ELECTRIC POWER CONSUMPTION FOR THE RAILBELT:

A PROJECTION OF REQUIREMENTS

by

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Institute of Social and Economic Research

Anchorage * Fairbanks * Juneau

prepared jointly for

State of Alaska
House Power Alternatives Study Committee
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I. INTRODUCTION

This report presents the results and documentation of the first systematic attempt to project future electric power requirements for the Alaskan railbelt using a technique which explicitly takes into account uses of electricity.

The study, undertaken jointly for the House Power Alternatives Study Committee of the Alaska Legislature and the Alaska Power Authority, had two purposes. The first was to develop a model of electricity use which would enable the legislature, administration, and others to analyze the impact of policy measures to alter electricity consumption patterns. The second was to forecast future electric power requirements for the railbelt as input to a study of the feasibility of developing the hydroelectric resources of the Susitna River.

The model which was developed as part of the study, an end-use model, is patterned after similar models developed and utilized by the federal government, various state government agencies, and electric utilities. It is a departure from traditional methods of electricity requirements forecasting (based largely upon trend analysis), which is widely recognized as being a necessary and worthwhile improvement. This is because the end-use model bases forecasts on estimates of the electricity requirements for specific uses.

This approach has the additional advantage over traditional electricity forecasting methods of explicitly presenting the assumptions made by the forecaster about the relationships between important variables. For example, the average household size is an important determinant of electricity consumption in the residential sector. Most analysts project that average household size will decline over the next twenty years. The end-use modeling technique requires that this factor be explicitly considered.

A major difficulty with a forecasting model of this type is the lack of data with which to construct and validate the model. Information is necessary on the appliances in the residential and commercial sector, the building stock and its characteristics, the machinery used in industrial processes, and the uses to which fuels which are alternatives (and competing) to electricity are put. Such data is difficult, if not impossible, to obtain, so estimates and indirect methods of obtaining information must often be utilized. Consequently, this model is a "first draft" and, as such, subject to improvement and refinement as more information becomes available. The level of effort expended on this model has been much less than more highly developed and sophisticated end-use models such as those used by the New England Power Pool, California Energy Commission, and Federal Energy Administration.

We expect more information to become available on a regular basis in the future as the general level of interest in and concern for energy consumption increases. This information will come both from work done in Alaska and in other states because the experience of other regions is often applicable to the Alaskan situation. Information from other areas will probably be in the form of better data on appliance electricity use, appliance lifetime, components of commercial electricity consumption, and consumer behavioral responses to changing energy prices and government regulations, incentives, standards, and controls designed to alter electricity consumption patterns.

Within Alaska, better and more current information will become available as a result of a variety of efforts. These would include,

1. Under provisions of the Public Utilities Regulatory Policies Act (PURPA), the large railbelt utilities are required to undertake various end-use studies.

2. Railbelt utilities have, in the past, and will, in the future, conduct end-use studies for their own planning purposes.

3. The 1980 censuses of population and housing will provide information on the geographic distribution of population, trends in household size, the characteristics of the housing stock, and the ownership rates for various appliances.

4. Efforts by local governments through surveys and analyses of existing records (tax records, building permits, etc.) to develop better information bases on the demographic and economic characteristics of their communities.

5. Energy audit programs presently in the initial stages at all levels of government which can provide information about not only where electricity is used but also the impact on consumption of conservation measures.

Information from these secondary sources can improve the modeling and projections. There was no primary data collection effort undertaken as part of this study. The reasons that no primary data were collected in the process of original model development were two. First, the cost of data collection through surveys is expensive. Second, and more important, without a definite understanding of what information was necessary for modeling and what information was available from secondary sources, any primary data collection would be premature and inefficient.

Now that the initial model development has been completed, it is possible to identify those areas where the model could be improved by primary data collection either through surveys or analysis of individual utility account records in conjunction with other primary data sources. The commercial-industrial component of electrical requirements is not well-specified in the model and would benefit most from additional primary data in the form of information on the proportions of electricity in different uses in the various categories of the commercial sector (retail, office, eduction, etc.) and the amount of electricity consumed in these different uses on an appliance or square foot basis. Unfortunately, because of the heterogeneity of the commercial sector, it is difficult to obtain a complete detailed picture of electricity use in this sector even through survey methods.

Another reason why the model may be expected to change over time, in addition to the fact that better data will be integrated into the parameters, is that conditions in electricity markets are currently in flux and the dynamics of change are presently not fully understood. Consumer behavior is difficult to forecast whenever behavior patterns differ from those of the past, as is presently the case. An example would be in consumer preferences for space heating in the presence of high prices for all fuels as well as relative fuel price uncertainty. To what extent will consumers utilize dual heating systems (wood and electricity, for example) or district (room-by-room) heating systems rather than single, centralized heating which has become the standard in recent years? Only time will provide us with the answers after we have had the opportunity to actually observe consumer behavior in these new situations.

In spite of these model shortcomings (which really are shortcomings of any forecasting technique because we have utilized all the available data), the methodology is a valid one. Every effort has been made to minimize the potential error which may arise because of misallocation of electricity consumption to a particular use. Differences of opinion regarding the parameters used in forecasting future use will obviously always be present. This model makes all those parameters explicit so that discussions about the projections can be structured around the numerical values chosen for these parameters.

The end-use model, in conjunction with an econometric model of the Alaskan economy, has been used to do thirty-year projections of electricity requirements. In a sense, it is presumptuous to think it is possible to forecast for thirty years into the future with any degree of confidence. The last thirty years have produced trends nationally that were unanticipated but had a profound effect on patterns of energy consumption such as suburbanization. Within the state, events such as the discovery of oil at Prudhoe Bay, which shaped the economy through the decade of the

1970s, were unpredictable. Similar, unanticipated factors (although the probability of another petroleum discovery on the magnitude of Prudhoe Bay is slight) will surely be important in the future. On the other hand, there are many things which we can anticipate with some assurance and, because we must try to plan the efficient future utilization of resources, we must attempt to define the future limits of electricity consumption.

In addition to the normal degree of uncertainty in projecting future events, two factors make projecting Alaskan electricity requirements particularly fraught with uncertainty. First, the small, absolute size of the economy and its dependence upon natural resources and government make the economy volatile and projections of future levels of activity subject to larger variability. Second, the ever changing conditions in national and Alaskan energy markets make it difficult to identify long-term trends in prices, fuel availabilities, federal and state policies, and consumer behavior. The projections should be interpreted with this variability and uncertainty in mind.

Specifically, any forecasting method which depends upon the past will necessarily be wrong to the extent it cannot anticipate change. We do try to take some changes into account but do not presume the ability to anticipate technological change which may be significant as a factor either increasing or decreasing electricity consumption from central station utilities.

The electricity end-use model has been constructed to maximize its potential applicability. It is not presently computerized, but the documentation in the technical appendixes is complete and structured in such a way that conversion to the computer would be a simple task. We recommend this be undertaken to facilitate future use of the model for forecasting and policy analysis as well as updating and validation. As used in this study, the model provides results for three electric power markets for five-year intervals. It can be modified to handle both other regions and shorter or longer time intervals.

In conclusion, we are forecasting electricity requirements at a time when changes are constantly occurring which can have substantial effects on the outcome. We feel the approach of this study is the most appropriate under the circumstances, recognizing at the same time that it can and, hopefully, will be improved in the future.

II. ECONOMIC GROWTH IN ALASKA AND ITS RAILBELT REGION

Introduction

The demand for electric energy is importantly affected by the level of population and economic activity in the region. This chapter describes the population and economic activity in Alaska and its Railbelt region. The railbelt currently contains the majority of the state's population and employment; it includes the Anchorage, Kenai, Seward, Matanuska-Susitna, Fairbanks, Southeast Fairbanks, and Valdez Census Divisions. This chapter discusses both the historical level and the probable future growth of population and economic activity. The projections of the future are the basis of the electricity demand projections.

The analyses of historical economic activity and demographic change provide a point of reference for discussing potential future growth. Examining past activity provides information not only on what happened but also on how things happened, which allows us to develop an understanding of the process of growth in Alaska. An understanding of how this process worked in the past allows us to assess the potential for future changes. We would not expect the future process of growth to differ qualitatively from the past.

Economic Growth

Alaska has a frontier economy. Alaska, like all frontier economies, can be characterized by its small size, relatively recent development, and isolation from major markets and production centers. Examining these characteristics helps both to explain past growth and to define the potential for future economic growth. The small size of Alaska means there are only limited local markets, which limit the local production of goods and services. The recent development of the economy means there are areas with only limited infrastructure and services.

Recent development and small size result in the need to import labor to staff major development projects; this migration requirement necessitates high wages to attract labor. Finally, the isolation from markets and producers means that transportation cost is an important component of the cost of living and producing in Alaska.

These characteristics have two general results for the Alaska economy. First, Alaska, like all frontier regions, is a high-cost region. The cost of living and producing goods and services is relatively higher in Alaska than in competitive regions. Secondly, resource development for export to other regions is the major source of growth for the economy. Because of the cost structure described above, only bonanza resource finds will be developed; the high cost of development means resource finds which would be developed in other areas will be overlooked in Alaska.

Economic growth in frontier regions is then driven by two forces. First, the development of resources is driven by changes in world market price and technology which may reduce production costs in the region. Secondly, growth generated by resource development leads to expansion of local markets. This will increase the production in the region of locally consumed goods and services and reduce the relative cost differentials, possibly encouraging future growth. Each of these causes of growth has been important in the past and will continue to be important in the future.

HISTORICAL ECONOMIC GROWTH IN ALASKA

The importance of natural resource development to the growth of the Alaska economy can be seen by examining the historical growth of the economy. European settlement of the region as a Russian colony was a means of exploiting Alaska's resources, primarily furs. During the American colonial period, major growth occurred with the development of the gold fields in Northwest Alaska in the late nineteenth century. The final major pre-statehood cause of growth was the expansion of the federal government presence in the state. This was primarily a result of the military expansion during World War II, the Korean War, and the Cold War. This expansion was a result of Alaska's strategic location, a type of natural resource (Kresge, et al, 1977).

Since statehood, economic growth has been dominated by the development of the state's petroleum resources and growth of state government. Two major petroleum developments have been responsible for growth during this period, the Kenai Peninsula-Cook Inlet and Prudhoe Bay. The Kenai fields were developed in the late 1960s, reaching peak production in 1970; employment increased both in Kenai and as headquarters employment in Anchorage. Employment associated with this development declined after peak output was reached in 1970. Development of the Prudhoe Bay fields had two major phases, field development and construction of the trans-Alaska pipeline to carry the oil to a port in Valdez. The construction project had major employment effects, adding 15,000 workers to the work force in 1976; however, field development and production will have more long-run effects.

A second major source of growth has been the expansion of state government. State government expenditures affect the economy by increasing employment in state government and through expenditures, such as for the Capital Improvements Program, in other sectors of the economy. State government expenditures have been a particularly important source of growth since 1970. The lease bonus received by the state in 1969 from the sale of the Prudhoe Bay lease held to a rapid expansion of state expenditures (Scott, 1978). The lease sale bonus and future revenues from petroleum production are a unique source of revenues since they are exogenous to the state economy. Because of this, the level of revenues and state expenditures does not depend on the level of economic activity in the state, but determines it.

Table II.1. describes the growth in employment in Alaska since 1960. Employment increased at an average annual rate of 4.1 percent per year during this period; this is about twice as fast as the growth of the U.S. economy during the period. We can distinguish three separate periods of growth between 1960 and 1979 by their relation to the development of Prudhoe Bay. The most rapid period of growth occurred between 1970 and 1976; employment grew at an annual average rate of growth of 8.1 percent per year. Prudhoe Bay influenced most of the growth in this period.

