-1995: A Report for the House Finance Committee, Second Session, Ninth Legislature, State of Alaska (Institute of Social and Economic Research, University of Alaska; August, 1976). We will refer to this as the ISER 1976 study.

There are several steps involved in the process of developing these forecasts, but essentially it is a two stage process. First, economic forecasts are developed using the MAP regional model. Stage two links the economic forecasts to forecasts of future electric power demand, covering the period through 1995. It should be apparent that the forecasts are dependent upon both the economic forecasts and the conversion of economic forecasts to electric power demand, and both stages will be reviewed.

The forecasts of future economic activity are dependent upon two major considerations: the properties of the model itself, and the assumptions about exogenous economic activity in the future that in effect drive the model.

Let us first consider the model. To so do it must first be noted that the required economic model is a sub-model of a larger system involving (in addition to the economic model) a fiscal model and a population model. The three are interdependent, as shown schematically in Figure III-1.

FIGURE III-1



In essence, this states that the economic model receives input from the fiscal and population models, the fiscal model receives input from the economic and population models, and the population model utilizes input from the economic model, but not directly from the fiscal model. Thus, when we talk about the economic model we are really describing the interaction of three models. To simplify things somewhat we can describe the important linkages between submodels and then consider the economic model in more detail.

The population-economic model link is the source of population estimates that are of direct interest, and reflect both natural population change and migration induced by changes in economic conditions. The population estimates are also used by the economic model for purposes of computing various per capita values for economic variables.

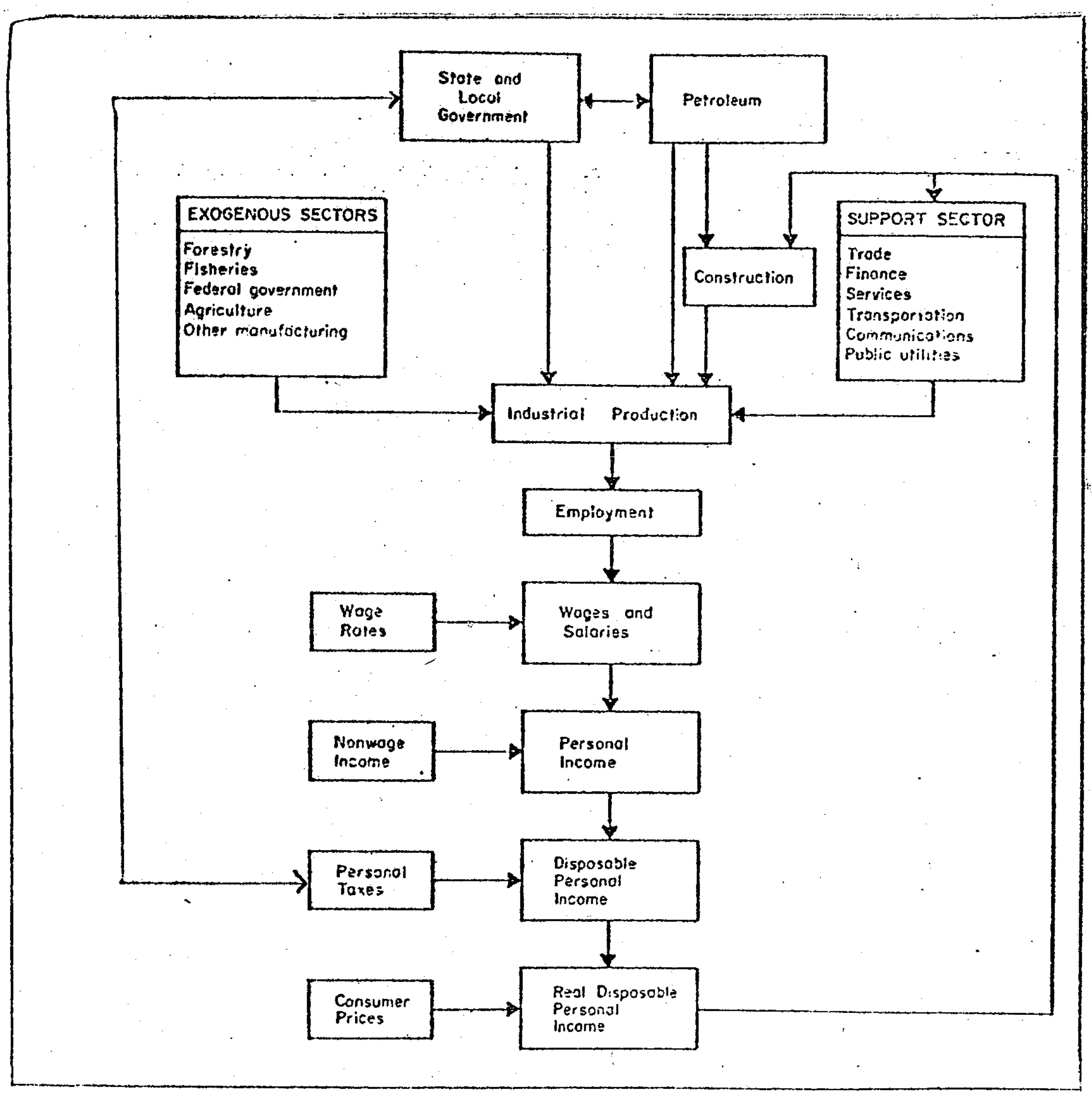
The significant link with the fiscal model relates to the role of state government expenditures as a source of major economic stimulus to the aggregate level of economic activity. In turn, state government (and local government) expenditures are dependent upon two key factors, the overall level of economic activity and the level of activity in the petroleum industry. The system allows for a variety of policy choices regarding state government spending and is one of the key points to consider in assessing economic forecasts.

We can now turn to a consideration of the economic model component of the system.

The MAP regional model belongs to a class of econometric models that are known as disaggregate economic base models. In essence, economic activity is classified as either endogenous or exogenous (or basic) (as described in Part II). Exogenous activity determines the level of endogenous activity, and the specific relationships between the two components of economic activity are what make up the system of equations that are the econometric model. These models can be quite simple or rather complex, and the MAP regional model falls in this latter category. It is possible to get a feel for the regional model by considering the MAP statewide model, which is structurally similar, but models the state as a whole, rather than by region. See Figure III-2.

FIGURE III-2

MAP STATEWIDE MODEL



Source: <u>Man-In-The-Arctic Program Alaskan Economic Model Documentation</u> (ISER, 1979).

As can be seen in Figure III-2, determination of industrial production involves the impact of exogenous sector activity, which includes forestry, fisheries, agriculture and other manufacturing, as well as federal government wages and salaries. Other exogenous sector activity includes the petroleum industry and components of contract construction such as major pipelines. State and local government expenditures may also be considered as exogenous for discussion purposes, although there is some interdependence between these expenditures and total economic activity. It should be noted that in constructing scenarios for forecasting or projection purposes it is primarily these exogenous variables that must be provided.

These exogenous variables combine with demand from the support sector and endogenous construction to generate total industrial production. Industrial production, through a series of steps, determines employment and income, and finally real disposable personal income, which in turn is a determinant of support sector and endogenous construction economic activity. This means that aggregate production depends on both exogenously determined and endogenously determined economic activity, where endogenous activity depends on total activity. As such, the system is a simultaneous equation structure.

It should also be noted that certain other variables enter the model as well. In particular, wage rates are used in determining total wage and salary payments, where the wage rates are in part dependent upon U. S. wage rates, which are determined exogenously. It should also be noted that the model is particularly sensitive to the wage rates used.

As stated earlier, the MAP regional model is structurally similar to the statewide model except that the model is disaggregated to seven regions. This means that scenarios (or future values for exogenous variables) must be specified on a regional basis and that forecasts of endogenous variables (such as income, employment, and population) will be generated on a regional basis. Otherwise the models are similar.

