

ALASKA LEGISLATURE SPECIAL COMMITTEE / SUBJECT FILES 8672

977 SCCOMM44: HOUSE POWER ALTERNATIVES STUDY COMM. 1979-80 977

THERMAL ENERGY CONSUMPTION

(10¹² BTU)

	1980		Δ		2000	
	Use	Raw	Use	Raw	Use	Raw
<u>Residential</u>						
Non-electric	11.06	15.80	8.93	12.76	19.99	28.56
Electric	0.91	3.65	0.73	2.93	1.64	6.58
Total	11.97	19.45	9.66	15.69	21.63	35.14
<u>Non-residential</u>						
Non-electric	7.19	10.27	5.80	8.29	12.99	18.56
Electric	0.5	2.00	0.41	1.64	0.91	3.64
Total	7.69	12.27	6.21	9.93	13.90	22.20
TOTAL	19.66	31.72	15.87	25.62	35.53	57.34

Assuming no change in basic approach to space heat generation.

ELECTRIC ENERGY CONSUMPTION

UNITS ARE 10⁶ KWH

	1980		Δ		2000	
	Use	Raw	Use	Raw	Use	Raw
Residential	548.6	2,194	442.8	1,771.5	991.4	3,965.5
Non-residential	855.0	3,420	690.0	2,760.0	1,545.0	6,180.0
TOTAL	1,403.6	5,614	1,132.8	4,531.5	2,536.4	10,145.5

RAW ENERGY PROFILE

(10¹² BTU)

	1980	Δ	2000
Residential			
° Fuel Thermal	15.80	12.76	28.56
° Electric Thermal	3.65	2.93	6.58
° Other Electric	7.49	6.04	13.53
Subtotal	26.94	21.73	48.67
Non-residential			
° Fuel Thermal	10.27	8.29	18.56
° Electric Thermal	2.00	1.64	3.64
° Other Electric	11.67	9.42	21.09
Subtotal	23.94	19.35	43.29
Other Electrical	0.47	0.37	0.84
Electrical Losses	1.51	1.23	2.74
GRAND TOTAL	52.86	42.68	95.54

Assume electric generation efficiency @ 25% and
6% transmission and distribution losses

WOOD USE CALCULATIONS:

1. Assumptions:

- a. 10% of all residences rely on wood as a fuel source.
- b. The average home is occupied by 2 1/2 people.
- c. The average home is 900 sq. ft.
- d. The average home consumes 90,000 BTU's per square foot per year (without domestic hot water).
- e. The average home heating system is 45% efficient.
- f. Utilization of wood as a primary fuel source is 50%.

2. Annual Chemical Energy Requirements =

$$285,000 \text{ population} \times 10\% \times \frac{\text{Home}}{2.5 \text{ people}} \times 900 \text{ ft.}^2 \times 90,000 \text{ BTU/ft.}^2 \\ \times 1/45\% \times 50\% = 1.03 \times 10^{12} \text{ BTU's/yr.}$$

3. Wood Harvest Requirement

$$\frac{\text{Ft.}^3}{31\#} \times \frac{\text{Acre}}{1325 \text{ ft.}^3} \times \frac{\#}{8,500 \text{ BTU}} \times 1.03 \times 10^{12} \text{ BTU} = 2950 \text{ acres.}$$

COAL-WOOD EQUIVALENCE:

1. $70\#/\text{ft.}^3 \times 8000 \text{ BTU/\#} \times 20' \text{ seam} \times 43,560 \text{ ft.}^2/\text{acre} = 0.48 \times 10^{12} \text{ BTU's}$
2. $0.48 \times 10^{12} \text{ BTU} \times \#/8,500 \text{ BTU} \times \text{ft.}^3/31\# \times \text{acre}/1325 \text{ ft.}^3 = 1374 \text{ acres}$

Notes on wood calculations: See "Alaska's White Spruce" by Forests, North, Ltd. (Prepared for Alaska Department of Commerce and Economic Development) 1979.

CALCULATIONS FOR SOLAR ENERGY USE IN HOT WATER HEATING:

1. Assumptions:

- a. Active solar panels.
- b. Solar energy accounts for 30% of residential hot water heat in 10% of all residences.
- c. Per capita daily hot water use is 20 gallons/day.

d. "R" chart methods are acceptable.

$$285,000 \text{ population} \times \frac{20 \text{ gal.}}{\text{capita}} \times \frac{8.3453\#}{\text{gal}} \times \frac{1 \text{ BTU}}{\#-\text{°F}} \times (100\text{°F})$$

$$\times (365 \text{ days/yr.}) \times 30\% \times 10\% = 0.05 \times 10^{12} \text{ BTU's/yr.}$$

WASTE HEAT RECOVERY CALCULATIONS:

1. Assume:

An additional 20% of heat wasted from the Fairbanks municipal utilities power generation plant is captured for uses as space heat.

$$2. \quad \frac{130,000 \text{ tons of coal}}{\text{year}} \times \frac{16.0 \times 10^6 \text{ BTU}}{\text{ton}} \times 0.7 \times 0.75 \times 0.20 =$$

$$0.22 \times 10^{12} \text{ BTU/YR.}$$

3. Assume a solid waste fired co-generation plant producing 20 megawatts should be installed and the waste heat thereby generated, consumed for waste heat use.

$$20,000 \text{ kilowatts} \times \frac{3413 \text{ BTU}}{\text{KWH}} \times 0.8 \times 0.75 \times 0.75 \times \frac{8760 \text{ Hrs}}{\text{Yr.}} =$$

$$0.27 \times \frac{10^{12} \text{ BTU}}{\text{Yr.}}$$

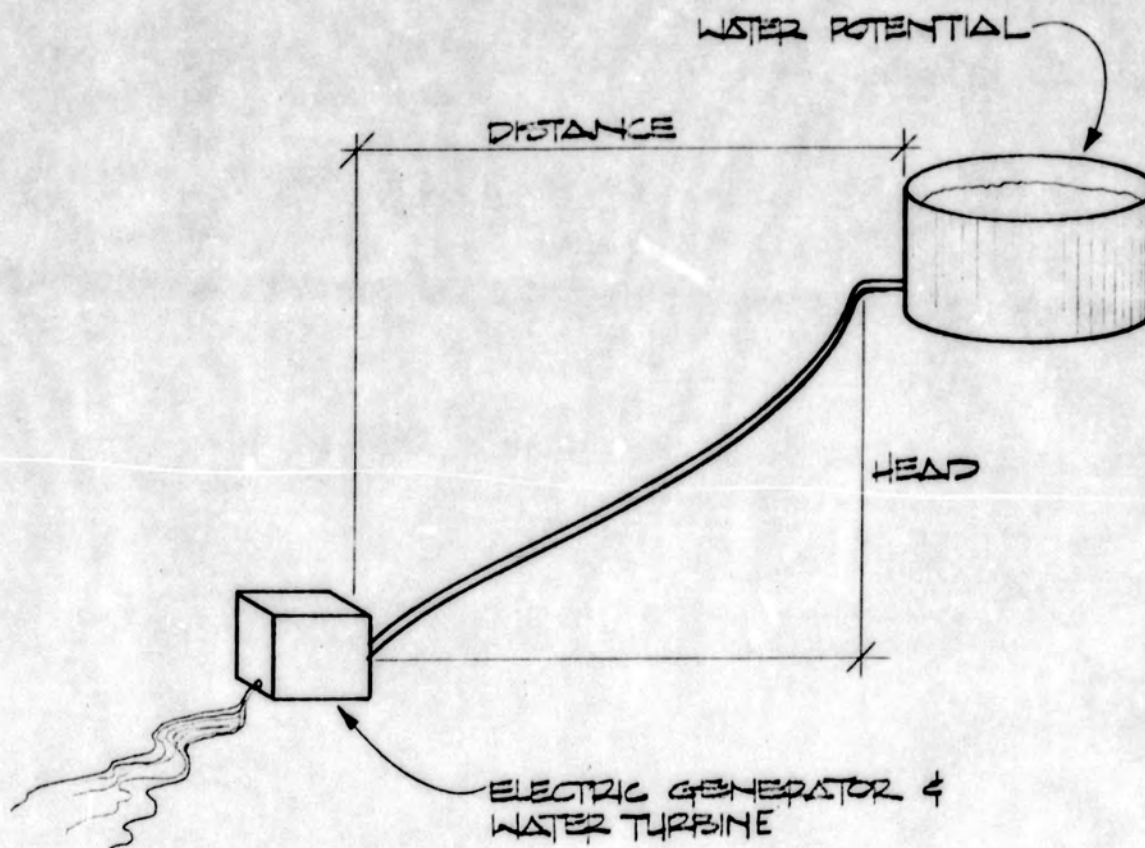
$$\text{Total waste heat capture} = 0.49 \times \frac{10^{12} \text{ BTU}}{\text{Yr.}}$$

SOLID WASTE AS AN ELECTRIC POWER PLANT FUEL

Assume 75% of sold waste in Anchorage may be utilized plus solid waste from surrounding areas.