TABLE II.1. ALASKA EMPLOYMENT GROWTH BY SECTOR

(Average Annual Percent Change)

	1960-1970	1970-1976	1976-1979	1960-1979
Basic Sector[a]	.7	4.6	- 7.0	.7
Support Sector[b]	6.1	12.3	2.9	7.5
State and Local Government	10.1	9.4	4.9	9.0
Total Nonagricultural Wage and Salary (plus military)	3.3	8.1	.4	4.1

[a]Includes mining, construction, manufacturing, and federal civilian and military employment. (Nonagricultural wage and salary does not include agricultural or fisheries employment.)

[b]Includes transportation, communications, utilities, trade, finance, and services employment.

SOURCES: Alaska Department of Commerce and Economic Development, The Alaska Economy Year-End Performance Report, 1978; and Alaska Department of Labor, Alaska Economic Trends, March/April 1980.

State government expansion as a result of the Prudhoe Bay lease sales, the development of the fields, and the employment expansion associated with construction of the Trans-Alaska Pipeline Service (TAPS) occurred during this period. The rate of growth of employment between 1970 and 1976 was more than twice the rate prior to 1970. The period after 1976 reflected the downturn in the economy after the completion of TAPS; average employment growth fell to less than one percent per year during this period. The adjustment after 1976 reflected most importantly the reduction in construction workers connected with the pipeline construction.

Economic growth affects more than total employment; the structure of the economy also changed, as reflected in Table II.1. In all periods, growth in both the support sector and state and local government is more rapid than total employment. This reflects a change in the structure of the economy, which is a result of three factors. The first factor is the increased importance of state government in the economy. Prior to 1970, the state's increased role resulted from a transfer of functions from the federal government to the new state. Since 1970, state government growth was primarily a response to available revenues. The second factor is the maturing of the economy. As an economy grows, it produces locally more of the goods and services it consumes. This structural change results in a nonproportional growth in the support sector. Finally, the composition of the basic sector has changed through time, so that employment numbers do not reflect its impact on the economy. The primary change is the reduction in military employment throughout the period. Because of this, the increase in the civilian basic sector was greater than reflected by Table II.1.

Two economic effects of the structural change which occurred in the past have been the reduced seasonality of employment and a narrowing of the cost of living differential between Alaska and the remainder of the United States. Alaska's dependence on natural resource production and severe winters historically resulted in seasonal increases in unemployment. As the economy matured, this seasonality has been reduced. As measured by the ratio of fourth-to-third quarter employment, seasonality decreased by about 14 percent between 1950 and 1976; this index was .75 in 1950 and .87 in 1976 (Huskey and Nebesky, 1979). The other major effect of structural change was a narrowing of price differentials. Prior to 1975, the Anchorage consumer price index increased at a yearly rate that was less than the national rate, which meant that the price differential between Alaska and the rest of the United States decreased. The expansion of the local support sector and the economy's size were primarily responsible for this. With the TAPS boom, this price trend was reversed because of bottlenecks which resulted from rapid increases in demand and resulting increases in prices.

RAILBELT ECONOMIC GROWTH

In this study, we are primarily interested in growth in the Railbelt region, the region which would be served by the Susitna Hydroelectric project. The Railbelt region contains the majority of the population and economic activity in the state; most of the recent economic growth has occurred in this region. The Railbelt region contains three separate subregions which are unique, separate economies. The regions are:

- Anchorage. This region contains the Anchorage, Matanuska-Susitna, Kenai, and Seward Census Divisions. Anchorage serves as the administrative, distributive, and transportation center for the state and so reflects growth in other regions of the state. Matanuska-Susitna is a major agricultural region of the state; recent growth has resulted from a suburban connection with Anchorage. Kenai and Seward have experienced growth as a result of both fisheries--the historically important natural resource industry, and petroleum--the currently important natural resource industry.

- Fairbanks. The region contains the Fairbanks and Southeast Fairbanks Census Divisions. Fairbanks is the regional center for most of interior Alaska. It is also an important government center, operating not only as a regional center but as the site of the University of Alaska's first campus and important military bases. Fairbanks' most recent major expansion occurred in connection with the development of Prudhoe Bay and construction of TAPS for which it served as a construction center.

- Valdez. The Valdez region contains the Valdez Census Division. This region recently experienced rapid growth as the terminus of the trans-Alaska pipeline and site of the oil terminal for Prudhoe Bay oil. Future growth should result from the location of the pipeline terminus in the area.

The remainder of the state consists of three major regions. Southern Alaska from Southeastern to the Aleutians contains the major fishing areas of the state. This region also contains the state capital at Juneau. In contrast to southern Alaska and the railbelt is village Alaska which includes most of western and northern Alaska. These include small Native villages whose pattern was established by subsistence patterns and larger regional centers which serve as governmental and distribution centers. The final regions are resource zones such as Prudhoe Bay. These zones are not necessarily developed or associated with any existing population center. These include Brooks Range minerals zones, Outer Continental Shelf zones, and major agriculture zones. Development of these areas will determine the future economic growth of the state.

Historical growth, as measured by employment, has been evenly distributed between the Railbelt region and the remainder of the state. Table II.2. shows that over the period 1965 to 1978, the railbelt has grown slightly faster, growing at an annual average rate of 4.8 percent per year, compared to 4.1 percent for the rest of the state. The railbelt grew most rapidly during the Prudhoe Bay period (1970-1976); employment in the railbelt grew at an annual average rate of 8.9 percent per year, compared to 6.3 percent for the rest of the state. During this

TABLE II.2. REGIONAL EMPLOYMENT GROWTH[a]

(Average Annual Percent Change)

	1965-1970	1970-1976	1976-1978	1965-1978
State	3.7	8.1	- .9	4.6
Railbelt	3.3	8.9	- 3.3	4.8
Anchorage	3.8	8.2	2.4	5.6
Fairbanks	2.2	7.7	-11.3	2.4
Valdez	2.6	45.2	-49.0	8.1
Rest of State	4.3	6.3	- 2.6	4.1

[a] Includes nonagricultural wage and salary employment plus military. Data limit end dates.

SOURCES: 1965-1974, Alaska Department of Labor.
1975-1978, Alaska Department of Commerce and Economic Development, Numbers: Basic Economic Statistic of Alaska Census Divisions, 1979.

period, the majority of the TAPS construction project occurred in this region. The two regional centers, Anchorage and Fairbanks, also reflected growth in the rest of the state. The location of TAPS employment also accounted for the more rapid decline in employment in the railbelt after 1976. Because of its slightly more rapid growth, the Railbelt region increases its share of state employment from 68.5 percent in 1965 to 70.3 percent in 1978.

The most rapidly growing subregion of the railbelt was Anchorage, which grew at an annual average rate of 5.6 percent during the period. Anchorage did not suffer a decline in employment between 1976 and 1978. The growth in Anchorage employment was not direct construction employment but support and government employment, so it did not suffer the immediate employment decline with completion of construction. Employment between

1976 and 1978 was buoyed by anticipations of future major projects and spending of wealth accumulated during the pipeline period. Both Fairbanks and Valdez were more directly affected by pipeline construction, growing very rapidly during construction and falling equally rapidly after pipeline construction was completed. In each region, a familiar Alaska employment pattern occurred, and employment did not fall back to pre-peak levels after the peak was reached.

FUTURE ECONOMIC GROWTH

The future growth of the state economy will follow a pattern similar to past growth. The characteristics of the economy we have described will continue to affect growth. The importance of the federal government presence in Alaska, both civilian and military, will continue. Although this provides a stable base for economic growth, it is not likely to be an important source of growth. Growth will most importantly result from development of Alaska's natural resources, expansion of state government, and expansion of the scale of the economy. State government expansion will result in increases in government employment, construction employment through the capital improvements program, and expansion of industry through the state loan program. Expansion of natural resource production beyond the bonanza finds depends on the location of reserves relative to transportation and developed areas; areas without easy access to infrastructure will be costly to develop. Expansion of natural resource industry beyond production will continue to be limited by small local markets and high production costs. Finally, as the size of the economy expands, we would expect a continued nonproportional expansion of the support sector as thresholds are reached in various industries.

Although historical analysis can provide some indication of the future growth of the economy, one thing should be evident: there is a large potential variability for the future course of economic activity in the state. The future development of natural resources depends importantly on world market prices. There is also uncertainty about the size and marketability of resource reserves in the state. The future level of state government activity is also uncertain. Because of the petroleum revenues from Prudhoe Bay, the state is in a position of having revenues which exceed expenditures. Expenditures are constrained only in the long run by revenues. In addition to the amount the state spends, the way the state spends its money will affect state growth. These areas of variability make any projection of future state economic activity probabilistic.

We chose to combine two approaches for forecasting future Alaska economic growth. For the period prior to 2000, we used the MAP econometric model of the Alaska economy (see Appendix B) to project future economic activity. This approach allowed us to create scenarios describing the possible future growth of exogenous events such as natural resource developments and levels of state government expenditures. Use of the model also provides consistency across alternate projections. Beyond 2000, when much less is known of possible exogenous events, we chose to forecast the growth of major economic variables by making assumptions about their rates of growth.

Nine separate state economic projections were made for this study (see Appendix C). These projections were the result of the combination of three separate economic scenarios and three state government expenditure scenarios. These projections were designed to capture the possible future range of economic activity. The three economic scenarios reflect probable low, moderate, and high levels of resource development and exogenous industry growth. Three alternate state government expenditure growth paths were assumed representing state expenditures as a declining, constant, and rising proportion of personal income. Each state expenditure assumption is possible since none exhausts the state's fund balance by 2000.

Of these nine, three were chosen to be used in the electricity demand projections. It was assumed that the three economic scenarios, in combination with a state expenditure assumption which assumed state expenditures would remain a constant proportion of personal income, would describe the most probable range of alternative futures. These scenarios are described below.

High Economic Growth

The high economic scenario assumes major resource development in the state. In addition to continued petroleum production at Prudhoe and in the Upper Cook Inlet, reserves in the National Petroleum Reserve and eleven OCS lease sales areas are assumed to be developed. Other mining is also assumed to grow with Beluga coal development and U.S. Borax developed. In-state processing of petroleum resources is assumed to increase with a major petrochemical development in Valdez, a petrochemical development using state's royalty gas in Fairbanks, and the Pacific LNG project. The Northwest gasline is also assumed to be built. Agriculture, fisheries, and forestry are all assumed to expand with maximum government support; major agricultural development occurs, and the foreign bottomfish effort is assumed to be replaced by the Alaska industry over the period. In addition to the state government spending assumed, the state capital is assumed to be moved to Willow during the projection period. (See Appendix C for specific scenario description.)

Table II.3. describes the projected growth in employment in the high scenario. In this scenario, the Railbelt region grows at the same rate as the state; both grow at a rate of 3.7 percent per year between 1980 and 2010. The region grows slightly slower between 1980 and 1990 and more rapidly between 1990 and 2000. This is mainly a result of massive OCS development which occurs during the 1980s outside the region. Examining the growth rates over decades ignores the rapid growth in the early 1980s associated with major construction projects which occur in the region.

By 2010, the region contains approximately 67 percent of the state employment; total employment in the railbelt equals 393,738 by 2010.[1] Growth is slightly faster in Fairbanks and Valdez than in Anchorage.