We can now consider the actual scenarios used and the forecasts of economic activity that resulted. There are three major elements to each scenario: (1) the level and composition of petroleum industry activity; (2) state government expenditure policy; and (3) assumptions about the exogenous sector activity. Two general scenarios were developed, where the only difference between the two was in the structure of the petroleum component.

The first petroleum scenario is referred to as the limited petroleum development scenario and is described as follows. (This is reproduced from the ISER 1976 Electric Power in Alaska Study, page 3-24.)

> Present developments are continued in Cook Inlet and Prudhoe Bay. Federal government activity is limited to leasing of Lower Cook Inlet and Federal areas in the Gulf of Alaska. The state and private interests (essentially the Native corporations) lease and develop in the areas adjacent to existing producing fields and near existing pipeline facilities. The state leases in the Beaufort Sea and North Slope Upland Area and Native leasing occurs in the North Slope Uplands as well as in the Yukon-Kandik and Copper River areas. Under this scenario, total production of oil rises from 2 million barrels/day in 1980 to nearly 3.6 million barrels/day by 1990. A gas pipeline is constructed from Prudhoe Bay through Canada. A LNG facility is constructed to process Gulf of Alaska gas.

The second scenario, titled the accelerated petroleum development scenario, is described as follows. (Same source.)

> The accelerated development case, in addition to all the activity in the limited development scenario, includes activities related to the opening of Naval Petroleum Reserve #4 for development by the Federal government. As a result of this, a second pipeline is constructed from the North Slope to carry oil on a route closely parallel to the existing trans-Alaska pipeline. Federal government activity includes further leasing in Lower Cook Inlet as well as the Bering Sea, the Beaufort or Chukchi Sea, and Pet 4. The state leases adjacent areas including the Gulf of Alaska, Beaufort/Chukchi, and west of Pet 4. Native leasing occurs on the North Slope in the vicinity of Pet 4. Oil production in this case rises from 2 million barrels/day in 1980 to 7.3 million barrels/day in 1990.

Other exogenous sector activity, primarily related to forestry, fisheries, non-petroleum mining, and other manufacturing, is not assumed to be a significant driving force in the economy. An initial growth rate of 6% for this sector declines to about 2.5% by the end of the 1975-1990 period. Hence, little, if any, of the industrial development assumed in the 1974 APS study is implicit in this scenario. This scenario was used with both the limited and accelerated petroleum development scenarios.

The third element of the scenarios, government expenditure policy, is generally as follows. (Pages 3-25 - 3-26, ISER 1976.)

> It is assumed that the structure of state and local taxation remains basically unchanged in the future, and that the pattern of total state and local government expenditures remains the same in terms of the proportion of the budget going into various categories. Nonpetroleum related revenues will be spent in the year they accrue. It is assumed that 25 percent of recurrent revenues in the form of royalties, production taxes, and property taxes will be saved after 1978 when Prudhoe Bay oil begins flowing. Of non-recurrent revenue, essentially the lease bonuses, 50 percent will be saved. The income from the reserve fund is spent as it accrues. Since state oil revenues are sensitive to the wellhead price of oil, this is assumed to be $5/barrel for all new reservoirs in the state.

These scenarios, when used to determine future values of endogenous variables (the "forecast"), are summarized in Tables III-5 and III-6.

TABLE III-5

SALIENT STATISTICS OF MAP PROJECTIONS

	Limited Development	Accelerated Development
1974		
Population (thousand persons)	350.659	350.659
Employment (thousand persons)	159.886	159.886
Wages and Salaries (real million $)	973.9	973.9
Petroleum Production (thousand b/d)	200	200
State and Local Government Expenditures (nominal million $)	793.2	793.2
1980		
Population (thousand persons)	456.927	471.429
Employment (thousand persons)	219.712	229.249
Wages and Salaries (real million $)	1,506.9	1,586.3
Petroleum Production (thousand b/d)	2,066	2,066
State and Local Government Expenditures (nominal million $)	1,973.3	2,058.1
1985		
Population (thousand persons)	547.913	614.811
Employment (thousand persons)	265.412	300.916
Wages and Salaries (real million $)	1,970.0	2,260.8
Petroleum Production (thousand b/d)	3,033	4,930
State and Local Government Expenditures (nominal million $)	3,408.8	4,084.4
1990		
Population (thousand persons)	641.344	738.004
Employment (thousand persons)	312.677	361.399
Wages and Salaries (real million $)	2,506.2	2,919.2
Petroleum Production (thousand b/d)	3,597	7,299
State and Local Government Expenditures (nominal million $)	5,026.1	6,197.1

Source: ISER 1976, p. 3-28.

TABLE III-6

(a) POPULATION FORECASTS, BY REGION, 1975-1990
(Thousands of Persons)
LIMITED DEVELOPMENT SCENARIO

Year	Anchorage	Other Southcentral	Fairbanks	Total of Regions
1975	163.9	53.6	57.8	275.3
1980	214.9	64.2	62.2	341.3
1985	272.0	78.8	70.0	420.8
1990	342.4	85.1	76.8	504.3

Source: ISER, Electric Power in Alaska, 1976-1995.

(b) EMPLOYMENT FORECASTS, BY REGION, 1975-1990
(Thousands of Persons)
LIMITED DEVELOPMENT SCENARIO

Year	Anchorage	Other Southcentral	Fairbanks	Total of Regions
1975	79.2	21.5	27.5	128.2
1980	104.9	25.4	29.8	160.1
1985	133.6	30.9	34.2	198.7
1990	168.5	32.9	37.8	239.2

Source: ISER, Electric Power in Alaska, 1976-1995.

We are now in a position to evaluate the economic forecasts generated by the model. Table III-7 contains some approximate values for 1980 population and employment which can be used for comparison to the forecasts.

TABLE III-7

APPROXIMATE VALUES FOR POPULATION AND EMPLOYMENT[1] (IN THOUSANDS), 1980

	Alaska	Anchorage	Fairbanks
Population	416	186	56
Employment	161	75	17

Source: Alaska Department of Labor. [1] Employment data are for December, 1979. Population data are for July 1, 1978, but are thought to approximate the current population levels.

It is clear that both the statewide and regional forecasts are high, both for the limited and accelerated cases. Statewide population forecasts for the limited and accelerated cases exceed estimated current population by 10% and 13% respectively. Comparable employment estimates are 14% and 20% high. The ISER employment projections include military employment and self-employed, while the data in Table III-7 include nonagricultural wage and salary employment only. The comparisons of employment forecasts have been adjusted accordingly. In the limited growth scenario Anchorage's population forecast is about 16% high, while that of Fairbanks is about 11% high. Employment projection errors were of the same approximate level of magnitude.

In evaluating these discrepancies two basic questions must be addressed: first, are the problems with the model itself, or second, are the errors due to the scenarios, or some combination of both factors? A review of the limited scenario for petroleum development indicates that current levels of activity have fallen short of those suggested in the scenario for 1980. The increased leasing of Native lands has not occurred, oil production is short of the 2 million barrels per day level, and the gas pipeline and LNG facility to process Gulf of Alaska natural gas have not materialized (for obvious reasons).

However, other factors may have occurred that would largely offset some of the "non-events" of the scenario. In particular, the wellhead price of oil is substantially above the 5 dollar per barrel assumed figure, and recent state government revenues have exceeded expectations of those held in 1976. It is not possible to determine if other assumed exogenous industry activity has grown at projected rates, but even if they have not, the missing impact should be slight. In the aggregate, however, it would appear that the limited scenario assumptions were not met, and at least some of the forecast error can be attributed to this cause.