190,000 tons $\times$ 2000 #/ton $\times$ 5,000 BTU/# = 1.9×10^{12} BTU's of raw energy for electric power plant fuel.

MICRO-HYDRO POTENTIAL INDEX:



Potential Energy = Weight of Water X Head

Potential Power = $\frac{\text{Potential Energy}}{\text{Time of Release}}$

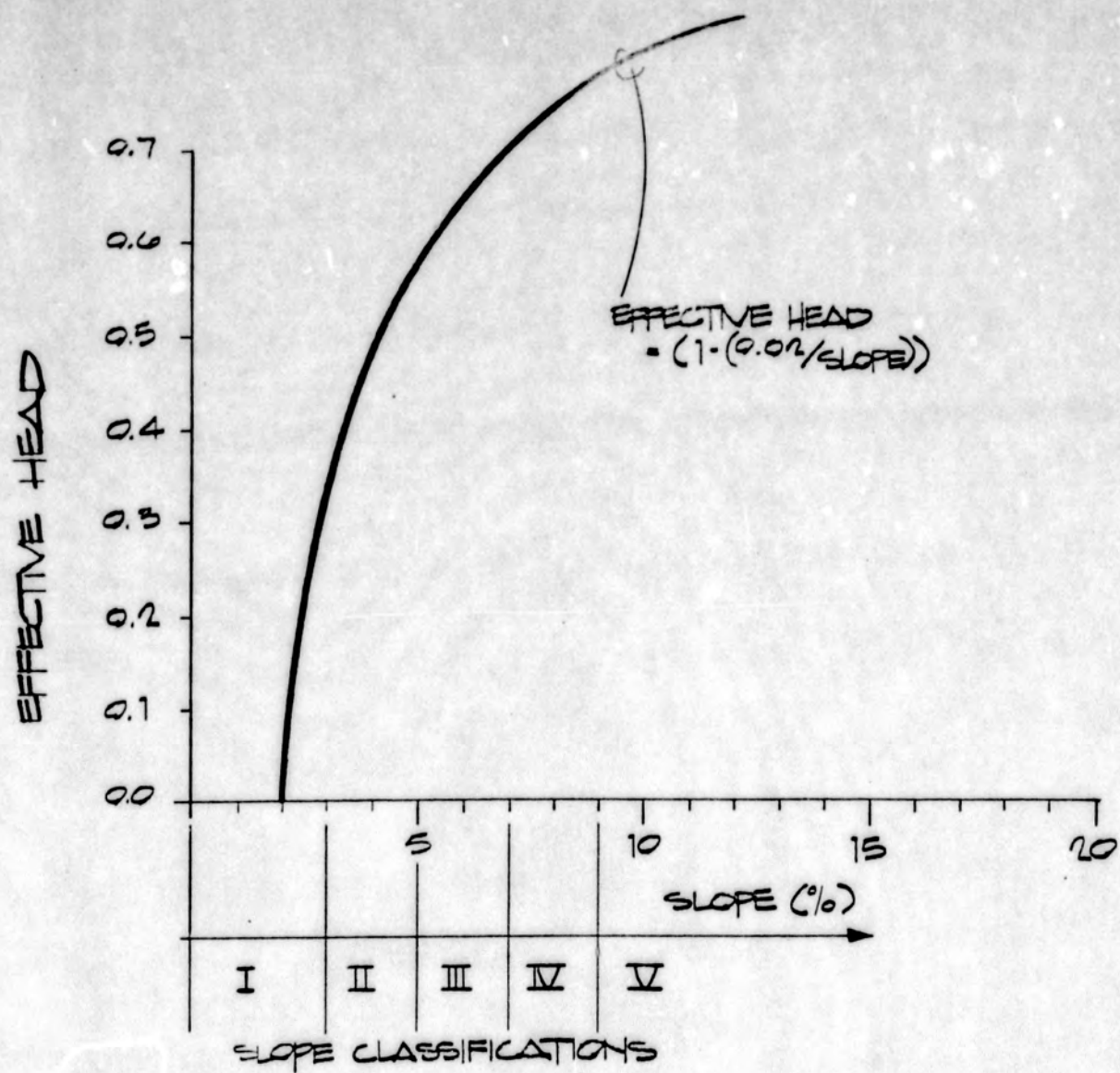
Friction Loss in Pipe = 0.02 Ft./Ft.
(assumed)

Slope = $\frac{\text{Head}}{\text{Distance}}$, Head = (Slope) X (Distance)

Effective Head = (Head - Friction Losses)

Assume Head = 1 Ft.

Effective Head = $(1 - \frac{0.02}{\text{slope}})$



SLOPE RANGE	EFFECTIVE HEAD
0 - 3	0.20
3 - 5	0.50
5 - 7	0.65
7 - 9	0.75
Greater than 9	0.80

Assuming (for example)

1. Basin Area = 10 sq. mi.
2. Precipitation = 24"/yr.
3. Slope Range = 0 - 3%
4. Head = 50'

Continuous power generation potential =

$$\begin{aligned}
 & \underset{\substack{\uparrow \\ \text{PRECIPITATION}}}{24"/\text{Yr.}} \left(\frac{62.4 \text{ #/Ft}^3}{12"/\text{Ft.}} \right) \left(\underset{\substack{\uparrow \\ \text{HEAD}}}{20 \text{ Ft.}} \right) \left(\frac{\text{HP-MIN}}{33,000 \text{ Ft.-#}} \right) \left(\frac{0.75 \text{ KW/H}}{\text{HP}} \right) \times \\
 & \left(\underset{\substack{\uparrow \\ \text{EFFECTIVE HEAD}}}{0.33} \right) \left(\frac{\text{YR}}{525,600 \text{ MIN}} \right) (10) (5280^2) = 9.92 \text{ KW}
 \end{aligned}$$

Example #2

Slope greater than 9%

Precipitation 50"/yr.

Continuous power generation potential =

$$50 \left(\frac{62.4}{12} \right) (20) \left(\frac{1}{33 \times 10^3} \right) (0.75) (0.8) \left(\frac{1}{525,600} \right) (10) (5280^2) = 50 \text{ KW}$$

If system efficiency = 40% and the assumed head for a facility is 50', the indices would relate to:

Potential (KW)	Penstock Length
Less than 50	N/A
50 - 100	Greater than 1500'
100 - 200	1000 to 1500
200 - 300	700 to 1000
Greater than 300	Less than 700'
Basin is 100 sq. miles in extent.	

MICRO-HYDRO

50 plants @ 50 kw each = 2,500 kw.

$$2,500 \times (365 \text{ days/yr.}) \times (24 \text{ hrs./day}) = 21.9 \times 10^6 \text{ kwh}$$

EFFECTED LAND AREA:

Precipitation collected, $(6.22 \times 10^9 \text{ Ft.}^3 / 1.67') / 27,878,400 = 134 \text{ square miles}$
20" precipitation zone

Average micro-hydro head, 150'

$$21.9 \times 10^6 \text{ kwh} \times 2.66 \times 10^6 = 5.83 \times 10^{13} \text{ Foot-Pounds}$$

$$(5.83 \times 10^{13} / 150') / 62.4 = 6.22 \times 10^9 \text{ Ft.}^3$$

Assume average impoundment to be 10' in depth.

$$(6.22 \times 10^9 / 10') / 27,878,400 = 22 \text{ square miles}$$

$$22 \text{ square miles} \times 25\% = 5.5 \text{ sq. mi.}$$

$$5.5 \times 640 = 3520 \text{ acres}$$

POWER POTENTIAL:

$$15 \text{ ft.}^3 / \text{sec.} \times 62.4 \text{ \#/ft.}^3 = 936 \text{ \#/sec.} = 56,160 \text{ \#/min.}$$

$$56,160 \text{ \#/min.} \times 150' = 8,424,000 \text{ ft.} - \text{ \#/min.}$$

$$= 8,424,000 / 33,000 = 250 \text{ HP} = 186 \text{ Kw}$$

****PLEASE NOTE****

**THE ORIGINAL FILE CONTAINS AN OVERSIZED DOCUMENT THAT
IS UNSUITABLE FOR FILMING. PLEASE REFER TO THE ALASKA
STATE ARCHIVES TO VIEW THE ORIGINAL.**

Description:

Diagram/map

Micro-hydropower potential

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A PRELIMINARY EVALUATION
OF
THE I.S.E.R. ELECTRICITY DEMAND FORECAST

(Working Paper #1)

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In October 1979, Energy Probe was asked by The House Power Alternatives Study Committee (HPASC) of the Alaska State Legislature to submit a proposal for a study that would evaluate the electricity demand forecasting method developed by the University of Alaska's Institute for Social and Economic Research (ISER). This report is the first of three to be prepared by Energy Probe, and presents an initial evaluation of the ISER forecasting model and the Man in the Arctic Project (MAP) model on which, in part, the electricity demand forecast is based.