TABLE II.3. HIGH SCENARIO EMPLOYMENT GROWTH

(Average Annual Percent Change)

	1980-1990	1990-2000	2000-2010[c]	1980-2010
State[a]	4.6	3.2	3.3	3.7
Railbelt Region[b]	4.2	3.4	3.3	3.7

[a] Total employment includes self-employed.

[b] Regional projections are for nonagricultural wage and salary employment plus military. This excludes self-employed and was the basis for electricity demand projections.

[c] Post-2000 growth assumed to be 33 percent per year, which is the approximate growth rate of the 1990-2000 period.

Anchorage's share of railbelt employment falls from 76.3 percent to 74.2 percent between 1980 and 2000. Fairbanks and Valdez increase their share from 22.1 to 23.1 and 1.6 to 2.7, respectively. These changes in shares result from growth in resource development and government employment outside the region.

Moderate Economic Growth

The moderate economic scenario also assumes important future resource development although the extent and timing differ from the assumed growth in the high scenario. As in the high scenario, petroleum development continues at Prudhoe and Upper Cook Inlet; however, the extent of further development is limited. Only six OCS lease sales areas are developed and development in the National Petroleum Reserve does not occur until the end of the projection period. Development of Beluga coal is the only nonpetroleum mining which occurs. The state's in-state processing of petroleum resources is more limited, a fuels refinery is built in Valdez and the Pacific LNG project is built. The Northwest gasline is also assumed to be built. Agriculture is given a low priority and development is limited. Only half the foreign bottomfish effort within the 200-mile limit is assumed to be replaced by Alaska fishermen over the period.

Table II.4. describes employment growth in the state and Railbelt region over the projection period. The Railbelt region grows slightly slower than the state over the period, growing at an average of 2.5 percent per year, compared to 2.6 percent for the state. As in the high case, the state grows slightly faster until 1990, and the region grows slightly faster after 1990. This is also a result of OCS development in the 1980s and the decade growth rates masking the large economic growth associated with large construction projects during the 1980s.

TABLE II.4. MODERATE SCENARIO EMPLOYMENT GROWTH

(Average Annual Percent Change)

	1980-1990	1990-2000	2000-2010[c]	1980-2010
State[a]	2.9	2.8	2.0	2.6
Railbelt Region[b]	2.6	3.0	2.0	2.5

[a] Total employment includes self-employed.

[b] Regional projections are for nonagricultural wage and salary employment plus military. This excludes self-employed and was the basis for electricity demand projections.

[c] Post-2000 growth assumed to be 2 percent per year.

By 2010, the Railbelt region contains 66 percent of the total state employment; total employment in the railbelt is 281,986 in 2010. The subregional growth is similar to the high case with Anchorage growing at a rate slightly slower than the remainder of the region. The Anchorage share of railbelt employment falls slightly from 76.3 to 74.8 percent over the period. Fairbanks and Valdez increase their shares of railbelt employment from 22.1 to 22.9 percent and 1.6 to 2.3 percent, respectively.

Low Economic Growth

The major source of growth in the low scenario is government spending. Only limited resource development takes place in this scenario. Petroleum production at Prudhoe Bay and in Upper Cook Inlet are assumed to continue and the Northwest gasline is built, but no other resource project is assumed to be developed. Agriculture is assumed to disappear from the state by the end of the period, while no bottomfish industry is assumed to be created.

Growth in both the state and Railbelt region are projected to be much lower in this scenario, averaging 1.9 percent per year and 1.8 percent per year, respectively. The Railbelt region is assumed to grow slightly slower than the state. By 2010, the Railbelt region has 68 percent of total state employment; by 2010, total employment in the railbelt is 231,559. As in the other scenarios, the Anchorage region grows slightly less rapidly than the other two railbelt subregions. By 2010, Anchorage accounts for about one percent less of the Railbelt region employment than in 1980. (See Table II.5.)

TABLE II.5. LOW SCENARIO EMPLOYMENT GROWTH

(Average Annual Percent Change)

	1980-1990	1990-2000	2000-2010[c]	1980-2010
State[a]	1.9	2.7	1.0	1.9
Railbelt Region[b]	1.6	2.9	1.0	1.8

[a]Total employment includes self-employed.

[b]Regional projections are for nonagricultural wage and salary employment plus military. This excludes self-employed and was the basis for electricity demand projections.

[c]Post-2000 growth assumed to be one percent per year.

Population Growth

Change in the population of Alaska will follow the growth of employment. The change in the region's population is a result of natural increase (the excess of births over deaths) and migration. In a rapidly growing region with a small population base, like Alaska, migration is the most important component of population change. Migration occurs primarily as a response to economic opportunities which include both relative employment opportunities and higher incomes. The relatively large increases in employment associated with major projects such as TAPS mean that the national increase in the region's labor force will not meet the employment requirements of the economy and migration will be needed to meet the labor requirements.

The growth in population may diverge from the growth in employment; recent experience shows that population did not increase as fast as employment. This is primarily a result of two factors, increasing labor force participation and change in the number of unemployed. Labor force participation rates measure the proportion of the population in the economy which wishes to be employed. Increases in this rate result from many factors. The increased participation of women in the labor force is a national trend. A change in the age distribution of the population which puts a greater proportion in the working ages will also increase participation rates. The region's labor force participation rates will also change if the migrants have different rates than the existing population. Finally, increased employment opportunities may bring a larger proportion of the population into the labor force. High incomes and employment opportunities in Alaska have this effect, especially when projects are located in rural areas with a high proportion of population which does not participate because of the lack of jobs. High levels of unemployment prior to a growth period may result in many of the jobs being taken by the unemployed with no need for migrants or population growth. As the economy expands, the yearly expansion of the Alaska labor force will provide labor for a large proportion of jobs created and migration will become less important as a force of population change.

HISTORICAL POPULATION GROWTH[2]

Table II.6. describes the historical growth of the state and the Railbelt region since 1960. Over the entire period, the railbelt grew slightly more rapidly than the state as a whole. Between 1960 and 1978, Alaska grew at an annual average rate of 3.3 percent, while the railbelt grew at 3.8 percent. Over the period, the railbelt increased its population share from 63 percent in 1960 to 70 percent in 1978.

The Railbelt region led the state in growth in each growth period, 1960-70 and 1970-76, as well as in the period of contraction, 1976-78. During 1960-70 and 1970-76, the railbelt grew at 3.6 and 5.8 percent per year, while the state as a whole grew at 3.0 percent and 5.0 percent, respectively. During each of these periods, the major causes of growth were located within the region--the Kenai oil fields and TAPS construction. Because of the location of major portions of the TAPS project in the region, it also suffered a more rapid population decline than the

TABLE II.6. HISTORICAL POPULATION GROWTH

(Average Annual Percent Change)

	1960-1970	1970-1976	1976-1978	1960-1978
State	3.0	5.0	- .7	3.3
Railbelt Region	3.6	5.8	- .8	3.8
Anchorage	4.5	6.1	.1	4.5
Valdez	1.3	16.5	-14.1	4.2
Fairbanks	1.5	3.7	-2.4	1.8
Rest of State	1.9	3.4	- .4	2.2

SOURCE: Alaska Department of Commerce and Economic Development, Division of Economic Enterprise, Basic Economic Statistics of Alaska Census Divisions, November 1979.

state as a whole, with population declining at an annual average rate of .8 percent per year, compared to .7 percent for the state as a whole.

Within the railbelt, Anchorage grew most rapidly, expanding at an annual average rate of 4.5 percent per year. The Anchorage expansion was a result of its service-support function and the location of families of project employees. Valdez also experienced rapid growth over the period, expanding only slightly slower than Anchorage at a rate of 4.2 percent per year.

One population characteristic which is especially important for projecting future energy demand is the number of households in the population. Changes in the average size of households can result in the numbers of households changing more rapidly than population. Changes in the social patterns, age structure and employment opportunities have resulted in rapid changes in the average household size in both the United States and Alaska. Table II.7. compares the average household size in 1970 and 1976 in both Alaska and the United States. The changes in the United States were reflected in Alaska; within this period, average household size dropped by about the same amount. The average household size in Alaska was 11.5 percent greater than in the United States in 1970; in 1976, it was 12.8 percent greater.

TABLE II.7. AVERAGE HOUSEHOLD SIZE

	1970	1976
United States	3.14	2.89
Alaska	3.50	3.26

SOURCES: U.S. Department of Commerce, Statistical Abstract of the United States, 1978, and Demographic, Social, and Economic Profile of States: Spring 1976, 1979.

PROJECTED FUTURE POPULATION GROWTH

Table II.8. describes the projected growth of population under all three scenarios previously described. The expansion of both the railbelt and state population is similar to the projected growth of employment. There are two major differences between employment and population projections. First, growth of population is assumed to be less rapid than employment over the entire period. Between 1980 and 2010, state population grows .3 percent slower than state employment in the high scenario, .2 percent slower in the moderate scenario, and .2 percent slower in the low scenario. This pattern is repeated in the Railbelt region. This reflects the historical pattern of increasing labor force participation which results from increases in working-age population and participation

TABLE II.8. PROJECTED GROWTH OF POPULATION

(Average Annual Percent Change)

	1980-1990	1990-2000	2000-2010[a]	1980-2000
High Scenario				
State	3.8	3.1	3.3	3.4
Railbelt	3.8	3.1	3.3	3.4
Moderate Scenario				
State	2.7	2.5	2.0	2.4
Railbelt	2.7	2.5	2.0	2.4
Low Scenario				
State	2.0	2.2	1.0	1.7
Railbelt	2.0	2.2	1.0	1.7

[a] Growth in this period at same rate as employment growth.

by women in urban areas and greater employment opportunities in rural areas. The second difference from the pattern of employment growth concerns the variability of growth between periods. In all scenarios, population in the Railbelt region grows at approximately the same rate as in the state; while the employment growth in the railbelt varies around the state growth rate. This reflects another historical pattern, the separation of place of employment and place of residence. With development in remote, unsettled areas of the state, many families of workers in these areas settled in the metropolitan regions of the state--Anchorage, Fairbanks, and Kenai. This pattern of settlement will most likely change as more activity occurs in other regions of the state.

Overall growth of population of the Railbelt region ranges from an annual average of 3.4 percent in the high scenario to 1.7 percent in the low. Railbelt population by 2010 reaches 773,804 in the high scenario, 576,037 in the moderate, and 476,007 in the low. Within the region, the distribution of population remains relatively stable throughout. The Valdez region expands its share of regional population to reflect its projected rapid growth in the moderate and high scenarios.

We assume in these projections that the average household size will decline following the projected national pattern. Table II.9. illustrates the effect of this assumption; the number of households is projected to increase more rapidly than population, resulting in the reduction in the average number of people per household. At both the state and regional levels, average population per dwelling unit is assumed to fall over the period, decreasing from 3.2 to approximately 3.7 at the state level in all scenarios and 3.04 to approximately 2.6 in the Railbelt region for all scenarios.[3] By 2010, the number of households in the Railbelt region is 294,115 in the high scenario, 216,020 in the moderate, and 180,235 in the low scenario.

TABLE II.9. PROJECTED POPULATION PER HOUSEHOLD

	1980	2010
High Scenario		
State	3.17	2.66
Railbelt	3.04	2.58
Moderate Scenario		
State	3.17	2.69
Railbelt	3.04	2.59
Low Scenario		
State	3.17	2.71
Railbelt	3.04	2.56

Conclusions

The economic and population growth projected in the three scenarios presented in this section is similar to past growth. The determinants of growth are primarily resource development and state spending. These scenarios differ slightly from past growth because it is not as centered in the Railbelt region as past growth. There are two important reasons for this. First, state expenditures play a much greater role in future projected growth. This increased employment is spread more evenly out of the region, concentrating in the capital but also serving other regions. Secondly, more resource development projects occur out of the region. The major future sources of petroleum and such important resources as bottomfish development will occur out of the Railbelt region.