Ongoing research with the MAP models (and in particular, the statewide model) has led to the conclusion that some of the error should be attributed to properties of the model itself. Earlier we noted some of the critical points of the model, and it is in these areas that some of the problems with the 1976 version of the model lay. The fiscal policy model linkages, depending upon the policy "rules" utilized, could lead to significant over-forecasting. A second point of concern was the sensitivity of the model to wage rates, and in particular the role of U. S. wage rates. Long run forecasts with the model (particularly in the later periods of a given forecast) seemed to over-respond to projected U. S. wage rates. In the early periods of the forecast this should not be a significant problem, nor an explanation of the present forecast error.

Two other questions about the properties of the model should also be noted. First, population is strongly affected by migration, and this has proved to be a difficult variable to forecast, both in terms of magnitude and timing. Lag effects on the down side of the boom period were not fully anticipated by the model. Second, there is a question as to whether the model adequately reflected the process of structural change and import substitution that occurred over the historical period and during the forecast period to 1980. It is not clear, however, that this difficulty would bias the forecasts upward, as appears to be the effect of the other problems noted.[III-1/]

In summary, several properties of the 1976 version of the MAP models have been noted which appear to have resulted in an upward bias to the forecasts. While it is not certain, it also appears that the effects tended to be cumulative (i.e., forecast error would tend to become proportionately greater in later time periods of the forecast). The only real test of this would be to reconstruct the scenario to fit what actually occurred and re-run the forecast. Aside from the cost of such an undertaking, there is a problem in terms of obtaining reliable data for some of the variables (especially population and some types of employment).

[III-1/] These criticisms of the model, it should be noted, have been provided in discussions with ISER personnel, and reflect the fact that the models have been subject to ongoing research and revision.

As noted above, the models have been updated and adjusted to compensate for at least some of the difficulties described above, and it is reasonable to expect that the long run forecasting properties have improved substantially.

The second major element of the electric power demand forecasts by ISER involves linking economic projections to electric power demand. Conceptually, the process can be described as follows:

Electric power demand = average consumption per customer X number of customers.

Where:
Number of customers = saturation rate X population.

The saturation rate is defined as the number of hookups divided by the population. Thus, forecasting demand is dependent upon forecasts of consumption per hookup, the saturation rate, and population.

In developing their forecasts, these variables were disaggregated by region and by type of customer. Three classes of customers were distinguished: residential, commercial/industrial, and other (primarily including government). It should also be noted that the study is projecting utility demand. Industrial demand is thus analogous to endogenous industrial demand. Specific demands for exogenous industrial demand are not estimated. Hence, such demand is only incorporated to the extent that the economic scenarios incorporate exogenous industrial demand. Implicitly, such demand would be met by utility generated power. The regions of interest in the present case are Fairbanks, Southcentral, and Anchorage.

The forecasts of residential demand involved a thorough analysis of both average consumption of electricity and saturation rates. Available data were rather exhaustively analyzed, particularly in respect to average consumption per customer. Analysis of elasticities suggested that consumption is responsive to changes in the price of electricity and to the level of income in the manner expected. A detailed analysis (relative to data availability) of other factors affecting demand was also carried out, considering such factors as geographic influences, electric appliance saturation levels, degree of electrification for space heating, etc.

Based on this analysis, four electrification scenarios were constructed: growth as usual, moderate electrification, low electrification, and no growth. The growth as usual case, based on regression analysis of historic data (implicitly assuming low electricity prices, increasing appliance stocks, and extensions of service to new customers at historic rates) resulted in projections of unrealistically high magnitudes, and are not considered further.

The moderate and low electrification scenarios incorporate assumptions regarding ceilings on new hookups (i.e., saturation rates) and higher future relative electric prices. The no growth scenario assumes no future growth in the average consumption per customer (implying rapidly rising electricity prices) and a ceiling on the saturation rate.

For commercial/industrial demand two scenarios were constructed, a <u>growth as usual</u> and a <u>minimum electrification</u> case. In the growth as usual scenario, both the number of customers and the use per customer were estimated using regression analysis, where the independent variables were either employment or wages and salaries for the region. The scenario probably overstates future demand, for reasons similar to those explored in the residential growth as usual case. The minimum electrification scenario assumes a reduced level of growth in average use, due to higher electricity prices, and a leveling off of the saturation rate.

The "other" demand component was estimated using regression analysis, where the independent variable was either population or employment. The regression equations were satistically good, and since this component of demand is relatively small, other scenarios were not constructed.

Eight electrification scenario combinations are possible, which, with two economic scenarios, yield sixteen different sets of possible forecasts. To simplify matters four electrification cases were selected. Case 1 combined residential growth as usual with commercial/industrial growth as usual. Case 2 reflects residential moderate electrification with commercial/industrial growth as usual. Case 3 combines residential low electrification with minimum commercial/industrial electrification. The final case explores no growth residential with minimum commercial/industrial electrification. The results of this effort are summarized in Table III-8. The accelerated growth economic scenario results are not included since it appears to be an improbable situation.

These results will be compared to other forecasts later in the chapter, but in passing it is worth noting that the rate of growth of demand decreases substantially in all cases (reflecting the declining economic growth rates of the economic forecast) and approaches the growth rates of the 1990-2000 period of the 1974 APS study for the low and mid-range cases. While these projections reflect a significant improvement in the quality of electric power forecasts for Alaska, certain questions regarding these forecasts should be raised.

First, assuming that the linkage components of the forecasts are accurate, the previously discussed tendencies of the economic model to

TABLE III-8

Utility Sales: Anchorage, South Central, Fairbanks Regions
(Millions of kWh)

Year	Case 1 Limited Development	Case 1 Accelerated Development	Case 2 Limited Development	Case 2 Accelerated Development	Case 3 Limited Development	Case 3 Accelerated Development	Case 4 Limited Development	Case 4 Accelerated Development
ANCHORAGE								
1974 (Actual)	867	867	867	867	867	867	867	867
1980	2,124	2,286	2,012	2,147	1,664	1,723	1,529	1,580
1985	3,734	4,822	3,245	4,076	2,550	2,924	2,347	2,679
1990	7,326	8,637	5,096	6,749	3,910	4,628	3,625	4,273
1995	10,633	15,350	7,982	11,514	6,071	7,416	5,679	6,918
FAIRBANKS								
1974 (Actual)	319	319	319	319	319	319	319	319
1980	631	658	598	616	485	495	446	455
1985	1,032	1,244	833	950	650	727	602	669
1990	1,534	1,891	1,090	1,256	861	977	803	907
1995	2,247	2,834	1,410	1,640	1,157	1,334	1,088	1,250
SOUTH CENTRAL								
1974 (Actual)	282	282	282	282	282	282	282	282
1980	762	933	717	849	563	612	503	544
1985	1,302	1,701	1,131	1,432	835	966	748	857
1990	1,659	2,178	1,390	1,774	1,087	1,267	987	1,142
1995	2,114	2,791	1,716	2,205	1,436	1,686	1,323	1,545
TOTAL								
1974 (Actual)	1,468	1,468	1,468	1,468	1,468	1,468	1,468	1,468
1980	3,517	3,877	3,327	3,612	2,712	2,830	2,478	2,579
1985	6,068	7,767	5,209	6,458	4,035	4,617	3,697	4,205
1990	9,519	12,706	7,576	9,779	5,858	6,872	5,415	6,322
1995	14,994	20,975	11,108	14,999	8,664	10,440	8,090	9,712

SOURCE: Electric Power in Alaska, 1976-1995.

overforecast suggest that the power demand forecasts may be high. Second, the range of forecasts is still substantial and it would be helpful if it were possible to be more selective in the choice of scenarios.

Narrowing the range of scenarios would require that more precise relationships between the demand for electricity and selected economic variables be established, and that more reliable forecasts of the relevant economic variables be developed. To some degree the latter problem has been addressed in the ongoing work on the MAP models. Whether or not significant improvements in the electric power demand linkages can be achieved without new data is another question.