The present report draws on information contained within the Detailed Work Plan submitted November 14, 1979 by Dr. Scott Goldsmith of ISER; May 1979 MAP model documentation; various publications relevant to the future social and economic activity in the state of Alaska; and personal discussions with ISER personnel.

Further reports in this series will deal with the sensitivity of electricity growth in the Railbelt region of Alaska to policy and market induced changes in the social, economic and physical factors which influence electricity growth; and with an analysis of the appropriate role and interpretation of electricity demand forecasts within the broader context of state energy policy development.

Because this report is a working document intended only for use by HPASC members and consultants, it is written in relatively technical language. Our final report, to be prepared by May 1980, will detail the three areas mentioned above in less technical language.

The views expressed herein are those of the authors, and not necessarily the House Power Alternatives Study Committee.

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1. INTRODUCTION

Electricity demand forecasting, like all quantitative forecasting, is an effort to view the past and present in a systematic way with a view towards making reasonable statements about the future. The basic problem is that the future is not known, and indeed cannot be known, even in a probabilistic sense. As a matter of fact, pretending to forecast the future is an indictable offence under the New York State criminal code.^{1.} Similar provisions, we are certain, are in effect elsewhere.

However, analysts often find it necessary to fly in the face of strict legality when the viability of a large project hinges on the need for it in the future. Hence, forecasting has become an integral part of planning for investments in energy, transportation, housing and a myriad of other functional service delivery areas. Forecasting the demand for such services comprises a two-stage process. In the first stage, aggregate social and economic activity is projected into the future (using, for example, the ISER MAP model); the second stage translates this aggregate activity into a detailed forecast of the demand for the product or service in question.

Stage I models tend to be rather ubiquitous, finding application in a number of functional areas. MAP, for example, has been used in a variety of forecasting environments including energy impact analysis and fiscal forecasting. On the other

hand, Stage II models are generally specialized and tailored to the problem at hand. In transportation planning, they are classified under the general heading of travel demand models. In energy demand forecasting, a number of different approaches have been developed, which have met with varying degrees of success. To the extent that a debate over appropriate forecasting methods exists, it is really a debate over the choice of a Stage II approach. In fact, as we argue below, the choice of a Stage II approach essentially dictates the output and hence the structure of the Stage I model to be used.

The argument over Stage II models centers on the extent to which the model should deal with two distinct but equally important aspects of the problem. Given an aggregate forecast from Stage I, should a Stage II model focus on the specific activity involved or should it focus on the decision of the consuming unit? In forecasting within a policy environment concerned with housing, for example, the latter dictates that we examine household budgets, prices and so on. However, a dwelling offers service far beyond simple shelter; amenity, proximity and opportunities for social interaction are but a few of these. Hence, the former approach would argue that the demand for housing is really a composite demand for the services offered by a structure. Transportation and energy are similar. Rarely are they required for their own sake; in reality they are crucial inputs into a number of satisfaction yielding activities.

In electricity demand forecasting it was once possible to

do a reasonable job of prediction by looking at a historical rate of growth and simply plotting future levels of consumption against time. A draftsman with a French curve (or an engineer with semi-log paper) could make a reasonable guess at future demand by simple curve fitting and extrapolation. However, it is logically clear that the growth in the demand for electricity has little to do with the passage of time per se. Rather, it is related to individual decisions to engage in a growing number of electricity using activities over time.

2. STAGE II MODELLING APPROACHES

Attempts to deal seriously with this complexity became necessary in the early years of the 1970's when historical rates of electricity growth ceased to be realized by most electrical utilities in North America. The formation of OPEC and the 1973 Arab oil embargo, with its subsequent increases in petroleum prices, ended the era of cheap energy; and all fuels, including electricity, rose in price rather dramatically. Unfortunately, the econometric demand forecasting models in use at this time² were incapable of dealing with such rapid changes and continued to point to historic or near-historic rates of electricity growth. ISER's 1975 electricity demand forecast for the State of Alaska (with which, we might add, ISER itself was not comfortable) is a case in point. The most telling criticism of its strict time-

series econometric approach is that potentially ludicrous activity forecasts result. In ISER's 1975 effort, initial results indicated a demand for electricity which implied 100% saturation of electric space heating in Fairbanks in the future. The point to be made here is that because individual activity levels are not explicitly identified in aggregate economic models, such models run the risk of implying physically unrealistic activity levels.

End use forecasting models in their pure form take the opposite approach by relying almost exclusively on activities, independent of the underlying economic conditions. The logic is simple: consuming units engage in various activities requiring energy. Energy growth can result from

- (a) engaging in additional energy consuming activities;
- (b) engaging in the same activities more intensively;
- (c) engaging in the same activities less efficiently;
- (d) any combination of the above.

The case of oral hygiene provides a humorous example. A household may switch from "manual" to electric toothbrushing, an additional energy using activity. Given an electric toothbrush, members of the household may wish to brush more regularly. When the toothbrush wears out it may be replaced with a model which delivers fewer brush strokes per unit of energy input. In any of these cases, electricity use increases. In principle, it is possible to examine all electricity use in this manner, noting

that all energy is used in a final form such as heat, light, motion or sound, and that it is transformed from its input form to its final end use form by a "device".

Again, in principle, electricity demand can be projected by forecasting the characteristics of devices and activities. This has become known as the engineering or end use approach to demand forecasting. The most telling criticism of this method in its pure form is that it is not sensitive to changes in prices, incomes and preferences, i.e. the decision aspect of the process modelled in Stage II. This is a generally accurate criticism whose resolution requires an examination of policies affecting the decisions of the individual consuming unit. In further work for HPASC, we will be discussing this problem.

For functional forecasting purposes, an approach is emerging which seeks to overcome the inherent difficulties of both extremes of Stage II modelling methods. The econometric-end use approach (EEU) attempts to deal with electricity use at the level of the activity while recognizing that the decision to own and operate a device, i.e. to engage in an activity at some level of intensity, is inherently a problem of microeconomic choice and therefore sensitive to prices, incomes and the availability of alternatives.
3.

In our opinion, an EEU approach is the only sensible way to forecast electricity demand and to justify a huge expenditure of public funds.

We are pleased that ISER agrees in principle with this general philosophy. The detailed work schedule circulated by ISER lays out a rather impressive plan. We anticipate problems arising because of the extensive data requirements of EEU, which will be intensified by the basic data problems of Alaska: short time-series and a small population. However, we fully support ISER's desire to cast the net widely at first, while recognizing that data, and more importantly time and financial constraints will require the net to be drawn in somewhat.

At this point we would like to comment on the allocation of resources for independent demand forecasting relative to the magnitude of potential capital investments. Given the magnitude of the stakes for a project such as Susitna, i.e. a potential investment of billions of dollars, we felt that far too little money is being spent on this crucial element of project feasibility. ISER will likely argue, and justifiably so, that data is simply not available to construct a full scale EEU model. The missing data, however, is not of the variety which is impossible to collect. With additional resources made available, it could be gathered and incorporated into the forecast model, resulting in a forecast method with which all could be reasonably comfortable.

In the following pages we will review the EEU approach to Stage II and the requirements of a Stage I model to provide requisite inputs into EEU. Our goal is two fold: first to

analyze and suggest approaches to particular problems for the benefit of ISER, and secondly to lay out the logic of ISER's forecasting proposal for the benefit of all consultants involved in HPASC activities. It is our hope that this will facilitate discussion and understanding of ISER's methods and in the longer term, identify avenues for potential policy intervention.