CHAPTER II ENDNOTES

1. Nonagricultural wage and salary plus military employment.

2. The populations described in this section are, except for 1960 and 1970 census figures, only estimates. This may explain some of the difference between growth of population and employment.

3. Regional differences reflect distribution of the population across subregions; each subregion had a different assumed starting value of population per household.

III. ELECTRICITY USE IN THE RAILBELT

Historical Patterns of Electricity Consumption

Between 1920 and 1970, net production of electrical energy in the United States by utilities grew at an average annual rate of 7.6 percent. The growth rate in the 1960s was only slightly below that long-term trend at 7.3 percent. In the 1970s, growth rates have been considerably lower. Table III.1. shows that between 1970 and 1978 the rate has been 4.6 percent, with growth in the years before 1973 twice that of later years (1973 was the watershed year of recession and oil embargo). Electricity consumption has grown historically at a faster rate than total energy consumption and, thus, has accounted for an increasing share of final energy demand.

TABLE III.1. HISTORICAL U.S. GROWTH RATES OF UTILITY NET PRODUCTION OF ELECTRICITY

Period	Average Annual Growth Rate (%)
1920-1930	8.7
1930-1940	4.5
1940-1950	8.8
1950-1960	8.7
1960-1970	7.3
1920-1970	7.6
1970-1978	4.6
1970-1973	6.7
1973-1978	3.5

SOURCE: U.S. Department of Commerce, Statistical Abstract, various years.

Nationally, industry is the largest user of electricity, most of it supplied by utilities, followed by the residential sector, and finally by the commercial sector. Table III.2. shows that industry has historically been the largest user of electricity but that in recent years combined residential and commercial consumption has surpassed that of the industrial sector.

TABLE III.2. PERCENT DISTRIBUTION OF U.S. ELECTRIC ENERGY USE

Year	Residential	Commercial	Industrial	Other
1920	5	11	54	30
1930	9	12	53	26
1940	13	12	51	24
1950	18	13	49	20
1960	23	14	49	14
1970	28	18	42	12

SOURCE: U.S. Department of Commerce, Historical Statistics of the United States, Colonial Times to 1970, 1975.

In the Alaska railbelt, historical growth in electricity sales has been more rapid than the national average. Table III.3. shows the level of utility sales in Anchorage and Fairbanks for selected years since 1940. Although above the national growth rates throughout, there is a pattern of deceleration of growth as the economy has developed and matured.

In the greater Anchorage area (encompassing the Census Divisions of Anchorage, Kenai-Cook Inlet, Matanuska-Susitna, and Seward [see map on Figure III.A.]), this growth has been relatively evenly divided between the residential sector and the commercial-industrial-government sector

TABLE III.3. ELECTRIC UTILITY SALES IN THE ANCHORAGE AND FAIRBANKS AREAS

Year	Sales (10^3 MWh)	Year	Sales (10^3 MWh)
1940	10	1965	467
		1966	523
1951	78	1967	*
1952	101	1968	660
1953	134	1969	757
1954	148		
		1970	897
1955	166	1971	1,048
1956	190	1972	1,168
1957	204	1973	1,300
1958	220	1974	1,408
1959	243		
		1975	1,683
1960	320	1976	1,886
1961	353	1977	2,050
1962	387	1978	2,179
1963	431	1979	*
1964	472	1980 (est)	2,353

Average Annual Growth Rate (%)

1940-1950	20.5
1950-1960	15.3
1960-1970	12.9
1970-1980	10.1

Note: Data from different sources not totally compatible.

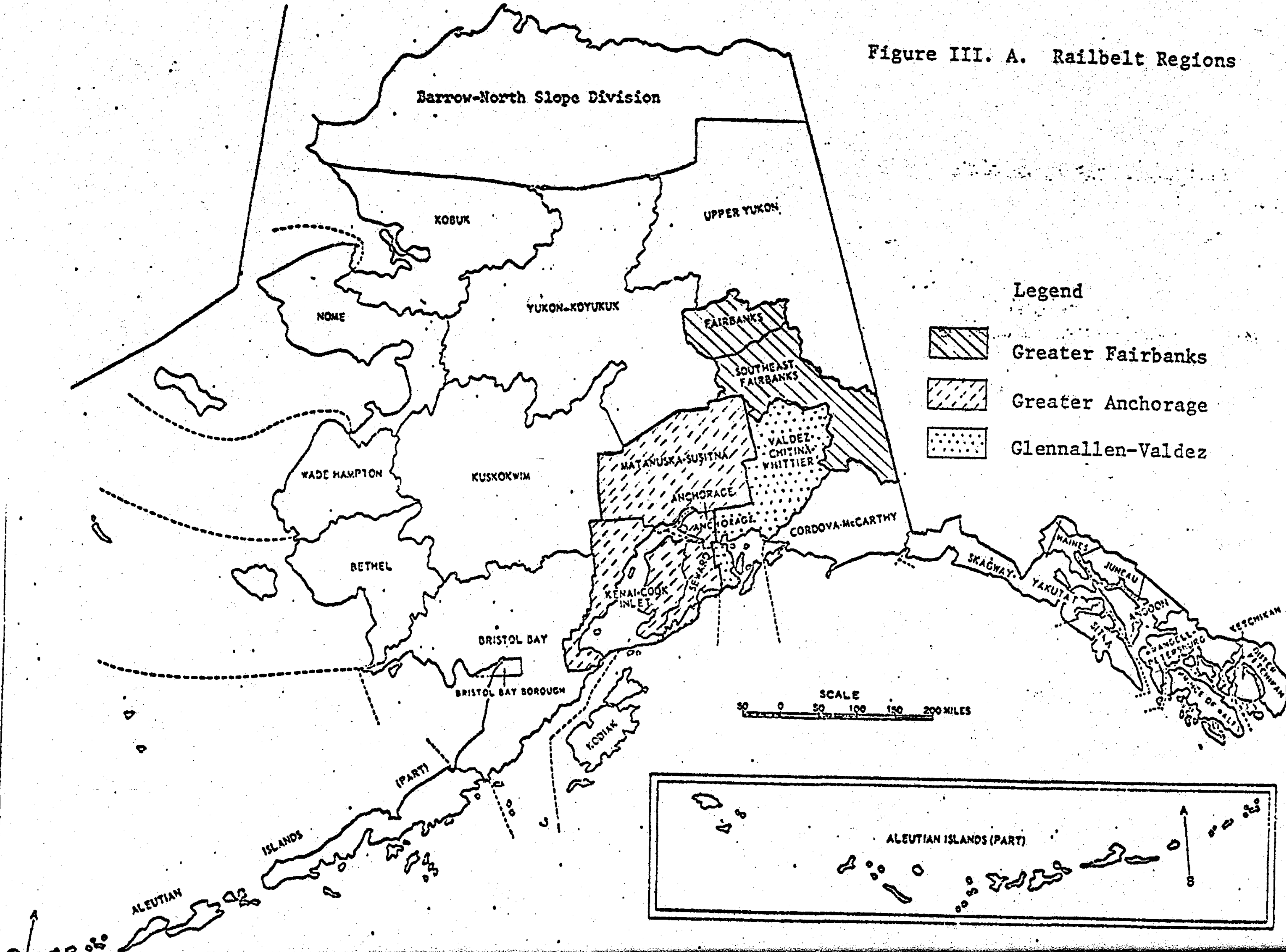
SOURCES: 1940 - U.S. Department of Interior, Susitna River Basin: A Report on the Potential Development of Water Resources in the Susitna River Basin of Alaska, 1952.

1951-59 - Bureau of Reclamation, Devil's Canyon Project: Alaska Feasibility Report, 1960.

1965-78 - Sales to Final Consumer from Federal Energy Regulatory Commission, Power System Statement.

1960-64 - Utility System Requirements from U.S. Department of Interior, Devil's Canyon Status Report, 1974.

Figure III. A. Railbelt Regions



with the latter being slightly larger. In the greater Fairbanks area (Fairbanks and Southeast Fairbanks Census Divisions), the commercial-industrial-government load has been substantially larger than the residential load except in the mid-1970s.

The high rate of growth of electricity sales in the railbelt is the result of both more rapid growth in the number of customers and in consumption per customer. Table III.4. compares the number of customers and annual growth in the number of customers over a recent period in the railbelt with the United States. Growth in the railbelt has exceeded

TABLE III.4. NUMBER OF ELECTRIC UTILITY CUSTOMERS

	Greater Anchorage (10^3)	Greater Fairbanks (10^3)	United States Average (10^6)
Residential			
1965	27.0	8.2	57.6
1978	77.0	17.5	77.8
Average Annual Growth Rate (%)	8.4	6.0	2.3
Commercial			
1965	4.0	1.3	7.4
1978	10.2	2.9	9.1
Average Annual Growth Rate (%)	7.5	6.4	1.6

SOURCES: Federal Energy Regulatory Commission, Power System Statements of Alaska Utilities, U.S. Department of Commerce, Historical Statistics of the United States, Colonial Times to 1970, and U.S. Department of Interior, Susitna River Basin: A Report on the Potential Development of Water Resources in the Susitna River Basin of Alaska, 1952.

the national average for two reasons. First, the railbelt population growth rate between 1950 and 1980 has been much larger than the national rate over the same period. Second, the proportion of households served by electric utilities was lower for Alaska than for the United States over much of the historical period so that some growth in the number of customers served occurred independent of population growth.

Table III.5. compares average annual consumption in the residential sector in greater Anchorage, greater Fairbanks, and the United States. Overall, the greater Anchorage area growth rate per customer has been about equal to the U.S. average, but the growth has been concentrated in the 1970s. In Fairbanks, the overall growth rate has exceeded the national average with all the growth occurring between 1965 and 1975. The same general pattern can be observed in the commercial-industrial-government sector.

Nationally, in the household or residential sector, the growth in electricity consumption has greatly exceeded that of energy in general. Although the overall annual growth rate for energy consumption in the residential sector (net of transportation) was 3.4 percent between 1950 and 1975 (household formation was 2 percent), the growth rate for electricity consumption was 7.2 percent annually so that between 1950 and 1975 electricity's share of residential consumption grew from 18 percent to 43 percent.[1] A considerable portion of this increased electricity share can be attributed to a substantial increase in electric space heating which accounted for less than 1 percent of households in 1950 but had risen to 12 percent by 1974.[2] Substantial increases in the proportion of households using electricity for hot water and cooking as well as growth in the percentage of homes having air conditioning also helped contribute to rapid growth in electricity's share of the residential sector.

TABLE III.5. AVERAGE ANNUAL RESIDENTIAL ELECTRIC USE PER CUSTOMER

(MWh)

	Greater Anchorage	Greater Fairbanks	U.S. Average
1950	2.4	-	1.8
1965	6.4	4.8	4.9
1966	6.9	5.7	5.3
1967	6.9	-	5.6
1968	6.8	6.6	6.1
1969	7.0	7.7	6.6
1970	7.5	8.4	7.1
1971	8.5	9.5	7.4
1972	8.8	10.5	7.7
1973	9.2	11.2	8.1
1974	9.0	11.6	7.9
1975	10.1	13.7	8.2
1976	10.8	12.6	8.4
1977	10.4	11.5	8.7
1978	10.9	10.2	8.8

SOURCES: Federal Energy Regulatory Commission, Power System Statements of Alaska Utilities, U.S. Department of Commerce, Historical Statistics of the United States, Colonial Times to 1970, and U.S. Department of Interior, Susitna River Basin: A Report on the Potential Development of Water Resources in the Susitna River Basin of Alaska, 1952.