We will conclude the review of forecasts by considering two final studies. The first is the Phase 1 Technical Memorandum: Electric Power Needs Assessment (Draft), Southcentral Alaska Water Resources Study (Level B), dated March 27, 1979. The second report is the Upper Susitna River Project Power Market Analysis, (U. S. Department of Energy, Alaska Power Administration) dated March, 1979. Upon inspection it is observed that the two studies (at least as far as power demand forecasts are considered) are essentially the same. Hence, only the latter study will be considered.

The demand forecasts are disaggregated into three components: utility demand, exogenous industrial demand, and military demand, by region. The regions considered are Anchorage-Cook Inlet and Fairbanks-Tanana Valley. The sum of the two regions is the "Railbelt" forecast.

The utility power demand forecasts are developed in two general steps. First, historic data covering a variety of dimensions of electric power production and use are analyzed, by region, to develop key ratios for forecasting purposes. From this analysis it is determined that the growth rate of net generation per capita ratio is suitable for forecasting purposes. Using historic growth rates, assumed future growth rates over the forecast period (1980-2025) are specified. These are presented in Table III-9.

TABLE III-9

ASSUMED GROWTH RATES IN NET GENERATION PER CAPITA (KWH/CAPITA) 1980-2025

Time Period	High	Mid	Low
1980-1985	4.5%	3.5%	2.5%
1985-1990	3.5%	3.0%	2.0%
1990-1995	3.0%	2.5%	1.5%
1995-2000	2.5%	2.0%	1.0%
2000-2025	2.0%	1.0%	0%

Source: 1979 Power Market Analysis (APA).

A 1980 low, high and mid-range projection of the KWH/capita figure is also developed, based on historic data analysis. The 1980 figures, when adjusted by the growth rates for Table III-9, provide estimates of KWH/capita for the respective forecast periods and assumed growth rates.

The second step of the forecast is to develop population projections for the respective high and low scenarios for each of the time periods. For the Anchorage-Cook Inlet region population estimates developed by ISER's regional model were used. These estimates were developed for the Southcentral Alaska Water Resources Study (Level B), and did not include a midrange scenario at the time the Power Market Analysis study was conducted, nor did it include estimates for the Fairbanks region. Fairbanks population estimates were obtained from a companion statewide forecast for the Southcentral Water Study, where the Fairbanks population was assumed to grow at the statewide rate. The population estimates are shown in Table III-10.

TABLE III-10

POPULATION ESTIMATES FOR THE RAILBELT AREAS
1980-2-25 (IN THOUSANDS OF PERSONS)

Year	Anchorage-Cook Inlet		Fairbanks-Tanana Valley		Railbelt	
	High	Low	High	Low	High	Low
1980	270	239	62	60	332	299
1985	320	261	77	68	397	329
1990	407	299	95	75	502	374
1995	499	353	114	82	613	435
2000	651	424	140	90	791	514
2025	904	491	179	99	1083	590

Source: Upper Susitna River Project Power Market Analysis, p. 34.

These population figures are not directly comparable to the population data of Table III-7. However, reference to the source document indicates that the population and employment projections for 1980, using the ISER model, are somewhat high. The low case population for Anchorage was estimated to be 205 thousand, and non-agricultural wage and salary employment was 84 thousand. When compared to the data of Table III-7 it appears that employment was overestimated by about 12%, while population was high by about 10%.

As was the case with the discussion of the 1976 ISER forecast the question is whether the error should be attributed to the growth scenario, to problems with the model, or to some combination of both. A review of the low case scenario suggests that part of the problem may be in overly optimistic assumptions. However, given that we are looking at, at most, a 2 year forecast, where presumably initial conditions were reflected by relatively current data, it is somewhat disturbing that the forecasts appear to be so high in the early period of the forecast. This would suggest that problems remain with the regional model.

There is another factor that may also be at work that should be mentioned. The ISER models are long run models, and may not capture the effects of short run variations in economic activity. In other words, the average long run accuracy of the models may be significantly greater than its accuracy for any specific year. In the present situation we simply do not have a long enough series of actual observations to test this hypothesis.

A final comment relates to the availability of current data by which to check model performance. Specifically, the data of Table III-7 are approximate. Modest errors in those data could substantially affect the size of our percentage error in forecasts computation.

To derive the utility electric demand forecasts, the KWH/capita ratio is multiplied by the population estimates. This was done for each scenario (high, mid, low KWH/capita factors) and the high and low economic scenarios. Of the six possible cases only the results of two were presented; the high-high and low-low. The mid-range was estimated as the average of the two.

The exogenous industrial demand was estimated using the techniques of the 1975 MA study, as modified in Alaska Electric Power: An Analysis of Future Requirements and Supply Alternatives for the Railbelt Region (Battelle Pacific Northwest Laboratories, for the Alaska Division of Energy and Power Development, March, 1978).[III-2/] The list of assumptions and projects utilized is included in the appendix. In general, the high scenario includes a broad range of new industry activities, including an aluminum smelter (or other energy intensive industry) utilizing up to 280 MW of peak power. The low range is substantially more modest but still appears optimistic.

Military (national defense) demand is also assumed to grow at specific rates (1% for the high case, -1% for the low case, and 0% for the mid-range case). This demand decreases in significance over time.

The forecasts for components of demand, by region, and for the railbelt are presented in Table III-11. Several comments are in order regarding these forecasts. First, there remains the question with regard to the population forecasts. To the extent that these are overstated, then the utility demand forecasts (assuming the accuracy of the KWY/capita ratio) will be overstated. Second, the assumed KWH/capita ratios reflect a broad array of assumptions about future energy use, including future prices of electricity, gains in efficiency, and gains from conservation. While the assumptions appear reasonable, there is still no underlying empirical analysis that would help choose among alternatives. In other words, explicit links between economic variables and the demand for electricity are not established.

[III-2/] The report contains a useful comparison of several of the power demand forecasts reviewed in this study, but does not develop significantly different forecasts of its own, and was therefore not included in the present study.

TABLE III-11

RAILBELT ELECTRIC POWER DEMAND, 1979 POWER MARKET ANALYSIS STUDY
1980-2025 (MILLION KWH)

Region	1980		1990		2000		2025	
	Low	High	Low	High	Low	High	Low	High
ANCHORAGE-COOK INLET								
Utility	2300	2720	3590	6630	5770	13920	6670	31700
Industrial	141	170	370	2100	550	3590	1310	8490
National Defense	127	135	115	140	104	165	81	211
Total	2568	3025	4075	8879	6424	17675	8061	40401
FAIRBANKS								
Utility	620	690	960	1570	1300	3000	1440	6320
National Defense	46	49	42	54	38	59	29	76
Total[1/]	666	739	1002	1624	1338	3059	1469	6396
RAILBELT[2/]								
Utility	2920	3410	4550	8200	7070	16920	8110	38020
Industrial	141	170	370	2100	550	3590	1310	8490
National Defense	173	184	157	203	142	224	110	287
Total	3234	3764	5077	10503	7762	20734	9530	46797

Source: Upper Susitna River Project Power Market Analysis (APA, 1979).

[1/] No industrial demand indicated for Fairbanks region.

[2/] Sum of Anchorage-Cook Inlet and Fairbanks.

Finally, the exogenous industrial demand component is of little use for planning purposes. There is no basis for deciding what specific projects would reflect potential buyers from utilities. Whether or not the availability of power at specific prices would affect industrial location decisions is also not addressed.

It should also be observed that there is at least a minor problem of double counting implied in the analysis. Specifically, the high industrial scenario and the high ISER scenario overlap. The result is that industrial demand in the ISER scenario results in population increases which lead to increased demand for utility supplied power. This demand should be netted out of the industrial scenario.