3. THE ECONOMETRIC - END USE APPROACH

EEU begins with the simple proposition that all energy is used in capital items or devices, which perform a specific task, i.e. an end use. Each device, by virtue of its design, has a specific energy input requirement for each unit of useful output, a concept similar to "First Law Efficiency". Devices are owned or rented and operated by consuming units. However, not all consuming units own all types of devices, nor do devices operate at all times. Further, many devices may be powered by more than one fuel. The decisions to own or lease and operate a device are economic decisions made by the consuming unit in light of prices, incomes, preferences and available options. For a given period, say a year, the total energy required by a consuming unit to power a given device is by definition its hours of operation times its power requirement. If the device is electrically powered, this energy demand will contribute to an electricity demand estimate.

Any portion of the electric power consumed by the economic unit which it generates itself, does not contribute to this utility forecast.

There are, of course, many consuming units and many devices. We may translate from the device level at the consuming unit by simply summing over devices and consuming units yielding the following expression for utility electric demand over a period of one year:

$$TUD = \sum_{k=1}^N \sum_{j=1}^M [D_{kj} \cdot E_{kj} \cdot I_{kj} \cdot R_{kj} - S_k] \quad (1)$$

where

TUD = total utility demand (kW.h)

D_{kj} = 1 if consuming unit k has device j
0 if otherwise

E_{kj} = 1 if device j is powered by electricity in consuming unit k
0 if otherwise

I_{kj} = intensity of use of device j by consuming unit k (hours)

R_{kj} = power requirement of device j by consuming unit k (kW)

S_k = amount of self supplied electricity by consuming unit k (kW.h)

N = total number of consuming units

M = number of distinct devices

4.

This is an accounting framework for utility demand. To operationalize it for forecasting purposes, each of the components must be related to known or "knowable" variables. Engineering

knowledge and economic theory suggest potential relationships.

Econometric or other techniques are used to estimate their direction and strength.

For operational purposes it is necessary to group consuming units into classes on the basis of predominant activity within the unit (i.e. residential, commercial, etc.), similarity in patterns of device ownership or energy requirements, or some other appropriate criterion. Clearly, there are losses in precision due to this sort of aggregation. After grouping consuming units into classes, the demand for utility electricity is obtained by the following expression:

$$TUD = \sum_{i=1}^Q CUD_i = \sum_{i=1}^Q \sum_{j=1}^M [N_i \cdot PD_{ij} \cdot PE_{ij} \cdot I_{ij} \cdot R_{ij} - S_i] \quad (2)$$

where

CUD_i = demand for electricity by class i (kW.h)

N_i = number of consuming units in class i

PD_{ij} = proportion of class i consumers owning device j

PE_{ij} = proportion of devices j in class i that are electrically powered

I_{ij} = average intensity of use of device j by members of class i (hours)

R_{ij} = average power requirement of device j owned by members of class i (kW)

S_i = amount of electricity self supplied by class i members (kW.h)

Q = number of consuming classes

The advantage of examining end use demand in this manner is obvious. Not only is it less data intensive than Equation (1), but also, key parameters become easier to pinpoint. For example, in an analysis of a subclass comprised of mobile homes built before 1970, space heating requirements would be rather similar.

Time, of course, is also a crucial consideration which must enter the model in a forecasting environment. The advantage of an end use model is that the factors developed above exhaust the realm of demand factors, and each will change over time. As time passes, classes of consuming units grow or decline, devices become more or less prevalent and more or less "electrical", self-supplied electricity may become more widely used, devices may be used more or less intensively, and device efficiencies will undoubtedly change. The latter is particularly important since many devices will be replaced over the forecast period and those which are not may be "retrofitted" to improve their performance.

While the passage of time is itself not the reason for change, the argument above suggests that it may prove fruitful to view demand growth in a temporal sense. At a point in time we begin with a "stock" of consuming units equipped with devices. Over the ensuing year the consuming unit may disappear, change or modify its collection of devices or means of powering them. In addition, new consuming units may be formed complete with new devices. Presumably these new devices would have energy consumption characteristics different from "old" devices. At the end of the year we

witness a revised "stock" of existing consuming units and devices comprised of the previous year's units plus net increases. This may be taken a year at a time for the entire forecast period yielding electricity requirements for specific annual points and annual increments in demand.

4. THE ISER MODEL AND SUGGESTED APPROACHES AND REVISIONS

In the context of the Railbelt region, EEU makes a great deal of sense for the residential and commercial sectors which, taken together, account for about 86% of Alaska's total electricity demand. Because industrial development in Alaska is largely of the major project variety, it is best to examine these in a case by case manner. Further, with the exception of block heating in vehicles, the transportation sector currently uses an insignificant amount of electricity. Again, this is best viewed as a special case.

ISER's EEU model, Figure 1 in their "Detailed Work Plan", incorporates most of the features of an ideal EEU discussed above. It is a stock/flow model which segregates consuming units into "new" and "old" and deals with four residential subclasses, and segregates devices into six categories including an "other" category for minor appliances.

The commercial sector should be divided into at least the

following groups:

- 1) Public/Institutional Buildings;
- 2) Large shopping plazas/office buildings (say larger than 100,000 or 250,000 sq.ft.);
- 3) Other commercial buildings.

This would be fruitful for two reasons: within each group there are similar requirements for electricity, and policies/programs may be specifically tailored, at a later date, to this particular pattern of consumption and occupancy/ownership.

Missing in ISER's proposed model is a term to account for electricity or energy supplied by the consuming unit and hence not required from a central system. This should be added to the model even though it may not greatly affect the magnitude of the final forecast. A number of considerations warrant its inclusion, not the least of which is the possibility of co-generation of electricity and steam for space heating in large commercial establishments, schools, hospitals, and the like.

The present ISER formulation allows for the scrapping of dwelling units but not for the replacement of appliances within existing units. A number of appliances ISER intends to consider have useful lives of substantially fewer years than either the forecast period or the structure. In ISER's model, this problem could be solved by adjusting the average consumption of appliances on an annual basis. It is better, however, not to confound the efficiency measure with the effect of new appliance stocks.

Given these structural refinements which we consider necessary, the ISER approach to residential and commercial electricity demand forecasting is methodologically sound. Since residential and commercial consumption in the railbelt are quite important, it is necessary to examine the components of the EEU model and to suggest possible approaches to modelling each component. In this case we refer initially to our formulation of EEU above, and explicitly to these elements pertaining to Stage II.

In Equation (2), total utility demand was expressed as the sum of class demands. Class demand is a function of the number of units in the class, the proportion owning various devices, the proportion of these devices powered by electricity, the average intensity of each device's use, the average power requirements of the various devices and the amount of self-supplied electricity. The number of consuming units in each class is essentially a modified form of the output of Stage I which we discuss below. The remaining factors are however, Stage II concerns which we deal with in turn.

PD_{ij} , the proportion of class i units owning device j , is obviously a variable whose value lies between 0 and 1. For certain end uses, i.e. space heating, its value equals unity and will continue to do so over the forecast period. In other cases like clothes drying and refrigeration, its value is a matter of choice, and while perhaps initially close to unity it is variable over the forecast period. In an ideal world we would hope to estimate this proportion on the basis of income level and distribution within the Railbelt Region, bearing in mind that the decision to own a "device" also commits the owner to operating expenses over its lifetime. Hence

the general price level of all competing fuels may be important.

PE_{ij} , the proportion of device j owned by class i which are electrically powered is also a variable whose value ranges between 0 and 1. Again, for certain end uses, especially refrigeration, its value is close to unity and will likely remain so over the forecast period. However, a great deal of choice exists in this area. A useful way to look at this problem has been proposed by Fuss

who suggests the decision to engage in an activity with a specific fuel is essentially separable. In other words, given a decision to engage in an activity, the choice of fuel is essentially a separate question,⁵ made on the basis of relative prices.

The question of the treatment of conservation arises in this instance. If conservation is factored into average energy requirements, then no more need be said. However, if we view each or any device as having a "base-line" energy requirement, then any effort to reduce it involves an explicit tradeoff of electricity for conservation. In this sense, conservation is self supply, and conservation has an average supply price equal to the amortized annual cost of the conservation project divided by the number of kilowatt-hours displaced during a year. Marginal costs may be calculated by assuming, ideally, various levels of conservation and calculating, presumably, a step function for the fuel equivalent value of various conservation schemes. The same logic may be applied to renewable energy projects as well.