The most important uses of electricity in the residential sector nationally are for space heating, water heating, refrigeration, cooking, air conditioning, and lighting.

In the Alaskan railbelt, electric space heating in 1978 was used by about 17 percent of the housing units, which contributed to both a larger proportion of total residential energy requirements supplied by electricity than nationally and also a larger portion of electricity use allocated to space heating. Table III.6. shows that the large proportion of housing units heating with electricity and the large unit requirements because of the number of heating degree days (as well as a lack of any substantial air conditioning load) result in a much larger proportion of railbelt residential electricity use for space heating than found nationally. Refrigerators, water heaters, lights, and cooking are next in order of importance.

In the commercial sector nationally, the same general growth patterns of electricity use emerge as in the residential sector. Between 1950 and 1975, annual growth of total energy use (net of transportation) was 4.4 percent; while that of electricity was 6.9 percent, so that its share of the total increased from 34 to 61 percent during the period.[3] The majority of commercial consumption of energy (and electricity) is in retail-wholesale trade, education, finance and other office, and health-related activities. In contrast to the residential sector, space heating and water heating are relatively unimportant. Table III.7. shows the proportions of electricity in various uses in the commercial sector in 1975.

Historically, lighting, cooling, and electromechanical uses of electricity have increased relative to space heating and water heating.[4] Substantial variation in end-use patterns for electricity exists among different types of consumers. Among the four primary commercial consumers, educational facilities use considerably less, and hospitals considerably more, than average amounts of energy for cooling, space

TABLE III.6.
1978 RAILBELT RESIDENTIAL ELECTRICITY CONSUMPTION
Part I: Appliances

		GREATER ANCHORAGE AREA			GREATER FAIRBANKS AREA			GLENNALLEN-VALDEZ AREA		
Households Served			65,250			15,250			1,340	
Appliance	Unit Consump. (kWh/yr.)	Appliance Saturation Rate (%)	Electric Mode Split (%)	Total Elec. Consump. (MWh)	Appliance Saturation Rate (%)	Electric Mode Split (%)	Total Elec. Consump. (MWh)	Appliance Saturation Rate (%)	Electric Mode Split (%)	Total Elec. Consump. (MWh)
Water Heater	3,475	99	34	76,319	97	43	22,103	91	40	1,695
Range	1,200	100	64	50,111	100	81	14,823	100	40	643
Elec. Dryer	1,000	71	90	41,693	66	98	9,863	48	75	483
Refrigerator	1,250	100	100	81,561	100	100	19,063	100	100	1,675
Freezer	1,350	46	100	40,519	42	100	8,647	43	100	778
Dishwasher	230	47	100	7,053	36	100	1,263	11	100	34
(Water)	700	--	16	7,308	--	15	1,601	--	4	38
Clothes Washer	70	77	100	3,517	74	100	790	65	100	61
(Water)	1,050	--	26	17,813	--	31	4,964	--	24	338
Television	400	148	100	38,627	149	100	9,089	80	100	429
Air Condition.	400	0	100	0	1	100	61	0	100	0
Total Major Appliances				364,521			92,267			6,174
Lights	1,000	100	100	65,250	100	100	15,250	100	100	1,340
Small Appl.	1,010	100	100	65,902	100	100	22,358[a]	100	100	1,786[b]
Total Appliances	13,135			495,673			129,875			9,300
Consumption/Household Served (kWh)			7,597			8,516			6,940	

[a] 1,466 kWh per household   [b] 1,333 kWh per household

TABLE III.6. (continued)
1978 RAILBELT RESIDENTIAL ELECTRICITY CONSUMPTION
Part II: Space Heating and Totals

	GREATER ANCHORAGE AREA				GREATER FAIRBANKS AREA				GLENNALLEN-VALDEZ AREA			
Housing Units Served	71,873				17,500				1,500			
Housing Type	Unit Consump. (kWh)	Housing Mode Split (%)	Elec. Heating Mode Split (%)	Total Elec. Consump. (MWh)	Unit Consump. (kWh)	Housing Mode Split (%)	Elec. Heating Mode Split (%)	Total Elec. Consump. (MWh)	Unit Consump. (kWh)	Housing Mode Split (%)	Elec. Heating Mode Split (%)	Total Elec. Consump (MWh)
Single Family	32,000	52	18.8	224,714	45,900	52	7.3	30,491	31,700	31	2	295
Duplex	21,200	8.3	18.4	23,203	30,400	7.3	7.2	2,796	20,900	13	0	0
Multifamily	15,000	26.7	19.9	57,396	20,200	27.7	10	9,792	13,900	13	0	0
Mobile Home	23,900	13	18.4	40,478	35,100	13	7.3	5,829	24,200	43	0	0
Total Space Heat				345,791				48,908				295
Consumption/Housing Units Served (kWh)	4,811				2,795				197			

SUMMARY

	Greater Anchorage Area	Greater Fairbanks Area	Glennallen-Valdez Area
Total Residential Consumption (MWh)	841,464	178,783	9,595
Appliance Consumption (MWh)	495,673	129,875	9,300
Space Heat Consumption (MWh)	345,791	48,908	295
Consumption/Household (kWh)	12,896	11,724	6,397

TABLE III.7. NATIONAL PROPORTIONS OF ELECTRICITY IN VARIOUS USES IN THE COMMERCIAL SECTOR, 1975

Lighting	41
Cooling	36
Other (primarily electromechanical uses)	15
Space heating	7
Water heating	1

SOURCE: Jerry Jackson and William Johnson, "Commercial Energy Use: A Disaggregation by Fuel, Building Type, and End Use," Oak Ridge National Laboratory, 1978, Table 5.

heating, and electromechanical uses; while hospitals use considerable amounts for water heating, and educational facilities use considerably smaller amounts for lighting.[5]

It is difficult to compare Alaskan railbelt commercial electricity use with these national patterns because of the lack of data on Alaskan consumption. Air conditioning is present but to a much smaller degree, and a portion of this demand is met by natural gas. Electric space heat is probably not more important in Alaska than nationally in spite of the higher incidence of electric space heat in the residential sector. This is because a larger proportion of the commercial load is in areas accessible to natural gas.

In this study, both the government and industrial sectors are combined with the commercial sector because of inconsistency of reporting of the government sector (included in commercial by some utilities) and the small size of the industrial sectors, as well as the fact that some utilities combine the commercial and industrial sectors for reporting purposes. Because of the presence of industrial users in the Alaskan data, one might expect a larger proportion of electricity attributable to electromechanical and other industrial uses. However, it is clear that industrial use of electricity is a much smaller proportion of Alaskan railbelt needs than national needs. This is evident first from the fact that 46 percent of Alaskan railbelt utility sales are residential compared to 28 percent nationally (1970 national data from Table III.2.). Second, Table III.8. shows that manufacturing activity in the railbelt, as reflected by employment, is relatively limited.

Considerations in Projecting Future Electricity Requirements

Several factors are generally recognized as important in the determination of the amount of energy consumed in various uses and the portion of that energy requirement satisfied with electricity.

PRICE

The price of energy relative to other commodities is important in the determination of how much energy is consumed. The price of electricity relative to other energy prices is an important determinant of how much of that energy consumption is in the form of electricity. Historically, both nationally and in Alaska, the real price of electricity (adjusted for changes in the cost of living) has declined. This has been true even during the 1970s when prices in general and energy prices in particular have moved rapidly upward. As it becomes cheaper, people tend to use more.

The movement of electricity prices in the future and the impact of these price movements on electricity consumption are difficult to forecast. Considerable sophisticated statistical analysis has been done nationally in an attempt to determine the exact relationship between

TABLE III.8.
RAILBELT POPULATION AND WAGE AND SALARY
EMPLOYMENT IN 1978

	GREATER ANCHORAGE AREA				
	Anchorage	Matanuska-Susitna	Kenai-Cook Inlet	Seward	Total
Resident Population	179,000	14,200	19,600	2,900	215,700
Employment Total	88,040	3,090	6,565	1,327	99,022
Mining	1,874	*	805	*	2,740[a]
Construction	6,431	235	485	12	7,163
Manufacturing	1,683	*	989	*	3,103[a]
Transportation-Communication-Utilities	7,924	307	574	*	8,865[a]
Wholesale Trade	4,197	51	240	*	4,498[a]
Retail Trade	12,668	588	950	201	14,407
Finance-Insurance-Real Estate	5,018	128	197	16	5,359
Services	15,526	363	853	164	16,906
Miscellaneous and Farm Workers	459	129	58	*	666[a]
State and Local Government	11,265	1,125	1,324	241	13,955
Federal Civilian	5,140	94	87	72	5,393
Military and Related Federal	15,854	8	3	101	15,966

*Information withheld to protect confidentiality.

[a]Author's estimate.

SOURCE: Alaska Department of Commerce and Economic Development, Division of Economic Enterprise, "Numbers: Basic Economic Statistics of Alaska Census Divisions," November 1979.

TABLE III.8. (continued)
RAILBELT POPULATION AND WAGE AND SALARY
EMPLOYMENT IN 1978 (Continued)

	GREATER FAIRBANKS AREA			GLENNALLEN-VALDEZ AREA
	Fairbanks	Southeast Fairbanks	Total	
Resident Population	54,100	5,300	59,400	5,900
Employment Total	27,061	1,719	28,780	2,043
Mining	54	0	54	10[a]
Construction	1,960	*	1,968[a]	89
Manufacturing	564	*	571[a]	10[a]
Transportation-Communication-Utilities	2,765	24	2,789	362
Wholesale Trade	798	*	805[a]	23
Retail Trade	3,274	86	3,360	236
Finance-Insurance-Real Estate	1,004	*	1,012[a]	56
Services	3,939	157	4,096	409
Miscellaneous and Farm Workers	86	*	93[a]	10[a]
State and Local Government	4,814	281	5,095	790
Federal Civilian	984	45	1,029	48
Military and Related Federal	6,819	1,089	7,908	0

*Information withheld to protect confidentiality.

[a]Author's estimate.

SOURCE: Alaska Department of Commerce and Economic Development, Division of Economic Enterprise, "Numbers: Basic Economic Statistics of Alaska Census Divisions," November 1979.

price and consumption. The studies generally conclude, as common sense would suggest, that higher electricity prices in the future will result in lower rates of growth of electricity consumption than in the past.

Because of a lack of Alaskan data, the inappropriateness of using national estimates of the price-consumption relationship, and the difficulties involved in trying to predict energy prices over the next thirty years, we do not specify a price-consumption relationship. We assume that electricity prices will continue to rise as they have since the mid-1970s and that growth in consumption per customer will generally follow the pattern since that time. That is, the nominal price of electricity will continue to rise, but the real price of electricity may not increase significantly. This is in contrast to the past when the real price of electricity consistently fell.

We assume that the electricity price relative to other fuels will not change in such a way as to significantly shift the proportion of appliances fueled by electricity. This is particularly important for space heating which is the largest single user of electricity per customer.

INCOME

Historically, as household and aggregate incomes have increased, electricity consumption has also grown. This consumption growth is manifest in the residential sector in both a larger stock of electrical appliances and a larger unit consumption of electricity within appliances. In the commercial-industrial sector, the same factors can be observed and, in addition, an increase in the number of commercial consumers. Higher aggregate income means more business activity in trades and services and, consequently, more utility customers.