To summarize this lengthy discussion of power demand forecasts Table III-12 has been compiled. It presents the forecasts of the four major studies considered for the common period of the forecasts (1980-2000). Demand by type for the high and low cases, for the railbelt area of each study, provides the basis for comparison.

With respect to utility demand forecasts there is reasonably good agreement among the forecasts, although to some extent this is a result of the interdependence of the 1974 APS and 1975 Market Analysis study, and the somewhat lesser interdependence of the 1976 ISER and 1979 Power Market Analysis studies. However, the range between high and low cases is still large enough to present real problems in terms of planning.

The disparities among the industrial forecasts is much greater, particularly with respect to the high scenarios. Again, this presents major difficulties for long run planning.

More generally, there are several comments that should be made in

TABLE III-12

COMPARISON OF FORECASTS
(MILLION KWH)

"Railbelt" Region	1980		1990		2000	
	Low	High	Low	High	Low	High
1974 APS						
Utility	3020	3860	5490	9210	8160	19970
Industrial	700	2310	1190	25020	2310	27260
Total 1/	4182	6632	7207	34757	11047	47807
1975 MARKET ANALYSIS						
Utility	3020	3550	5470	8540	8100	18520
Industrial	140	710	350	20390	710	20460
Total 1/	3550	4650	6250	29360	9290	39460
1976 ISER 2/						
Utility	2478	3517	5415	9516	11849	23521
1979 POWER MARKET ANALYSIS						
Utility	2920	3410	4550	8200	7070	16920
Industrial	141	170	370	2100	550	3590
Total 1/	3234	3764	5077	10503	7762	20734

Source: Computed from Tables in text.

1/ Total includes national defense.

2/ ISER 2000 data extrapolated at the 1985-1995 growth rate.

attempting to summarize and evaluate the forecasts. In Part II of the paper evaluation criteria were suggested and it is worth reflecting on these. The first suggested that demand should be considered on a disaggregate basis. To some extent this has been the case, although the disaggregation has not always been carried out to the level desired. In particular, the commercial/endogenous sector has generally received insufficient analysis. A primary obstacle to this has been a lack of data. This suggests that future analyses may have to address the problem directly.

The second point of reference focused on the relationship of economic variables, both of a micro and macro nature, that influence demand. Only the ISER 1976 study addressed this problem directly. Difficulties with data again were a major problem, and while much of the analysis was productive, subsequent efforts have not built in those results.

As a consequence, we still do not have quantitative knowledge as to how demand is going to respond to future electric prices, and at least as serious a problem is that no effort has been devoted to the analysis of future electric prices or prices of alternative energy sources. The problem has been "assumed" away, perhaps with reasonable assumptions, but nevertheless, with assumptions.

Equally serious is the fact that the analyses are also generally lacking with respect to other key factors influencing future demand. In particular, gains in efficiency and gains from conservation efforts are treated by assumption. It is of course much easier to point out the problems than to deal with them, but the deficiencies remain, and are potentially serious.

Finally, the question of future industrial demand is dealt with in a totally unsatisfactory manner. Constructive forecasting of industrial demand must come to grips with the whole problem of industrial location decisions. Under what conditions will industry locate in the railbelt area and will the industries be buyers of utility produced power? Until such questions are addressed seriously aggregate power demand forecasts will be of little use for decision making.

PART IV. THE LATEST PROJECTIONS

As part of the Susitna Power Alternatives effort, ISER has undertaken a major effort to improve both the methodology and quality of electric power demand forecasts for the railbelt area. The present section of this review will consider two documents that are presently available reporting on the study effort. These are:

1. Electric Power Consumption for the Railbelt: A Projection of Requirements - Executive Summary, by Scott Goldsmith and Lee Huskey; Institute of Social and Economic Research (May 16, 1980).

2. Electric Power Consumption for the Railbelt: A Projection of Requirements - Technical Appendices, by Scott Goldsmith and Lee Huskey; Institute of Social and Economic Research (May 23, 1980).

In the following discussion, three major tasks will be undertaken. First, we will attempt to provide a cohesive overview of the methodology and assumptions underlying the study. Second, the projections will be reviewed. Third, these projections will be compared to those developed in earlier studies.

The methodology underlying the present study is based upon two major components. The first of these utilizes the MAP econometric model to generate regional estimates of population, employment, and household formation. From these estimates regional housing stocks are projected. These estimates in turn serve as the building block for the second major component - the end use model.

The end use model projects demand for electric power by disaggregating demand into several components, including household consumption, commercial-industrial consumption, and other comsumption. Particular emphasis is placed on household consumption, which is further disaggregated by type; space heating, major appliances, small electric appliances, and lighting. By following this approach it is possible to incorporate a substantial amount of information regarding factors affecting electric demand, by end use. It also imposes major data requirements.

The above provides only a general description of the methodology. To more accurately access the overall approach it is necessary to consider the components in some detail. The basic element of the economic projection is the MAP model. This has already been described in detail in Part III. Comments here will be limited to changes that have been made for the present study.

Several changes have been made in the basic model itself. First, it has been updated by re-estimating equations to include 1978 data and to include revised time series. Second, some equations have been respecified to deal with problems that were noted in our earlier discussion of the model. These include changes related to exogenous wage rates and production. Third, the fiscal model component has been adjusted to reflect recent changes in State tax laws and operation of the Permanent Fund.

Other modifications and additions need to be noted. A household formation sub-model has been added which generates projections of household formation at the statewide level. Next, a regional allocation model has been developed that disaggregates statewide projections of employment, population, and households to regional levels. This modification was developed to provide a more satisfactory process for regional disaggregation than could be achieved using the earlier regional econometric model.

Finally, the model has incorporated a housing stock model that utilizes the regional household formation estimates to generate estimates of regional housing stocks. The housing stocks are disaggregated into one family, duplex, multifamily and mobile home units.

Utilization of the model involves three major sets of assumptions. The MAP model itself is dependent upon the assumed exogenous economic scenarios and the fiscal policy assumptions. The sub-models, and in particular, the household formation and housing stock models are dependent upon a sizable set of parameters, some of which are set by assumption.

The present study, as was the case with earlier ISER studies, utilizes low, moderate, and high economic scenarios for the 1980-2000 period, and utilizes assumed growth rates for the period after 2000. It is impossible to summarize the scenarios (they are contained in the Technical Appendices). However, it should be noted that the scenarios do reflect a broad spectrum of judgment of individuals involved in the analysis of state economic activity, both private and public. They appear to reasonably bracket probable ranges of development.

Three fiscal policy scenarios were also utilized in initial projections, but for power demand projections only one was used. It assumed that real per capita state expenditures increase at the same rate as real per capita income. This was the "middle" assumption, and may turn out to be somewhat conservative.

Parameters related to the household formation and housing stock sub-models were based on a thorough analysis of available information. In many instances such information was dated or of limited quality. In view of the circumstances there is not much that can be done until better information becomes available. Furthermore, while inaccuracies may affect the allocation of demand, they probably do not affect the aggregates seriously.

We can now turn to the second major element of the methodology, the end use model. As explained above, the end use model builds an estimate of total demand by aggregating demand for detailed end use components. Three broad catagories are treated and will be looked at in some detail. The first covers household demand, including space heating, major appliances, small electrical appliances, and lighting.

Demand for space heating will be dependent on a broad array of factors including, for example; the mode split (electric versus other types), size and type of dwelling, effeciency, and heating degree days. Projections must reflect how each of these variables will change over time (with the exception of heating degree days, which can be assumed constant). Projections of the housing stock are provided by the model, but the mode split and effeciency are projected independently.