We feel it is useful to view conservation and renewables in this way when considering existing activities at a point in time. The major point is that given an existing activity, like space and

water heating (the major ones) the consuming unit can choose not only to switch from one conventional fuel to another but can also choose to supply a portion of its requirements with conservation. In an oil heated home, for example, the household may switch to gas, electricity, or conservation for all or part of its heating on the basis of relative prices. Considering conservation as an explicit fuel represents a useful modification of interfuel substitution analysis.

R_{ij} , the average power requirement of device j in class i , becomes basically an engineering design parameter when conservation is treated as a fuel. Consequently it is a function mainly of vintage, not confounded by retrofit. One item that should be examined is the trend in device efficiencies over time. This may well be an appropriate area for regulation.

I_{ij} , the average intensity of use of device j by class i members is also a consumer choice variable although to a limited extent in the major consumption categories. Actions like reducing inside temperatures and the like are evidence of the economizing behavior of households under this category; how much farther we can go in this area is certainly questionable. In this case, comfort and convenience bound choice from below. To the extent that there is flexibility it is likely price and income related.

The final term in our formulation is S_i , the amount of self-supplied electricity by members of class i . In this instance we suggest that this term be kept pure in the sense that conservation not be viewed as self supply in this term. We include S_i in the

model for the reasons stated above. There is a price at which self-generation or cogeneration becomes attractive whether by means of water power, wind, or conventional fuel. The model should be sensitive to this possibility.

The above relates to our formulation and also to ISER's model. The remaining terms in ISER's model relate to new household formation which we discuss below and the various "scrapping rates". Scrapping of a device involves not only physical deterioration but also economic considerations, one of which is the device's fuel requirements. Logically, the scrapping rate should increase with decreasing energy requirements for new models a particular device. This is extraordinarily difficult to measure and project over time; however, it is something to be kept in mind.

Generally speaking, we are impressed with ISER's proposed method for handling the Stage II modelling of the residential and commercial sectors. With the modifications suggested above we can wholeheartedly endorse ISER's approach and we look forward to working with ISER on further questions of approach and sensitivity analysis. With respect to the ISER approach to non-residential and commercial use of electricity, we reserve judgement since the method has not yet been developed. We will, of course, comment at an appropriate time and we are confident that ISER will take a sound approach, based on their work to date.

5. STAGE I APPROACHES

We now turn to the merits of the MAP model of the Alaskan economy as a Stage I model for econometric end-use forecasting. Regional economic forecasting can take a variety of forms. Some approaches being considered in the "Detailed Work Plan" are input-output analysis, the economic base approach, Curtis Harris' locationally efficient model, and the Delphi technique. These all have strong and weak points but none is a serious contender to a moderately detailed econometric model like MAP.

What is required of the Stage I model? It must provide the number of consuming units in each class for the end use equation. That is, in the number of housing units of several types and the number of firms, employees, square footage, or business volume for commercial and institutional units. It must be sensitive to the scenarios of fast, likely, and slow growth mentioned in the "Detailed Work Plan". It must respond to changes in oil and gas pricing, energy and other major investment projects, national economic trends, and demographic realities including migration. While the current MAP models incorporate most of the latter functions, the restriction of demographic projections to persons (not households or families), the introduction of housing only through the dollar volume of construction, and the lack of other physical measures of economic activity closely related to the number and type of consuming units are major deficiencies. As noted in the "Detailed Work Plan", data must be gathered and incorporated into new versions of MAP.

What regional techniques must be added? In our opinion none of the above mentioned techniques merit much effort.

Input - output analysis is appropriate when a region has a large industrial base which relies to a great extent on inter-industry sales. Alaska does not have such an economy yet, and the method's well-known data-intensity suggests that it need not be considered further. Shortcuts to true regional input-output data gathering -- such as the use of technical coefficients borrowed from other studies -- are inappropriate for an unusual state economy such as that of Alaska.

The strong points of economic base analysis -- a technique which is useful when the regional economy pivots on clearly defined basic industries -- are already contained within the MAP model. The simple economic base methods are too elementary; ISER is well beyond them already in its work. The ^{same} criticism holds for purely extrapolative methods. Just as ruler and graph paper are inappropriate for local forecasting, they are too simplistic for the economic part of econometric-end-use analysis.

Curtis C. Harris developed a regional forecasting model at the detailed industry level based on short time series changes in output by industry and state and incorporating transportation costs estimated by optimization techniques. Alaska clearly is not likely to exhibit consistent locational cost patterns of industrial development necessary to take Harris' approach.

Delphi, a technological and political forecasting technique developed first at the Rand Corporation is unlikely to yield the moderately detailed consuming unit forecasts needed here. However, it may always be considered for developing scenarios for energy projects, general economic growth levels, or energy policy decisions. Hence it is

not a Stage I model but a source of exogenous and policy variable values for any forecasting method.

Among general methods for forecasting regional economic activity, one not yet mentioned is shift-share analysis. This method is based on statistical estimation of the contribution to a state's industrial growth of industry factors and regional factors. It is an excellent basic method which is sufficiently incorporated in a MAP-type econometric approach. While both input-output and shift-share methods are usually performed with a great deal of industry detail, such detail is not needed in our Stage I approach.

What is needed is more detail aimed at household characteristics and building stock characteristics. While data source end points for households are well-known and trusted, a region such as Alaska can have rapid and crucial post-Censal fluctuations in households and household size. As for buildings, only dwelling units are enumerated in the Census. Building stock estimates for non residential units are rare above the city level.⁶ Land use surveys and Civil Defense surveys give spotty data sets, but the building stock is basically an unknown quantity for regions such as states. For the current research, increased information on the building stock is important.

As an expedient it is suggested that housing be looked at in detail (so as to allow better end use forecasts for space and water, heating, lighting, and appliance loads); that large commercial and institutional uses be examined through enumeration of structures; and that the rest be treated by the use of employment or sales estimates.

Recent efforts by others in energy forecasting suggests two approaches: 1) macroeconomic econometric models such as MAP, and 2) microeconomic simulations of consuming unit responses to changes in price, income and the availability of alternatives. The former is necessary to introduce national and major regional trends. The latter is used to discover what the distributional effects of new pricing and supply levels will be.

A study commissioned by a number of New York consumer groups and carried out at Cornell University was used in testimony before the New York State Energy Master Plan Meetings in September 1979.⁷ In this approach, Green, Mounq, and Saltzman utilized a four-sector economic/demographic state econometric model with a partially integrated energy sub-model. The four sectors were residential, industrial, commercial and transportation. All major energy types - electricity, oil, gas and coal - were forecasted simultaneously. This Cornell model as well as another model developed with end use detail by the New York State Energy Office, predicted significantly lower electricity requirements than had previous state plans. It should be noted that while the Cornell Model is not extremely complicated (57 economic equations, 150 demographic equations) it contains household formation functions for each age-sex cohort. Unfortunately the Cornell Model does not give explicit place in its structure to self-supply wood space heating, or conservation.

Furthermore, in the Cornell approach, a microeconomic simulation was linked to the macro model in order to relate income and price changes and restrictions on fuel supply to consumer demand for the

different fuels.⁸ This, of course, requires an extensive data base of individual households studied by survey research methods. In this case a sample of 7000 households was utilized.

While such microsimulation may be beyond current possibilities in evaluating Susitna (and we are not convinced that such further study should be considered extravagant) it suggests again the need to make the energy forecasting version of MAP more oriented to consuming units, households, and to the biggest devices of all, buildings.

Looking in more detail at MAP, based on the May 31, 1979 documentation, we note that it has more than enough economic detail, but not enough demographic information because of households not appearing explicitly. Finally a housing and/or buildings component is lacking; this is a critical shortcoming.

In the "Detailed Work Plan" we support most strongly Items A 7 - 9 on electricity consumption; Item 10 on households, houses, and appliances. These are more important, in our estimation, than the refinement of the MAP economic model per se. They should receive top priority.

Regional disaggregation (Task B) is important, but less so than getting on to EEU forecasting for the Railbelt region as a whole. Thus the Items in D are crucial -- interfuel substitution plus the addition of conservation.

A general evaluation of the MAP models serves to reveal several strengths in addition to the above shortcomings. First despite the limited length of the Alaska data series, the resulting equations are adequate by conventional statistical benchmarks, at least for forecasting use. The detailed fiscal and native/non-native/military results, needed for earlier applications, are well developed, but may not be particularly helpful in the current application.