We assume that real incomes per capita will continue the general pattern of growth of the past. During the years of oil pipeline construction in Alaska, real incomes grew much more rapidly than the national average; but in the post-pipeline era, the level of Alaskan personal income per capita is moving back toward its previous relationship to national trends. This implies more and larger appliances and larger living units in the future.

FUEL AVAILABILITY

In most of the Greater Anchorage area, consumers have a choice among electricity, natural gas, fuel oil, and other fuels for their needs. In Greater Fairbanks and Glennallen-Valdez, natural gas is not available. Changes in fuel availabilities in the future could significantly affect electricity consumption patterns. We assume that there will be no significant change in the availability of different fuels in the future or in the geographic distribution of economic activity and housing units within regions which would significantly alter the fuel-use opportunities available to consumers.

CONSERVATION

Some conservation measures will affect the use of electricity independent of price effects. Federal, state, and local government regulations and incentives can be directed at conservation. Estimating the impact of such conservation measures on consumption is difficult because each policy generally involves technical, institutional, and consumer behavior considerations which, because conservation programs are relatively new, are not well understood. We assume that substantial federal conservation programs are mandated and implemented during the next five years. (Some may be administered by state and local governments.) The effects of these programs will be less than the idealized engineering analyses would indicate, and the impacts will be observed to occur over a period of years because of institutional constraints and the time required for old, less efficient appliances to wear out and to be replaced by more energy-efficient counterparts. The implementation and impact of the automobile fuel efficiency standards is an example of the type of program assumed for electricity conservation.

TECHNOLOGICAL CHANGE

Over a thirty-year period of time, substantial technological change can be expected to occur in the use of electricity as a result of price and other incentives. Some change may result in increased electricity consumption as electricity substitutes for other types of energy. The electric car is an example of a new and possibly very substantial use of electricity which could be energy conserving. Other changes could significantly reduce utility supplied electricity consumption. Co-generation and solar voltaics are examples of this phenomenon.

We do not speculate on the possible impact of these developments on utility electricity sales. Although it is important to consider such developments, they should be analyzed in separate studies which directly involve engineers and other technicians familiar with the prospects and problems of such emerging technologies.

Projection Methodology

Utility-supplied electric power requirements are projected on the basis of an end-use model driven by projections of households, the composition of the housing stock, and employment. A simplified diagram of the end-use model is shown as Figure III.B.

The model is divided into five submodels, each of which uses a different formulation to forecast a portion of total consumption. The submodels are as follows:

1. Residential appliances
2. Residential space heating
3. Commercial-industrial-government
4. Street lighting
5. Second homes

This division was chosen because different variables determine consumption for each of these uses and because further subdivisions, where appropriate

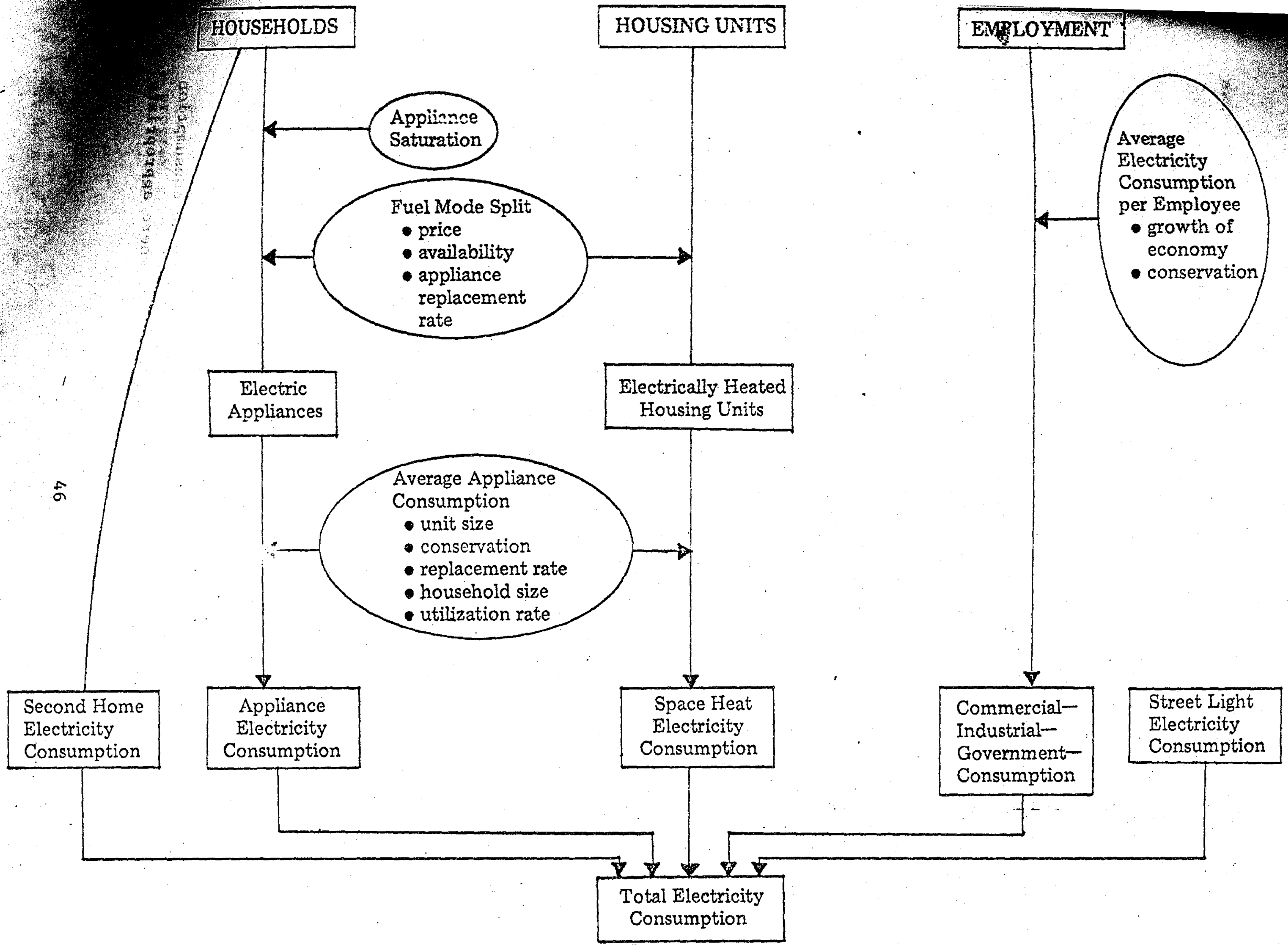


Figure III. B. Diagram of Utility-Supplied Electricity Requirements Model

FIGURE III.B.

(the commercial-industrial-government sector), were not possible because of the way the utilities report sales.

The residential appliance model forecasts requirements for nine separate appliances plus lighting and unspecified small appliances. The appliances are as follows:

1. Water heater
2. Range
3. Clothes dryer
4. Refrigerator
5. Freezer
6. Dishwasher
7. Clothes washer
8. Television
9. Air conditioner
10. Lighting
11. Small appliances

These appliances are separately identified because over time we would not expect growth of electricity consumption in the different appliances to respond identically to changes in economic projection variables.

The model first calculates the number of households who own and operate each appliance. This is the product of households, the saturation rate, and, for those appliances that may be fueled by gas or oil, the electric mode split. Average annual consumption per appliance is separately calculated as the weighted average annual consumption of appliances of each vintage, or age group. Newer appliances tend to be larger, but in the future they will also be more energy efficient. Thus, it is important to keep track of the vintage, or age, of appliances as well as how long they last before wearing out.

The residential space heating model forecasts requirements for four different housing types based upon the assumption that the space heating requirements and characteristics of each is different. These divisions are as follows:

1. Single family
2. Duplex
3. Multifamily
4. Mobile home

The number of housing units determines the potential electric space heating load. (Each household corresponds to or resides within a housing unit, but because of vacancies, there will normally be more housing units than households.) We assume all housing units must be heated even if unoccupied as long as they are available for a household. As in the case of appliances, only a portion of all heating systems will use electricity--the electric mode split. The model also estimates the average consumption per unit. The product of the number of units and average consumption is total residential space heating consumption. In addition to different housing types using different amounts of energy for space heating, newer units use more fuel because they are larger; but in the future, they will be more efficient. Also, older units may be retrofit to be more efficient. Thus, the average unit consumption will vary with the age of the unit.

The commercial-industrial-government model is much simpler because of a lack of data. Nonagricultural wage and salary employment serves as a proxy for establishments. New establishments are equivalent to increases in employment. New establishments, since most of the electricity consumption is determined at the time of construction, consume electricity at different rates than existing establishments whose consumption remains constant.

These three model components account for about 99 percent of utility sales. The remainder is miscellaneous, composed of street lighting and second or vacation homes. For simplicity, street lighting is a small, fixed percentage of sales in other categories. Consumption by second homes is based on a very rough estimate of the number of households with second homes.

The parameters used in the model are derived from analyses of a large number of sources, both within and outside the state. None are based upon econometrics or other sophisticated techniques because of data limitations. Because of the severe data limitations and the novelty of this approach within Alaska, a large degree of judgment is involved in choosing parameter values. They are all explicit and explained in the appendixes.

An important part of model development is model validation, that is testing the model before it is used to gauge how well it forecasts. Two partial tests of the model were done. The first was a "backcast" to see how well the model, calibrated on 1978, could predict consumption in 1970 and 1960. The model predicted too high. The problem was traced to a probable underestimation of the growth rate of average appliance consumption for which adjustments were subsequently made.

A second test would be to predict 1979 consumption since preliminary 1979 figures began to become available after the model was constructed. The model projects an 8 percent growth between 1978 and 1980, including a shift to a normal winter in 1980 from an abnormally warm one in 1978 (which would account for about one-quarter of the projected growth). Actual growth between 1978 and 1979 was 3 percent; so that if growth between 1979 and 1980 were also 3 percent, independent of weather-related factors, the model will have predicted well for an initial two-year period. It appears as though there was a slight underestimate of growth in residential space heating demand in the outlying areas of the Greater Anchorage region for 1979, but this may correct itself in 1980. Although it is some consolation that the model appears reasonable in the short run, its validity in the long run is more important. Further analysis of the model structure and methods used to determine the parameters is the only way to assure that the model is appropriate for long-run analysis.

Electric Power Requirements Projections

One set of assumptions about electricity consumption behavior was applied to three sets of economic projections. The economic projections are minimum, maximum, and most likely economic growth cases. All economic cases are assumed to be identical with respect to relative energy price, per capita income, energy availability, and conservation measures. The major assumptions about electricity consumption in the projections are as follows:

- The electricity market is presently in relative equilibrium except for space heating use of electricity in Fairbanks where a significant shift away from electric space heat is underway.
- This relative equilibrium (in terms of the price of electricity relative to other fuels) is projected to remain in effect throughout the period of the projections such that no major shift toward or away from electricity use in favor of alternative fuels occurs.
- This assumption is consistent with a long-run projection of decontrol of energy prices and movement of relative fuel prices towards equivalency as market forces play a larger role in price determination.
- The price of energy relative to other goods and services will continue to rise. The reduction in electricity consumption resulting from this price rise will be more than offset by the effect of rising real incomes acting to increase electricity consumption.
- Federal policies designed to conserve energy will be effective in the area of electric appliance efficiency standards but will have a smaller impact on electricity consumption through the building stock through incentives for retrofitting and the application of new building standards. These programs will go into effect during the 1980s.
- No state conservation policies specifically directed at the use of electricity are implemented.