Determination of electric power demand for major appliances is carried out in a somewhat similar fashion. Nine major appliances are included, such as; water heater, cooking range, refrigerator, freezer, dishwasher, etc. Several variables are involved in projecting demand, including (for each type of appliance, by region) mode split, change in effeciency, average annual consumption, the saturation rate, the number of households, and the average size of households. Because the demand for electricity also depends on the composition of the stock of appliances this must also be incorporated. While the housing stock and size distribution is obtained from the MAP model component several of the other parameters must be supplied independently. Small appliances and lighting demand are treated in much less detail.

It should be clear from the above discussion that the data requirements of the household component of the end use model are substantial. The Technical Appendices provide a detailed analysis of both the parameters used and the sources of the parameter estimates. Not surprisingly, major data gaps existed, not only at the regional and statewide level, but nationally.

The commercial-industrial component of end use was treated at a much greater level of aggregation. Basically, this involved looking at power consumption per square foot of commercial-industrial floor space, or at power consumption per employee. While greater disaggregation, that would reflect differences in demand by type of industry would be desired, data simply do not exist that would permit this analysis. However, design and effeciency targets were assumed that would reflect possible improvements due to conservation efforts.

The study also provides estimates of military net generation and self-supplied industry net generation. Both components are included as exogenous. The military estimate assumes that present levels of net generation will hold for future years.

Self-supplied industrial demand was projected for the low, medium and high scenarios, based on four specific projects. These were the Pacific Alaska LNG terminal, the Alpetco Refinery, Cook Inlet Oil Development, and Fairbanks petrochemical production. It should also be noted that the Northwest Alaska Gas Pipeline project, the State Capitol move, and Beluga coal development were incorporated in the utility sales forecast.

We can now turn to a discussion of the forecasts. This will be done in two steps. First, projections of the MAP model itself will be considered. Second, the electric power demand forecasts generated by the end use model will be reviewed.

As discussed earlier, three economic/fiscal scenarios were utilized to generate projections of population, employment, and household formation. The "medium" fiscal scenario was used in each case, in conjunction with the low, middle, and high economic scenarios. It should be re-emphasized that this approach was used for the 1980-2000 period only.

To place these projections in perspective, they are compared to earlier projections developed by the MAP model. Table IV-1 compares statewide projections for the 1980-1990 period, based on the ISER 1976 and 1980 studies. Two conclusions are immediately apparent. First, the 1980 figures for the

TABLE IV-1

COMPARISON OF ISER 1976 and 1980 STATEWIDE POPULATION AND EMPLOYMENT PROJECTIONS, LOW SCENARIO
(in thousands)

	1976 ISER		1980 ISER	
Year	Population	Employment	Population	Employment
1980	456.9	219.7	421.7	210.0
1985	547.9	265.4	481.3	243.7
1990	641.3	312.7	511.6	254.5
Annual Growth Rate	3.4%	3.6%	1.95%	1.94%

Source: Computed from Table III-5 and Tables C.10 and C.11, ISER, 1980.

TABLE IV-2

COMPARISON OF RAILBELT POPULATION PROJECTIONS: 1979 POWER MARKET ANALYSIS AND ISER, 1980 STUDY; LOW AND HIGH SCENARIOS
(in thousands)

	Power Market Analysis		ISER 1980	
	Low	High	Low	High
1980	299	332	278	278
1985	329	397	319	354
1990	374	502	340	403
1995	435	613	375	480
2000	514	791	422	546
Annual Growth Rate	2.72%	4.4%	2.1%	3.4%

Source: Computed from Table III-10 and Tables C.13 and C.14, 1980 ISER Study.

1980 study are about 8% lower than in the 1976 study. Second, the rate of growth of population and employment are substantially less. One result of this is that the 1990 projections for the current study are about 20% below the 1976 study projections. While part of this difference can be attributed to differences in the scenarios for the two studies, it appears that a substantial part of the difference is also due to respecification of the model. It should also be noted that the 1980 study initial projections start with relatively current data, whereas the 1976 study projections reflect a five-year forecast.

Table IV-2 compares railbelt population projections for the period 1980-2000, based on the 1979 Power Market Analysis report and the 1980 ISER Study. Similar differences exist again. The base period estimates are lower and the average annual growth rates are less in the 1980 ISER Study than in the 1979 Power Market Analysis. Again this reflects differences in the scenarios, in which the 1980 ISER scenarios are probably somewhat more conservative. More importantly, however, the projections reflect the effects of respecification.

There is no way to measure the accuracy of the new forecasts. However, from a judgmental perspective, it would appear that the new estimates are an improvement. First, the projections are somewhat more consistent with the long run history of the state. Second, re-estimation of equations with more recent data should tend to reduce potential upward bias due to pipeline construction. Third, respecification of problem equations with better information should improve the predictive accuracy of those equations.

While the performance of the model has probably been improved, it should be re-emphasized that the projections are dependent upon the given economic and fiscal scenarios. It has already been indicated that the economic scenarios have been developed with considerable care and review. One question that should be raised concerns the fiscal scenario. In particular, the use of the middle fiscal scenario should at least be reviewed in light of the current legislative session.

It is not possible to compare prospective levels of State government spending for the coming fiscal year directly with the middle fiscal policy scenario. Neither is it possible to predict whether or not future Legislatures will maintain presently indicated patterns. However, it is not unreasonable to guess that if future years reflect the current year, that the high fiscal scenarios might be more appropriate.

The impact of this can be substantial. For example, the low economic/ moderate government scenario yields a population fo 636 thousand (statewide) in the year 2000, a growth rate of 2.1%. The low economic/high government scenario results in a population of 680 thousand, and a growth rate of 2.4%. In the case of the high economic/moderate government scenario population is 831 thousand in the year 2000. The high economic/high government scenario yields a population of 908 thousand. The respective growth rates are 3.4% and 3.9%. Clearly the choice makes a significant difference.

Let us now look at the electric power demand forecasts. Table IV-3 reproduces the summary forecasts of the study. More detailed estimates by utility sales components are not available, although hopefully they will be included in the final report.

TABLE IV-3

TABLE B. PROJECTED ELECTRIC UTILITY SALES AND MILITARY PLUS SELF-SUPPLIED INDUSTRIAL NET GENERATION (10^3 MWh)

Year	Utility Sales: Anchorage	Utility Sales: Fairbanks	Utility Sales: Anchorage+ Fairbanks	Utility Sales: Glennallen-Valdez	Total Utility Sales	Military Net Generation	Self-Supplied Industry Net Generation
1978	1,747	427	2,174	38	2,212	334	414
1980	1,907	446	2,353	37	2,390	334	414
1985							
L	2,249	619	2,868	53	2,921		414
M	2,438	669	3,107	64	3,171	334	571
H	2,676	769	3,445	116	3,561		847
M-E	2,438	669	3,107	64	3,171		571
1990							
L	2,510	666	3,176	60	3,236		414
M	2,782	742	3,524	75	3,599	334	571
H	3,249	914	4,163	119	4,282		981
M-E	2,782	742	3,524	75	3,599		571
1995							
L	3,097	813	3,910	66	3,976		414
M	3,564	949	4,513	88	4,601	334	571
H	4,438	1,227	5,665	124	5,789		981
M-E	3,564	949	4,513	104	4,617		571
2000							
L	3,981	1,040	5,021	80	5,101		414
M	4,451	1,177	5,628	102	5,730	334	571
H	5,519	1,537	7,056	136	7,192		981
M-E	4,973	1,416	6,389	136	6,525		571
2005							
L	4,375	1,154	5,529	88	5,617		414
M	5,226	1,397	6,623	119	6,742	334	571
H	7,013	1,988	9,001	176	9,177		981
M-E	6,220	1,834	8,054	165	8,219		571
2010							
L	4,807	1,277	6,084	95	6,179		414
M	6,141	1,671	7,812	140	7,952	334	571
H	8,927	2,586	11,513	223	11,736		981
M-E	7,624	2,318	9,942	200	10,142		571

L = Minimum economic growth

M = Likely economic growth

H = Maximum economic growth

M-E = Likely economic growth with shift to electric space heat and appliances in residential sector

Source: ISER 1980, Executive Summary.