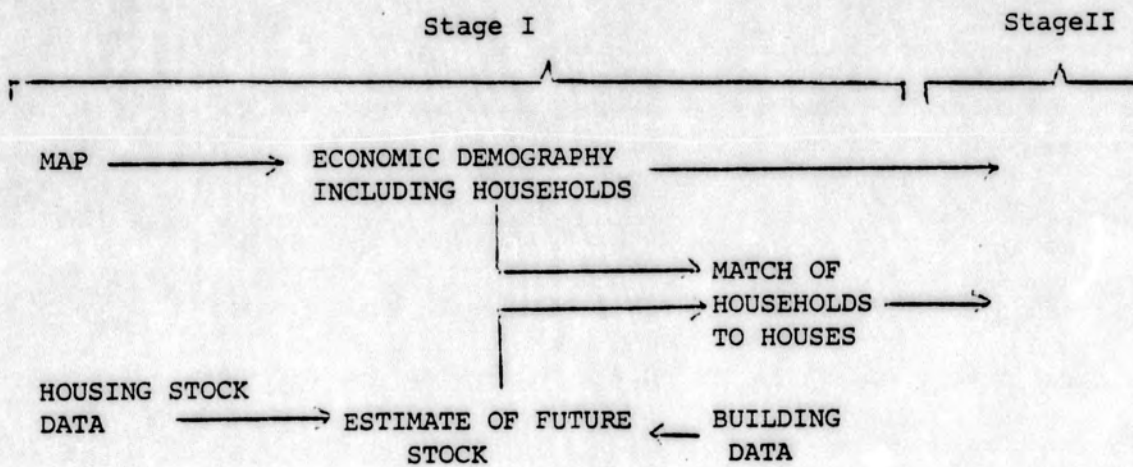
What is needed, more than any other modification, is a housing sub model. Whether the data can be gathered for such an addition remains to be seen. Lacking a formal housing model, some intermediate step is required based on the housing stock data from the decennial censuses. A brief outline of each alternative is in order.

A full-blown econometric sub model for housing would flow from the following modifications to MAP:

- 1) inclusion of household formation equations in the demographic sub model
- 2) a set of equations for the housing stock (or alternatively changes to that stock) by age and type of unit.

Some of the crucial right hand variables would be from the construction and investment functions of the economic model as well as the household formation results.

If the time series data are lacking for the housing modifications to MAP, then the available census benchmarks -- number of dwelling units by age and type -- should be combined with recent data on housing starts, mobile home sales, building permits, etc., to update the distribution of the housing stock. This results in the following structure:



6. CONCLUSIONS

Energy demand forecasting, the most crucial element of energy policy development, is difficult in the face of growing uncertainties. In order to maintain confidence in forecasting procedures, the analyst is faced with the need to develop what amount to relatively more sophisticated models and forecasts than has traditionally been the case.

Pure econometric and pure end use forecasts suffer inadequacies; hence, a blended approach combining the best elements of each is necessary. This blended EEU approach is difficult because of its data requirements and because modifications must be made to the structure of the underlying econometric and end use models on which it is based.

In the long run, an EEU forecasting system for Alaska can be developed with MAP, suitably modified, at its heart. Its data requirements are not yet attainable in a small region such as Alaska with a short data history. Therefore, in the short term, ad hoc forecasting must be carried out with the outputs of the current version of MAP. These outputs must be obtained by using a very wide range of input scenarios.

The most crucial shortcoming of the current version of MAP is the lack of a housing sector and this must be bridged by some reasonable if imperfect method of estimating Alaskan housing stock and characteristics in recent years.

7. FOOTNOTES

1. Joan Robinson, "What are the Questions?", Journal of Economic Literature 15, December, 1977, p. 1322.
2. These are an extremely expensive and sophisticated version of semi-log paper. See Herman Daly, "Energy Demand Forecasting: Prediction of Planning?", Journal of the American Institute of Planners, January 1976.
3. Robert W. Shaw Jr., "New Factors in Utility Load Forecasting", Public Utilities Fortnightly, July 19, 1979, pp. 19 - 23.
4. Much as Dr. Goldsmith's is a stock/flow approach to accounting for demand.
5. M. A. Fuss, "The Demand for Energy in Canadian Manufacturing: An Example of the Estimation of Production Structures with Many Inputs", Journal of Econometrics 5, January 1977, pp. 89 - 116.
6. B. Jones, D. Manson, J. Mulford, M. Chain, The Estimation of Building Stocks and their Characteristics in Urban Areas, Program in Urban and Regional Studies, Cornell University, 1976.
7. W. Greene, T. Mount, and S. Saltzman, "Forecast of the Demand for Major Fuels in New York State 1980 - 1994", Technical Report, September 4, 1979.
8. S. Caldwell, W. Greene, T. Mount and S. Saltzman, "Forecasting Regional Energy Demand with Linked Macro/Micro Models", Working Paper in Planning #1, Department of City and Regional Planning, Cornell University, January 1979, forthcoming in Papers of the Regional Science Association 45.

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STATUS REPORT

HOUSE POWER ALTERNATIVES STUDY COMMITTEE

ALASKA STATE LEGISLATURE

JANUARY 30, 1980

The House Power Alternative Study Committee was established by the Legislative Council in August 1979 to supervise the \$200,000. appropriation contained in Chapter 76, SLA 1979. The legislation mandates completion of a study which discusses the assumptions of the Sustina Hydroelectric Project and the feasibility of alternatives for power generation such as coal, natural gas and small hydro. The appropriation was originally directed to the Legislative Research Division. Because several months of time were lost due to the agency's demise, the study has been somewhat restructured to best meet the requirements of the legislation. We have attempted to plan our work to coordinate with that of the Alaska Power Authority as proposed in the fall of 1979.

The Committee had been guided by the belief that a project of the magnitude of Sustina deserves thoughtful, objective review. The State of Alaska has never before attempted public works planning or construction on this scale. Although we recognize that hydroelectric power is generally superior to fossil-fuel generated forms, Sustina's huge capital costs point out the need for scrutiny from those not intimately involved with the project's construction. The question is not only if Sustina will be built, but at what pace and size once the decision to procede is made.

There are several areas that interested parties have pointed to as deserving greater attention. Although the Committee's concerns have

focused on the economics of the project, we will mention some of the other problem areas. The next few paragraphs highlight these gaps in present knowledge.

Power market demand analyses which include current data, and use state of the art analytic techniques, have not yet been performed. The estimate of future power market demand is vital to the project, since the cost of the dam can only be repaid by selling the generated power. If the demand for electric power is less than the capacity of the dam, either consumers will have to pay inordinately high charges for the use of electricity, or the state will have to bail out the largest public works project ever attempted in Alaska.

The uncertainty of the existing demand projections is compounded by the uncertainty of the cost estimates for the project. Sustina will be one of the largest hydroelectric projects ever attempted in a sub-arctic region, and will be constructed in an active seismic area. These engineering problems, which may be solvable with proper effort and money, take on a special significance when one considers the effect of cost overruns. Preliminary economic analysis have shown the project to be the lowest-cost alternative for power generation in the run if cost overruns are modest. Prior experience with large-scale sub-arctic construction is limited, but the conclusions that can be drawn from it are unsettling.

Previous studies that have evaluated the costs and benefits of alternative means of generating power in the Railbelt area have been conducted with less than total rigor. Questions of discounting, cost

overruns, backup capacity and financing costs have been treated critically, if at all. This previous work, by the Batelle Institute and the Alaska Power Administration, did fulfill its assigned task--pointing out the best alternative for more detailed study. The Phase I feasibility study that will provide the foundation for the decision to build the project must contain a fully rigorous cost-benefit analysis.

The legislative and executive branches of government have only begun to consider possible financing options. Should those who will benefit from the project, or the entire state, be required to pay for it? Perhaps the cheapest method of financing would be general obligation bonds, approved by the voters, backed by the full faith and credit of the state. The state can earn a return on surplus cash that is greater than our cost of borrowing in such a situation. If the costs of the project are met from the general fund, and repaid into the general fund as the power is sold, the citizens of the state will be foregoing use of the cash while paying more for the project in the long run - without being required to approve such a plan. In either case, the costs of the project would be subsidized by the entire state for the benefit of Railbelt consumers of electricity.