- No significant state policies designed to alter the price or availability of alternative fuels to consumers or utilities are implemented.
- No new technologies are assumed such as solar voltaics for electricity generation or electric cars.
- Additional growth in population will be centered in utility service areas.
- Assumptions specific to residential appliance electricity consumption include the following:

  1. Growth in major appliance saturation rates generally follows a continuation of national trends.
  2. As appliances wear out, their replacements are generally larger and contain more features requiring more energy. (This assumption is independent of the appliance efficiency standards assumption.)
  3. For some large appliances, the reduction in average household size reduces average electricity requirements.
  4. Changes in consumption rates resulting from changes in the size and other characteristics of the appliance stock occur over a period of time according to the rate at which appliances wear out and are replaced.
  5. Residential electricity consumption not attributable to the appliances specified in the end-use model or to lighting is projected to increase 5 percent annually per household. This assumption reflects both the relationship of appliance purchase and utilization with real income and the development of new electrical appliances not currently available.

- Assumptions specific to residential electric space heating requirements are as follows:

  1. A slight trend toward single-family homes comprising a larger portion of the housing stock.
  2. The average size of new housing units continues to grow in a reflection of a national trend.
  3. No significant shift in the geographic distribution of the housing stock occurs to areas where electricity is the least expensive fuel. At the same time, the

service areas of existing natural gas utilities or the introduction of new gas utilities into regions not now served does not occur.

4. The introduction of alternatives to central space heating which would involve the use of electricity in conjunction with other fuels such as fuel oil, wood, or coal does not result in a significant increase in the space heating load.

5. No significant utilization of electric heat pumps occurs.

- Assumptions specific to commercial-industrial-government utility-supplied electricity consumption include:

  1. Growth in electricity requirements in excess of residential requirements will occur both because employment is projected to increase more rapidly than population and because, without specific conservation measures enacted by standards and regulations, less conservation of electricity will occur in this sector than in the residential sector.

  2. The distribution of end uses of electricity within this sector will not shift markedly over the projection period.

- Miscellaneous utility sales, composed of street lighting and second home use, will grow at rates consistent with overall utility sales and remain an insignificant portion of the total.
- Military net energy requirements are assumed constant in spite of mandated conservation efforts.
- Self-supplied industrial net energy requirements are composed of those projects identified and included in the economic scenarios. They do not include possible projects attracted to Alaska by the prospect of inexpensive electricity.

The projections of utility sales as well as military and self-supplied industrial net generation are presented in Table III.9. and detailed projections by consumer category in Table III.10. for the <u>most likely</u> case and in Table III.11. for the high and low cases.

TABLE III.9. PROJECTED ELECTRIC UTILITY SALES AND MILITARY PLUS SELF-SUPPLIED INDUSTRIAL NET GENERATION

(10^3 MWh)

	Utility Sales						
Year	Anchorage	Fairbanks	Anchorage+ Fairbanks	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

TABLE III.10.
PROJECTED ELECTRIC UTILITY SALES TO FINAL CONSUMERS
(10^3MWh)
GREATER ANCHORAGE
MEDIUM

Year	Residential			Total Residential	Commercial Industrial Government	Misc.	Total
	Large Appliance	Small Appliance	Space Heat				
1978 (actual)	365	131	346	841	884	22	1,747
1980	382	144	395	921	966	20	1,907
1985	464	203	508	1,175	1,238	25	2,438
1990	523	255	578	1,356	1,397	29	2,782
1995	627	334	717	1,678	1,849	37	3,564
2000	753	427	906	2,086	2,319	46	4,451
2005	858	509	1,045	2,412	2,760	54	5,226
2010	975	604	1,198	2,777	3,301	63	6,141
Annual Growth Rate							
1980-1990	3.2	5.9	3.9	3.9	3.8	3.8	3.9
1990-2000	3.7	5.3	4.6	4.4	5.2	4.7	4.8
2000-2010	2.6	3.5	2.8	2.9	3.6	3.2	3.3
1980-2010	3.2	4.9	3.8	3.8	4.2	3.9	4.0

Components may not sum to totals due to rounding error.

TABLE III.10. (continued)
PROJECTED ELECTRIC UTILITY SALES TO FINAL CONSUMERS
(10^3MWh)
GREATER FAIRBANKS
MEDIUM

Year	Residential			Total Residential	Commercial Industrial Government	Misc.	Total
	Large Appliance	Small Appliance	Space Heat				
1978 (actual)	92	38	49	179	243	5	427
1980	95	41	51	187	255	4	446
1985	123	60	48	231	431	7	669
1990	142	78	44	264	470	8	742
1995	175	105	37	317	622	10	949
2000	211	137	25	373	792	12	1,177
2005	242	166	17	425	958	14	1,397
2010	278	200	15	493	1,161	17	1,671
Annual Growth Rate							
1980-1990	4.1	6.6	(1.5)	3.5	6.3	7.2	5.2
1990-2000	4.0	5.8	(5.5)	3.5	5.4	4.1	4.7
2000-2010	2.8	3.9	(5.0)	2.8	3.9	3.5	3.6
1980-2010	3.6	5.4	(4.0)	3.3	5.2	4.9	4.5

Components may not sum to totals due to rounding error.

TABLE III.10. (continued)
PROJECTED ELECTRIC UTILITY SALES TO FINAL CONSUMERS
(10^3MWh)
GLENNALLEN - VALDEZ
MEDIUM

Year	Residential: Large Appliance	Residential: Small Appliance	Residential: Space Heat	Total Residential	Commercial Industrial Government	Misc.	Total
1978 (actual)	6	3	0	10	29	0	38
1980	6	3	0	9	27	1	37
1985	9	5	0	14	49	1	64
1990	10	7	1	18	56	1	75
1995	13	9	1	23	64	1	88
2000	15	12	1	28	73	1	102
2005	18	14	1	33	85	1	119
2010	21	17	2	40	99	1	140
Annual Growth Rate							
1980-1990	5.2	8.8	-	7.2	7.6	-	7.3
1990-2000	4.1	5.5	-	4.5	2.7	-	3.1
2000-2010	3.4	3.5	7.2	3.6	3.1	-	3.2
1980-2010	4.3	6.0	-	5.1	4.4	-	4.5

Components may not sum to totals due to rounding error.

TABLE III.11.
PROJECTED ELECTRIC UTILITY SALES TO FINAL CONSUMERS
(10^3MWh)
GREATER ANCHORAGE
LOW

Year	Residential			Total Residential	Commercial Industrial Government	Misc.	Total
	Large Appliance	Small Appliance	Space Heat				
1978 (actual)	365	131	346	841	884	22	1,747
1980	382	144	395	921	966	20	1,907
1985	444	193	476	1,113	1,113	23	2,249
1990	489	238	539	1,266	1,218	26	2,510
1995	564	301	643	1,508	1,557	32	3,097
2000	679	385	816	1,880	2,060	41	3,981
2005	736	437	900	2,073	2,257	45	4,375
2010	795	494	982	2,271	2,487	49	4,807
Annual Growth Rate							
1980-1990	2.5	5.2	3.2	3.2	2.4	2.7	2.8
1990-2000	3.3	4.9	4.2	4.0	5.4	4.7	4.7
2000-2010	1.6	2.5	1.9	1.9	1.9	1.8	1.9
1980-2010	2.5	4.2	3.1	3.1	3.2	3.0	3.1

Components may not sum to totals due to rounding error.

TABLE III.11. (continued)
PROJECTED ELECTRIC UTILITY SALES TO FINAL CONSUMERS
(10^3MWh)
GREATER FAIRBANKS
LOW

Year	Residential			Total Residential	Commercial Industrial Government	Misc.	Total
	Large Appliance	Small Appliance	Space Heat				
1978 (actual)	92	38	49	179	243	5	427
1980	95	41	51	187	255	4	446
1985	118	58	48	224	389	6	619
1990	135	73	44	251	408	7	666
1995	159	95	36	290	515	8	813
2000	194	125	24	343	686	11	1,040
2005	211	144	16	371	771	12	1,154
2010	230	165	12	407	857	13	1,277
Annual Growth Rate							
1980-1990	3.6	5.9	(1.5)	3.0	4.8	5.8	4.1
1990-2000	3.7	5.5	(5.9)	3.2	5.3	4.6	4.6
2000-2010	1.7	2.8	(6.7)	1.7	2.3	3.2	2.1
1980-2010	3.0	4.8	(4.7)	2.6	4.1	4.0	3.6

Components may not sum to totals due to rounding error.

TABLE III.11. (continued)
PROJECTED ELECTRIC UTILITY SALES TO FINAL CONSUMERS
(10^3 MWh)
GLENNALLEN - VALDEZ
LOW

Year	Residential			Total Residential	Commercial Industrial Government	Misc.	Total
	Large Appliance	Small Appliance	Space Heat				
1978 (actual)	6	3	0	10	29	0	38
1980	6	3	0	9	27	1	37
1985	8	5	0	13	39	1	53
1990	9	6	0	15	44	1	60
1995	10	7	1	18	47	1	66
2000	12	9	1	22	57	1	80
2005	14	11	1	26	61	1	88
2010	15	12	1	28	66	1	95
Annual Growth Rate							
1980-1990	4.1	7.2	-	5.2	5.0	-	5.0
1990-2000	2.9	4.1	-	3.9	2.6	-	2.9
2000-2010	2.3	2.9	-	2.4	1.5	-	1.7
1980-2010	3.1	4.7	-	3.9	3.0	-	3.2

Components may not sum to totals due to rounding error.

TABLE III.11. (continued)
PROJECTED ELECTRIC UTILITY SALES TO FINAL CONSUMERS
(10^3MWh)
GREATER ANCHORAGE
HIGH

Year	Residential			Total Residential	Commercial Industrial Government	Misc.	Total
	Large Appliance	Small Appliance	Space Heat				
1978 (actual)	365	131	346	841	884	22	1,747
1980	382	144	395	921	966	20	1,907
1985	485	211	520	1,216	1,432	28	2,676
1990	574	282	640	1,496	1,719	34	3,249
1995	728	390	842	1,960	2,432	46	4,438
2000	886	509	1,076	2,471	2,991	57	5,519
2005	1,065	646	1,327	3,038	3,903	72	7,013
2010	1,302	817	1,623	3,742	5,094	91	8,927
Annual Growth Rate							
1980-1990	4.2	7.0	4.9	5.0	5.9	5.5	5.5
1990-2000	4.4	6.1	5.3	5.2	5.7	5.3	5.4
2000-2010	3.9	4.9	4.2	4.2	5.5	4.8	4.9
1980-2010	4.2	6.0	4.8	4.8	5.7	5.2	5.3

Components may not sum to totals due to rounding error.

TABLE III.11. (continued)
PROJECTED ELECTRIC UTILITY SALES TO FINAL CONSUMERS
(10^3MWh)
GREATER FAIRBANKS
HIGH

Year	Residential			Total Residential	Commercial Industrial Government	Misc.	Total
	Large Appliance	Small Appliance	Space Heat				
1978 (actual)	92	38	49	179	243	5	427
1980	95	41	51	187	255	4	446
1985	134	66	48	248	513	8	769
1990	162	89	45	296	609	9	914
1995	208	125	38	371	843	13	1,227
2000	257	167	27	451	1,070	16	1,537
2005	315	215	21	551	1,417	20	1,988
2010	387	278	21	686	1,874	26	2,586
Annual Growth Rate							
1980-1990	5.5	8.1	(1.2)	4.7	9.1	6.1	7.4
1990-2000	4.7	6.5	(5.0)	4.3	5.8	5.9	5.3
2000-2010	4.2	5.2	(2.5)	4.3	5.8	5.0	5.3
1980-2010	4.8	6.6	(2.9)	4.4	6.9	5.7	6.0

Components may not sum to totals due to rounding error.