Before comparing these forecasts to others, a few comments are in order. While we are relatively comfortable with the economic projections, with the exception of the question raised in regard to the choice of the fiscal scenario, it is difficult to evaluate the results of the end use model. First, the model requires an extremely detailed set of parameters and assumptions. The data requirements to estimate the parameters are large, and the quality of the data was often lacking. Even so, the parameter estimates were researched in as great detail as possible, and there were no gross errors apparent.

A second question relates to the effect of collective errors in the parameters as opposed to individual errors. Intuitively, one can appeal to the law of large numbers and assume that errors in parameters tend to be self canceling. However, there is no guarantee that this will be the case.

One approach to resolving the question is sensitivity analysis. Basically this consists of varying the parameters, one by one, by a specified percentage, and comparing the before and after projections. Practically speaking, such a process would be extremely costly given the number of parameters involved. An intermediate solution is to judgementally select those parameters that can be expected to have the greatest effect and test those. No sensitivity analysis has been carried out, or at least none has been reported to date.

Before turning to a comparison of the various studies, it is appropriate to return to the question of the choice of fiscal scenarios. In particular, it is of interest to consider utility demand under the high government scenario. The study does not report power demand for the high government scenarios, but we can at least estimate these by using the population estimates that were generated. For example, under the high economic/moderate government scenario per capita electric consumption for the railbelt was 12.9 thousand KWH per year for the year 2000.

Population for the railbelt under the high/high scenario was approximately 597 thousand in 2000. Hence the estimate of power demand is about 7701 thousand MWH. This is about 9% above the high economic/moderate government projection of 7056 thousand MWH. Thus, the understatement does not appear serious if the wrong scenario has been selected.

Let us now look at a comparison of the 1980 ISER projections with those of earlier studies reviewed. Table IV-4. Several observations can be noted immediately. First, the base year (1980) utility demand figures are substantially below all of the other studies except the low scenario of the 1976 ISER study. Second, the rate of growth of both the low and high scenarios is substantially below that of any of the other studies. In fact, the high scenario growth rate is generally close to the low scenarios in the other studies. Third, the range between the high and low projections has been drastically reduced. Finally, the self-supplied industrial component is only a small fraction of that in the earlier studies that specifically identified that component.

There are two general reasons that might explain these major changes. First, the aggregate level of economic activity, and in particular population and employment is lower in the ISER 1980 study than in previous studies. Second, the difference may be attributed in part to differences in per capita consumption of electricity. While we cannot directly determine which of these factors is responsible for a particular share of the change in the projection,

TABLE IV-4

COMPARISON OF FORECASTS
(MILLION KWH)

"Railbelt" Region	1980 Low	1980 High	1990 Low	1990 High	2000 Low	2000 High	Average Annual Growth 1980-2000 Low	Average Annual Growth 1980-2000 High
1974 APS								
Utility	3020	3860	5490	9210	8160	19970	5.1%	8.6%
Industrial	700	2310	1190	25020	2310	27260	6.5	13.1
Total 1/	4182	6632	7207	34757	11047	47807	5.0	10.4
1975 MARKET ANALYSIS								
Utility	3020	3550	5470	8540	8100	18520	5.1	8.6
Industrial	140	710	350	20390	710	20460	8.5	18.3
Total 1/	3550	4650	6250	29360	9290	39460	4.9	11.3
1976 ISER 2/								
Utility	2478	3517	5415	9516	11849	23521	8.1	10.0
1979 POWER MARKET ANALYSIS								
Utility	2920	3410	4550	8200	7070	16920	4.5	8.3
Industrial	141	170	370	2100	550	3590	7.0	16.5
Total 1/	3234	3764	5077	10503	7762	20734	4.5	8.9
1980 ISER STUDY 3/								
Utility	2353		3176	4163	5021	7056	3.9	5.6
Industrial 4/	359		359	675	359	675	0.0	3.2
Total 1/	3101		3869	5172	5714	8065	3.1	4.9

Source: Computed from Tables in text.

1/ Total includes national defense.

2/ ISER 2000 data extrapolated at the 1985-1995 growth rate in the 1976 ISER study.

3/ Excludes Glennallen-Valdez

4/ Excludes Glennallen-Valdez

it is possible to make some indirect estimates of the relative importance of each.

The approach that has been followed in doing this is as follows. Railbelt per capita consumption of electric power was estimated, using the demand and population figures of the 1980 ISER study. This was done for the high and low scenarios. These per capita figures are then multiplied by the population figures of the 1979 Power Market Analysis. If the differences in demand are due solely to differences in population levels then we should get demand estimates equivalent to those in the 1979 Power Market Analysis. Inspection of Table IV-5 reveals that this is not the case.

TABLE IV-5

COMPARISON OF ISER 1980 ADJUSTED AND 1979 POWER MARKET ANALYSIS PROJECTIONS (MILLION KWH)

Period	ISER 1980		ISER 1980 Adjusted		1979 Power Market Analysis	
	Low	High	Low	High	Low	High
1980	2353	2353	2530	2809	2920	3410
1990	3176	4163	3493	5171	4550	8200
2000	5021	7056	6117	10204	7070	16920

Source: Computed by Author. See text for details.

Rather, a major difference in the two sets of projections must be attributed to differences in per capita consumption, since less than 1/3 to 1/2 of the variance is explained by differences in population levels. It is not possible to pinpoint the sources of these differences, but two general factors appear to be at work. First, the per capita consumption for 1980 in the 1979 Power Market Analysis is about 9.77 (thousand KWH) as opposed to 8.46 in the 1980 ISER study.

Since the ISER 1980 study had access to more recent data on both population and power consumption, the estimate is presumably more accurate. The net effect is that the 1980 ISER projections start from a lower base and a lower implicit per capita consumption figure.

The second factor is the growth rate of per capita consumption. For the low scenarios of both studies the average annual growth rate of per capita consumption is about 1.7%. However, in the high scenario of the 1979 Power Market rate is about 3.7%, while for ISER 1980 it is about 2.1%. This, in conjunction with the lower base year figure explains the major differences. It does not, however, explain why the rates are so different. The 1979 Power Market rates were set by assumption, and the low case appears to conform well with the ISER results. The same is not true with respect to the high scenario. Since the ISER 1980 study reflects extensive and thorough analysis of a broad range of factors influencing demand (and per capita consumption) considerably more weight should be given to those results than results based on pure assumption.

The majority of our discussion has focused on a comparison of the 1979 Power Market Analysis and the ISER 1980 study. This was due mainly to the recency of the Power Market study and the comparability of some of the methodological components. In addition, as discussed before, the methodological credibility of some of the earlier studies is open to question.

In summary, the 1980 ISER Study reflects a substantial improvement in the level of power demand projections. This stems both from improvements in the MAP model itself and from the development and utilization of the end use model. The projections certainly reflect a degree of "reasonableness" that has been lacking in earlier studies. At the same time questions do remain, both with respect to the ISER 1980 effort and more broadly with the question of future demand in general.

PART V. SUMMARY AND CONCLUSIONS

The present paper has attempted, in relatively non-technical terms, to provide economic framework within which to review the major electric power demand forecasts for the railbelt region of Alaska. In addition, those studies have been reviewed and evaluated in the context of that framework. In general those studies reflect a progression in both methodological approaches and the inclusiveness of analysis. This is not to suggest that all questions and issues have been resolved.

There are several points that should be mentioned. First, it is worth re-emphasizing some of the comments at the close of Part III. The response of future demand to changes in prices and income is still not known, nor has there been a detailed analysis of possible future electricity prices. Whether efforts to obtain such information is warranted may be a question, since in the absence of major changes in relative prices impacts on aggregate demand might be modest in any event.