If the project were financed with revenue bonds, to be repaid from the sale of Sustina power, the market would fix the real costs of the project by evaluating the likelihood of repayment. The greater the confidence with which the market views the projects chance of success, the lower the interest rate on the revenue bonds. A gua-

rantee of such debt would distort borrowing costs. Again, such a guarantee (similar in concept to a general obligation bond) would amount to a statewide subsidy for the project, without the benefits of a direct vote. The question of such subsidy, which normally would seem unfair when only one region is receiving direct benefits, is complicated because approximately two-thirds of the state's population lives in the area that would receive power from the project.

The alternative sources of power for the Railbelt area have not been adequately explored. Sustina appears to be the best option; however, thorough analyses of the potential of natural gas, small-scale renewable energy sources and conservation/efficiency efforts have not been done. All of the alternatives to Sustina could potentially provide electricity to Railbelt consumers at a much lower cost than the dam. Until they have been given proper attention by independent specialists, their potential should not be dismissed.

Other concerns exist because of the dam's location on a stream that generates a large portion of one of the most valuable fisheries in the state. Although the dam will be built beyond the tributaries where salmon spawn, changes in stream flow levels, siltation and temperature will effect the salmon runs. Again, adequate studies need to be performed before a decision on the Sustina project is reached. No comprehensive study program of the Sustina River fisheries has been started, although construction of the project has been contemplated since statehood.

The placement of the dams in an active seismic area is another reason for caution. The stresses that result from filling large reservoirs have been known to trigger earthquakes, and such earthquakes could result in destructive flooding and loss of life. If the state is to attempt this project, it must do so in full understanding of the seismic risks and attendant design costs.

Since taking full control of the project this past fall, the Alaska Power Authority has begun the process of designing a Phase I Plan of Study that will fully evaluate the problem areas expressed above. The Committee's work has been designed to guide and support their efforts, to ensure the wisest planning and decision-making. The Committee is fortunate to have an excellent working relationship with the Power Authority. We have coordinated our study with the Authority as much as possible to prevent duplication of effort while providing criticisms of their work at the most useful times.

Briefly, the Committee has work in progress, or plans to complete work in the following areas:

1. Power Market Demand
2. Potential for Conservation and Alternative Energy Sources
3. Potential of Natural Gas
4. Criteria for Evaluation of Project Benefits and Costs
5. An Overview of the Policy, Management and Financing Issues Central to the Sustina Project.
6. General Tracking of Phase I Study Progress

A detailed description of the Committee's work to date follows.

1. Power Market Demand Projections

This section of the study is being performed by the University of Alaska's Institute for Social and Economic Research. The Alaska Power Authority has participated in the design and funding of this analysis, and will use the results of ISER's work for the power market demand section of the Sustina Phase I study.

The ISER study will include a methodological review, data collection and updating, economic projections, assessment of interfuel substitution possibilities, electricity use projections and an assessment of the probabilities of the various scenarios and projections. The Institute is using a combination of econometric modeling and end use forecasting, the first time that this approach has been used in Alaska. This new (to Alaska) approach by ISER provides a more accurate method of forecasting demand in a time of volatile energy prices.

The Committee has retained Energy Probe of Canada to work with ISER in evaluating the suitability of their modeling, and to provide the Committee with an evaluation of ISER's work. A draft report by Energy Probe is available at this time. The Committee has also retained Brad Tuck, an economist at the University of Alaska School of Business, to provide an assessment of the ISER work.

2. Potential of Conservation and Renewable Energy

This section of the study will evaluate the portion of power

demand that might be met by improved conservation, or efficiency in energy use, and the use of small-scale, alternative energy sources. The Alaska Center for Policy Studies is managing this section of the study, which also includes an analysis of the end uses of energy in the Railbelt area. Various portions of this section are being performed by Mark Fryer and Assoc., The Federation for Community Self-Reliance, the Alaska Public Interest Research Group and Richard Seifert.

3. Natural Gas

This section of the study is being done under the direction of economist Gregg Erickson. It will address the institutional limitations on the future use of natural gas for power generation, the future price and availability of natural gas, the efficiency of gas fired generations facilities and the potential for the use of natural gas in direct consumer applications.

4. Overview

Arlon Tussing and Assoc. has provided, as background document, a review of Alaska electric utilities and the regulatory framework in which they operate, with a brief history of the Sustina Hydroelectric Project. Tussing and Assoc. are also preparing a report for the Committee that will review the major policy issues of the Sustina project, and discuss the management and financing of electric power projects in Alaska.

5. Additional Study Work

Larry Katkin, of Dynamic Research, completed an assessment of the geotechnical aspects of the Phase I Study plan. The Committee plans to have an economist prepare a short paper detailing methodology for the assessment of the various power alternatives, socio-cultural impacts and fisheries studies.

6. Related Legislation

The Committee, in cooperation with House Resources, has designed a comprehensive energy conservation bill. The bill covers state government facility energy use, utility policy, and provides various mandates and incentives for increased energy efficiency in the residential, commercial and industrial sectors. The legislation, entitled, "An Act Establishing A State ^{Energy} Conservation Policy", will be introduced by the first week of February. The Committee has actively participated in the design of the House of Representatives "energy package".

House Bill 570 was introduced, and appropriates 7.5 million dollars to the Power Authority for fiscal year 1981, at which time the Authority expects to be ready to make a go/no go decision on the project. The bill also includes 90,000. dollars for continued legislative oversight of the Phase I study. The evaluation of power alternatives will be the primary focus of the oversight. It cannot be performed until later this year, when the Authority will be reviewing all of the available alternatives in detail as part of the FERC

licensing procedure. An appropriation for University of Alaska geophysical work in the Sustina River basin is also contained in HB 570. The program would provide experience for University geology students that would aid them in efforts to participate in Phase II of the Sustina effort.

7. Participation in the Alaska Power Authority's Selection of a Private Firm to Carry Out the Phase I Plan of Study

The Committee analyzed the three voluminous proposals submitted to the Authority by Acres American, International Engineering and Harza. Katkin, a geotechnical consultant, was retained by the Committee to review the quality of the geotechnical aspects of the proposals. The Committee focused on the sections of the study dealing with power market demand projections, power alternatives, environmental impacts and public participation.

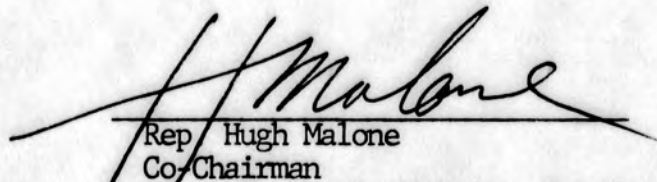
Rep. Rogers presented detailed testimony to the board of the Authority. The testimony strongly supported the choice of Acres American for several reasons:

1. Acres possessed the greatest experience with sub-arctic construction and planned to retain the most experienced firm in Alaska for geotechnical work.
2. Acres planned to spend a greater portion of the budget in-state than any of the firms.
3. The Acres proposal contained the most objective and detailed studies of power market demand and power alternatives.
4. The Acres proposal provided for the most extensive and direct public participation process.
5. The Acres proposal provided for the most expert, objective check on the quality of seismic work.

Concurring with the Committee analysis and other testimony, the A.P.A. chose Acres to be the firm to carry out the Plan of Study.

There are over a score of state agencies and legislative committees investigating related energy questions. We have tried to keep everyone apprised of our work, and in turn have enjoyed the benefits of their comments, as well as questions and suggestions from the public. A draft of Power Alternatives Study will be submitted to the legislature on April 15, 1980. A final report will not be available until May, because the power market demand work by ISER cannot be completed until then. A detailed breakdown of our budget is attached.

Any member of the legislature or public is welcome to contact the Committee for further information or copies of available reports. Inquires should be directed to Mark Wittow, Study Coordinator, c/o Rep. Malone, Pouch V, Juneau, Alaska 99811. The phone is 907-465-3711/3799.


Rep. Hugh Malone
Co-Chairman
House Power Alternatives Study
Committee


Rep. Brian Rogers
Co-Chairman
House Power Alternatives Study
Committee

House Power Alternatives Study Committee

Budget Breakdown

January 30, 1980

Total Budget -- \$200,000. Detailed information on each of these contracts is contained in the preceding status report.

Contractual:

Larry Katkin, Dynamic Research Corp.
Geotechnical Analysis (report available) \$1100.

University of Alaska Institute for
Social and Economic Research.
Power Market Demand Forecast 30,000. +
(detailed work plan available) (30,000 from the APA)

Alaska Center for Policy Studies.
Potential for Conservation and
Renewable Energy Use 68,500.
(detailed work plan available)

Gregg Erickson.
Natural Gas Potential 20,000.