TABLE III.11. (continued)
PROJECTED ELECTRIC UTILITY SALES TO FINAL CONSUMERS
(10^3MWh)
GLENNALLEN - VALDEZ
HIGH

Year	Residential			Total Residential	Commercial Industrial Government	Misc.	Total
	Large Appliance	Small Appliance	Space Heat				
1978 (actual)	6	3	0	10	29	0	38
1980	6	3	0	9	27	1	37
1985	11	6	1	18	97	1	116
1990	13	9	1	23	95	1	119
1995	16	11	1	28	95	1	124
2000	18	14	1	33	102	1	136
2005	23	18	2	43	131	2	176
2010	28	23	2	53	168	2	223
Annual Growth Rate							
1980-1990	8.0	11.6	-	9.8	13.2	-	12.4
1990-2000	3.3	4.5	-	3.7	.1	-	1.3
2000-2010	4.5	5.1	7.2	4.9	7.4	7.2	5.1
1980-2010	5.3	7.0	-	6.1	7.1	2.3	6.2

Components may not sum to totals due to rounding error.

The projected rates of growth of consumption are considerably below historical growth rates and all previous projections. In the most likely case, the average annual rate of growth over the thirty-year period is 4.1 percent with somewhat more rapid growth in the 1990s and somewhat less rapid growth after 2000.

The reasons for projecting slower growth in the future are three:

1. The long-run rate of economic growth of the state will moderate. In the most likely case, the growth of population in the railbelt over the next thirty years is projected at 2.4 percent annually. The statewide population growth rate during the twenty years since statehood has been about 3 percent annually.

2. Conservation measures and other factors will moderate the rate of increase in electricity consumption per customer.

3. Electric utilities will saturate their market areas.

Table III.12. shows the performance of previous electric power requirements studies in predicting the 1980 net energy sales of railbelt utilities. Of nine studies done, six significantly overestimated the growth rate between the time the study was conducted and 1980. Only those studies done before 1970 underestimated the actual growth rate, and all were closer to the actual growth rates than those done since 1970. This suggests that the projections done during the 1970s may have been upwardly biased because of the influence of the overall rapid growth of the economy during the mid-1970s.

The lower projected growth rates of consumption in this report are consistent with recent projections done nationally and in other states. A recent article in the New York Times noted:

> Last year electricity consumption rose only 2.8 percent in this country, down sharply from the 7 percent annual rate of growth that the industry routinely experienced until the early 1970s. So far this year, consumption has actually dropped, by 1.4 percent.

TABLE III.12. PERFORMANCE OF PAST PROJECTIONS OF RAILBELT ELECTRIC POWER REQUIREMENTS

HITTING 1980 ON TARGET[a]

Study Number[b]	Year of Publication	Net Energy (10^3 MWh) Year of Forecast	Net Energy (10^3 MWh) Forecast for 1980	Annual Growth Rate of Net Energy Between Forecast Year & 1980: Implicit in Forecast	Annual Growth Rate of Net Energy Between Forecast Year & 1980: Actual	Percent Error in Forecast of Growth Rate to 1980 (%)
I.1	1952	101	1,600	10.4	12.4	- 16
I.2	1960	320	2,391	10.6	11.1	- 6
I.3	1969	833	2,355	9.9	11.0	- 10
I.4	1974	1,549	3,450	14.3	9.2	+ 55
I.5	1974	1,549	3,543	14.8	9.2	+ 62
I.6	1975	1,851	3,240	11.9	7.3	+ 63
I.7	1976	2,093	2,985	9.3	5.9	+ 58
I.8	1978	2,397	3,000	11.9	4.8	+148
I.9	1979	2,469	3,155	27.8	6.5	+328

[a]Assuming 1980 Net Energy consisting of 2,390 of sales plus 10 percent losses.

[b]See Appendix I.

[c]Net Energy figures calculated from sales plus 10 percent for losses.

One reason is that the mild winter sharply reduced the needs of those who heat their homes with electricity.

"I think what we've seen in the last year is probably the precursor to the 1980s--much, much lower growth rates" said Roger W. Sant, Director of the Carnegie-Mellon Institute of Research. "I suppose 3 percent growth is now the conventional wisdom, but my guess is that it will still be quite a bit lower than that."

The Edison Electric Institute, the trade association for the nation's investor-owned utilities, is now updating its long-term forecast, last published five years ago. William McCollam, Jr., President of the institute, said in an interview that the study analyzes growth rates, over the next 20 years, ranging from 2 percent to more than 5 percent a year.

"But the most important conclusion in our study," he said, "is that factors of choice are far more important than factors of chance. He added, "If the nation doesn't go to what we call the preferred scenario--in the order of magnitude of 4-to-4.5 percent a year--then we are not going to have the healthy economic growth that we ought to."[6]

This article indicates substantial disagreement among experts about what the new long-term trend in the electricity growth rate may be. It is clear, however, that everyone expects the rate to be lower than historically.

California is a state which has done considerable analysis of its energy situation. The state government estimate of electricity sales growth between 1978 and 2000 is 2 percent annually. In contrast, the combined estimate by the large utilities is 3.4 percent. Between 1973 and 1978, the average annual growth rate was 1.2 percent.[7] (This covers the years of the Great Recession and consequently may be downward biased.)

Drawing parallels between Alaskan experience and that of other states or the nation as a whole can be misleading because of different circumstances. Comparisons do suggest, however, that if Alaskan electric power requirements are to grow faster than in other states or the nation, such growth must be attributable to one of several factors:

1. More rapid economic growth
2. Increase in electric space heating
3. Less implementation of conservation measures

Consumption per customer has always exceeded the national average, and its growth is unlikely to be a contributing factor to higher overall growth in electricity requirements.

Detailed sensitivity analysis of the projection results has not been done at this time. It is clear from the projections using the three economic scenarios and the implied slow growth rate of electricity consumption per capita that the projections are more sensitive to the assumptions about economic growth than to those of consumption per capita.

The only case where this is not true would be if there were a significant shift in space heating and residential appliances toward the electric mode. The impact of this could be almost as substantial as that of a shift from the <u>most likely</u> to the <u>maximum</u> economic growth scenario. Such a case is presented for illustrative purposes in Table III.13. Here all of the economic assumptions are the same as the <u>most likely</u> case, and the only changes in the electricity use assumptions involve a greater preference for electricity in the residential sector after 1990. The specific assumptions are as follows:

- In the period after 1990 for Glennallen-Valdez and after 1995 for the remainder of the railbelt, the price of electricity falls relative to that of alternative fuels because of a shift in generation capacity towards coal plants, hydroelectric facilities, or other types of facilities which have costs independent of the prices of natural gas and fuel oil. It is

TABLE III.13.
PROJECTED ELECTRIC UTILITY SALES TO FINAL CONSUMERS
(10^3MWh)
GREATER FAIRBANKS
MEDIUM - ELECTRIC SPACE HEAT

Year	Residential			Total Residential	Commercial Industrial Government	Misc.	Total
	Large Appliance	Small Appliance	Space Heat				
1978 (actual)	92	38	49	179	243	5	427
1980	95	41	51	187	255	4	446
1985	123	60	48	231	431	7	669
1990	142	78	44	264	470	8	742
1995	175	105	37	317	622	10	949
2000	238	137	235	610	792	14	1,416
2005	292	166	399	857	958	19	1,834
2010	345	200	589	1,134	1,161	23	2,318
Annual Growth Rate							
1980-1990	4.1	6.6	(1.5)	3.5	6.3	7.2	5.2
1990-2000	5.3	5.8	18.2	8.7	5.4	5.8	6.7
2000-2010	3.8	3.9	9.6	6.4	3.9	5.1	5.1
1980-2010	4.4	5.4	8.5	6.2	5.2	6.0	5.7

Components may not sum to totals due to rounding error.

TABLE III.13. (continued)
PROJECTED ELECTRIC UTILITY SALES TO FINAL CONSUMERS
(10^3MWh)
GREATER ANCHORAGE
MEDIUM - ELECTRIC SPACE HEAT

Year	Residential			Total Residential	Commercial Industrial Government	Misc.	Total
	Large Appliance	Small Appliance	Space Heat				
1978 (actual)	365	131	346	841	884	22	1,747
1980	382	144	395	921	966	20	1,907
1985	464	203	508	1,175	1,238	25	2,438
1990	523	255	578	1,356	1,397	29	2,782
1995	627	334	717	1,678	1,849	37	3,564
2000	919	427	1,257	2,603	2,319	51	4,973
2005	1,166	509	1,722	3,397	2,760	63	6,220
2010	1,391	604	2,250	4,245	3,301	78	7,624
Annual Growth Rate							
1980-1990	3.2	5.9	3.9	3.9	3.8	3.8	3.9
1990-2000	5.8	5.3	8.1	6.7	5.2	5.8	6.0
2000-2010	4.2	3.5	6.0	5.0	3.6	4.3	4.4
1980-2010	4.4	4.9	6.0	5.2	4.2	4.6	4.7

Components may not sum to totals due to rounding error.

TABLE III.13. (continued)
PROJECTED ELECTRIC UTILITY SALES TO FINAL CONSUMERS
(10^3MWh)
GLENNALLEN - VALDEZ
MEDIUM - ELECTRIC SPACE HEAT

Year	Residential: Large Appliance	Residential: Small Appliance	Residential: Space Heat	Total Residential	Commercial Industrial Government	Misc.	Total
1978 (actual)	6	3	0	10	29	0	38
1980	6	3	0	9	27	1	37
1985	9	5	0	14	49	1	64
1990	10	7	1	18	56	1	75
1995	16	9	14	39	64	1	104
2000	22	12	28	62	73	1	136
2005	26	14	38	78	85	2	165
2010	31	17	51	99	99	2	200
Annual Growth Rate							
1980-1990	5.2	8.8	-	7.2	7.6	-	7.3
1990-2000	8.2	5.5	39.6	13.2	2.7	-	6.1
2000-2010	3.5	3.5	6.2	4.8	3.1	7.2	3.9
1980-2010	5.6	6.0	-	8.3	4.4	2.3	5.8

Components may not sum to totals due to rounding error.

assumed that prices of natural gas and fuel oil rise sufficiently high to make electric power relatively more attractive in the residential sector.

- Replacement appliances in subsequent years are largely electric.
- New additions to the housing stock in subsequent years are primarily electrically space heated, but electric space heat retrofitting does not occur.

CHAPTER III ENDNOTES

1. Eric Hirst and Jerry Jackson, "Historical Patterns of Residential and Commercial Energy Uses," _Energy_, Vol. 2, 1977, pp. 131-140. In this discussion, electricity use is in terms of primary energy; that is, it includes generation and transmission losses.

2. _Ibid_.

3. _Ibid_.

4. Jerry Jackson and William S. Johnson, "Commercial Energy Use: A Disaggregation by Fuel, Building Type and End Use," Oak Ridge National Laboratory, 1978, p. 11.

5. _Ibid_., p. 13.

6. Anthony J. Parisi, "Electricity Use No Longer Soaring, Nation Expected to Benefit in 80's," _New York Times_, April 6, 1980, p. 1.

7. California Energy Commission, _California Energy Demand 1978-2000, A Preliminary Assessment_, August 1979, pp. 1-4.