Second, with respect to the ISER 1980 study, the two principal questions relate to the choice of the fiscal scenario and the sensitivity of the end use model to parameters used.

A third, and continuing concern centers on treatment of exogenous industrial demand. While the ISER 1980 study reflects a reasonable set of assumptions related to exogenous industrial demand, the central question is not addressed. Specifically, for what industries, and at what prices, would availability of electric power be a significant factor in the location decision, and hence on total demand for electric power?

With these comments in mind, what can be said about the use of these projections in regard to the Susitna proposal? Clearly, accurate demand projections are an essential element in the overall analysis. The ISER 1980 projections appear to be sound, and with some further analysis should provide a reasonable guideline for planning purposes. The primary point of concern relates to exogenous industrial demand. If "low cost" power were to be a significant factor in the location decision and major exogenous demand were to materialize, it would seriously understate aggregate power demand.

This may or may not be a serious problem. If utility demand, as projected, appears sufficient to absorb the bulk of the Susitna project output, then in one sense the exogenous demand question is moot. In the broader context of planning for total railbelt power needs, the exogenous industrial demand issue remains significant.

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Table 12. Assumed Industrial Development

INDUSTRY	RATE OF GROWTH	ASSUMPTION
Kenai Peninsula:		
Chemical Plant:	Low	Existing, with planned expansion by 1980, then, no change to 2000.
	Mid	Existing, larger expansion assumed by 1980, continued expansion to 2000.
	High	Existing, largest yet expansion assumed by 1980, larger expansion to 2000.
LNG Plant:	Low	Existing, with no change assumed to 2000.
	Mid	Existing, no change before 1980, steady expansion thereafter.
	High	Existing, expansion assumed before 1980 and continuing to 2000.
Refinery:		Existing, plus same assumptions as LNG plant.
Timber Processing:	Low	Small start before 1980, expansion to high value by 2000.
	Mid	Larger start before 1980, expansion to high value by 1990.
	High	Largest start before 1980, no change to 2000.

U. S. Corps of Engineers
1975 Interim Feasibility Report

Table 12. Assumed Industrial Development

(continued)

INDUSTRY	RATE OF GROWTH	ASSUMPTION
Other Vicinities:		
Mining and Mineral Processing:	Low	Start-up after 1980, five-fold expansion by 2000.
	Mid	Start-up by 1980, five-fold expansion by 1990, double by 2000.
	High	Large start-up by 1980, double by 1990, no change to 2000.
LNG Plant:	Low	Start-up after 1980, no change to 2000.
	Mid	Start-up before 1980, no change to 2000.
	High	" " " " " " " "
Beluga Coal Gasification:	Low	Pilot project power between 1990 and 2000.
	Mid	Pilot project by 1990, full operation by 2000.
	High	Pilot project before 1980, full operation by 1990, no change to 2000.
Nuclear Fuel Enrichment:	High	Start at full operation before 1990, no change to 2000.
Timber:	Low	Start-up after 1980, full operation by 2000.
	Mid	Start-up before 1980, full operation by 1990, no change to 2000.
	High	Full operation start-up before 1980, no change thereafter.
New City:	Low	Initially loaded after 1980, load tripled by 2000.
	Mid	Initially loaded before 1980, tripled by 1990 2 1/3 expansion by 2000.
	High	Larger initial load before 1980, 2 1/3 expansion by 1990, no change to 2000.

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Table 13. Estimated Industrial Power Requirements

Rate of Development	Industrial Capacity in MW								
	Low Range			Mid Range			High Range		
Year	1980	1990	2000	1980	1990	2000	1980	1990	2000
Anchorage Area: Kenai Peninsula:									
Chemical Plant 1/	11	11	11	12	14	16	13	16	20
LNG PLant 1/	.4	.4	.4	.4	.5	.6	.5	.6	.7
New Plant		10	10	10	10	10	10	10	10
Refinery 1/	2.2	2.2	2.2	2.2	3	4	3	4	5
Timber 1/	2	3	5	3	5	5	5	5	5
Other Vicinities:									
Coal Gasification			10		10	250	10	250	250
Mining and Mineral Processing		5	25	5	25	50	25	50	50
Nuclear Fuel Enrichment								2500	2500
Timber		5	7	5	7	7	7	7	7
New City		10	30	10	30	70	30	70	70
TOTAL (rounded)	20	50	100	50	100	410	100	2910	2920
Fairbanks Area 2/									

Source: 1974 Alaska Power Survey Technical Advisory Committee Report on Economic Analysis and Load Productions, pages 81-89.

1/ Existing Installations

2/ Timber processing and oil refinery loads totaled less than 10 MW.

National Defense - Historical data from Army and Air Force installations in the Anchorage and Fairbanks areas indicate reasonable energy assumptions to be:

1. 0 percent annual growth for mid-range forecast, 1 percent for high range, and -1 percent for low range.

2. A 50 percent load factor was assumed for use with energy (net generation) to obtain peak load.

Self-Supplied Industries - The following assumptions were developed from existing data and conditions, consultations with many knowledgeable people in government and industry, and from reports on future developments.

1. Industries will purchase power and energy if economically feasible.

2. Forecast based on listing in the March 1978 Battelle report.

3. High range includes existing chemical plant, LNG plant, and refinery as well as new LNG plant, refinery, coal gasification plant, mining and mineral processing plants, timber industry, city and aluminum smelter or some other large energy intensive industry.

4. Mid-range includes all of the above except the aluminum smelter.

5. Low range includes all listed under high range except the aluminum smelter and the new capital.

6. In some instances, high, mid, and low range may be differentiated by amount of installed capacity as well as the type of installations assumed.

7. No self-supplied industries are assumed for the Fairbanks-Tanana Valley area. Any industrial growth has been assumed either (1) included in utility forecasts or (2) not likely to be interconnected with the area power systems.

8. Net generation forecast calculated from forecasted capacity and a plant factor of 60 percent.

The ISER model assumed the following Cook Inlet area industrial scenario. It is compared to industries assumed for the self-supplied industrial forecasts of this report.

Cook Inlet Industrial Scenarios
Assumptions

ISER	Self-Supplied Industries Forecast
HIGH RANGE	
Oil treatment and shipping facilities	Existing refinery (2.4 MW)
Small LNG	Existing LNG plant (.4 to .6 MW)
Beluga Coal (40 employees in shipping)	Coal gasification (0 to 250 MW) 2/
New capital (2,750 employees 1982-84)	New city (0 to 30 MW)
Refinery-petrochemical complex 1/	New refinery (0 to 15.5 MW)
Pacific LNG	New LNG plant (0 to 17 MW)
Bottom fish industry	
Oil lease development	Mining and mineral plants (5 to 50 MW)
No new pulp mills or sawmills	Timber (2 to 12 MW)
	Existing chemical plant (22 to 26 MW)
	Aluminum smelter or other energy intensive industry (0 to 280 MW)
MID RANGE 3/	
LOW RANGE	
Pacific LNG	New LNG plant (0 to 17 MW)
	Existing refinery (2.4 MW)
	Existing LNG plant (.4 MW)
	Existing chemical plant (22 MW)
	Coal gasification (0 to 10 MW)
	New refinery (0 to 15.5 MW)
	Mining and mineral plants (0 to 25 MW)
	Timber (2 to 12 MW)

1/ A recent decision by ALPETCO changes this to the Valdez area. The changes involved were not enough to warrant forecast revisions.

2/ Part of coal gasification could be equivalent to "Beluga Coal," but it is much more than "40 employees in shipping."

3/ At the time this forecast and analysis was performed, no ISER mid-range projections of populations and employment had been developed.