Arlon Tussing and Assoc.
Policy, Management and Financing Issues 17,500.

Energy Probe.
Demand Analysis Review 10,000.
(preliminary report available)

Brad Tuck.
Demand Analysis Review 6,000.

Sim Van der Ryn.
Study Design 2,000.

Personal Services

Mark Wittow.
Study Coordinator (at standard A.A. rate) 10,500.

Travel 7,500. (reserved)

The uncommitted portion of the study funding will be used for work on coal potential and criteria for evaluation of costs and benefits.

House Power Alternatives Study Committee

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Pouch V
Juneau, Alaska 99811

Rep. Terry Gardiner
Speaker of the House
Pouch V
Juneau, Alaska 99811

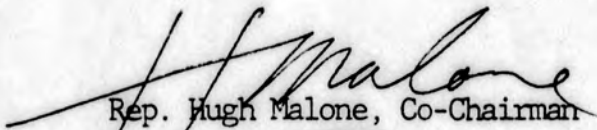
April 15, 1980

Dear Terry:

Chapter 76 of SLA 1979 mandated the completion of a study which discussed the assumptions of the Susitna Hydroelectric Project and the feasibility of various alternatives for power generation in the Railbelt such as coal, natural gas and small hydro. The appropriation was directed to the Legislative Research Division; a report was to be submitted by April 15, 1980.

As you know, the Legislative Research Division was dissolved shortly after Chapter 76 was enacted. The House Power Alternatives Study Committee was established by the Legislative Council in August 1979 to oversee the study. We offer the following report to satisfy the April 15 deadline set out in Chapter 76. A final report will be available by May 20, 1980.

Sincerely,



Rep. Hugh Malone, Co-Chairman



Rep. Brian Rogers, Co-Chairman

Attachments:

1. Power Market Demand Study (by ISER, draft)
2. Review of Demand Forecasting (Tuck, draft)
3. Commentary on ISER work (Energy Probe, draft)
4. End Uses of Energy in the Railbelt (Ak. Center for Policy Studies)
5. Potential for Energy Conservation in the Railbelt (Center)
6. Alternative Energy Potential (Fryer and Assoc.)
7. Susitna Geotechnical Evaluation (Dynamic Research)
8. January 30, 1980 Status Report

9. Background and History - Susitna and Railbelt Power (Tussing and Assoc.)
10. Solar Energy Potential (Center)

To be completed:

1. Analysis of Management, Policy and Financial Issues for Railbelt Power Generation (Tussing and Assoc.)
2. Potential of Natural Gas for Power Generation (G. Erickson)
3. Potential of Coal for Power Generation (G. Erickson)
4. Policy and Management Issues for Energy Conservation and Alternative Energy (Center)

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#44:22

FOR COMMITTEE USE ONLY

BACKGROUND INFORMATION ON
THE ELECTRIC POWER INDUSTRY IN ALASKA AND ITS REGULATION

WITH A HISTORY OF
THE PROPOSED SUSITNA RIVER HYDROELECTRIC PROJECT

FOR THE ALASKA STATE LEGISLATURE
HOUSE OF REPRESENTATIVES
POWER ALTERNATIVES STUDY COMMITTEE

31 December, 1979

ARLON R. TUSSING AND ASSOCIATES, INC.

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INTRODUCTION

This report is intended to provide basic background information for members and legislative staff of the Alaska House of Representatives' Power Alternatives Study Committee, and its consultants and contractors, regarding ---

- *** the existing electric utility industry in Alaska's Railbelt;
- *** the state and federal governmental agencies that promote, plan, and regulate the generation and distribution of electricity in Alaska; and
- *** the history and status of the proposed Susitna hydroelectric project.

Because of the short time the authors had to prepare this report, it is incomplete in some places, is not annotated with respect to sources, and has not been reviewed except by contractor personnel. It is not intended for wide public distribution in the form presented here.

The Contractor, Arlon R. Tussing & Associates, Inc., will repeat the information presented here in a revised and annotated form in a later report to the Committee. The second report will review the technical, economic, and policy issues that the Alaska legislature and the people of Alaska should take into account in considering the proposed Susitna project or alternatives to it.

Barbara F. Morse conducted the research for this report and wrote much of the text, with assistance from Lois S. Kramer. Arlon R. Tussing completed and edited the manuscript in its present form, and accepts full responsibility for any errors.

ELECTRIC POWER INDUSTRY FUNCTIONS

Electric utilities: Generation, transmission, distribution.

The electric power business has three main branches: generation, transmission, and distribution. Electric utilities as power distributors own and operate the local low-voltage lines, transformers, and switching facilities that deliver electricity to retail customers in their respective service areas.

Utilities may also own generating plants (fossil-fuel, hydro, nuclear, etc.), alone or jointly with other utilities, or they may purchase electricity from other utilities, federal power projects, or other entities. Some utilities are wholly self-sufficient, but most utilities buy and/or sell electricity; some are net buyers (buy more than they sell) and others are net sellers at wholesale.

Utilities either own the high-voltage transmission lines connecting the generating plants with their distribution systems, or depend on other utilities or governmental entities to wheel power for them.

Non-utility generation: Cogeneration.

Institutions and industrial plants often produce electricity to meet their own requirements at lower cost than they could purchase power from a utility, or to supplement or backstop utility-supplied power. Where power generation is incidental to, or a co-product of other activities, such as raising steam for space heating or industrial processes, it is called cogeneration.

In Alaska's Railbelt, the chief non-utility power producers are military installations, the University of Alaska at Fairbanks, and petroleum-related installations on the Kenai peninsula.

Interconnection.

Transmission lines owned by electric utilities and other entities are typically interconnected into regional interties or power grids that allow the utilities (and non-utility power producers) to lend, exchange, or sell power to one another. Interconnection helps ---

- (1) to minimize joint costs (one utility can shut down a high-cost generating unit when another utility has surplus power available at lower cost);
- (2) to level daily and seasonal peaks (the loads of different utilities peak at different times of the day or the year; thus interconnection can reduce their joint need for high-cost peaking generation capacity); and
- (3) to meet emergencies (interconnection reduces the utilities' joint need for reserve generating capacity).

In the Anchorage area, the generating capacity of even the two major utilities, Chugach Electric Association and Anchorage Municipal Light and Power, are only nominally interconnected (at the Eklutna substation). In the Fairbanks area, however, there is an intertie composed of Golden Valley Electric Association, the Fairbanks municipal utility, the University of Alaska, and the two military bases.

METHODS OF ORGANIZING AND FINANCING ELECTRIC POWER SUPPLY.

The chief forms of business organization in the electric power industry are private utilities, cooperatives, municipal utilities, and federal agencies.

Private utilities.

Private or investor-owned electric utilities account for about three-fourths of the electricity sold in the United States, but their role is insignificant in Alaska and none currently exists in the Railbelt area.

A private utility is an ordinary business corporation governed by a board of directors responsible to the shareholders, who are typically individuals, other businesses, and financial institutions (insurance companies, pension funds, etc.). Its earnings are taxable, and it has no power to issue tax-exempt bonds.

Most private utilities do business only in a single state and have local operational management, but many are controlled by multi-state utility holding companies that make major construction and financing decisions. State public utility commissions or public service commissions like the Alaska Public Utilities Commission (APUC) typically regulate retail rates and terms of service for private utilities, while in most cases (but not in Alaska), the Federal Energy Regulatory Commission (FERC) regulates their wholesale rates and service.

Cooperatives.

Rural electrification (REA) cooperatives (or coops) are subscriber-owned utilities, governed by a board of directors

elected by the ratepayer-members. Most coops outside of Alaska are distribution utilities for small towns and rural areas, and buy their power from private utilities or federal projects. Coops, however, currently generate more than half of the electricity sold in Alaska's Railbelt. Anchorage-based Chugach Electric Association (CEA), with about 75,000 subscribers, is the largest electric utility in Alaska.

CEA sells electricity to two other coops, Matanuska Electric Association (MEA) and Homer Electric Association (HEA). Golden Valley Electric Association (GVEA), the state's second largest utility, serves the Fairbanks area, the upper Tanana valley, and the Nenana-Healy-McKinley Park area.

The retail business of electric coops is regulated by state utility commissions, including APUC, and their interstate wholesale business is regulated by FERC. As private enterprises, electric cooperatives do not have the power to issue tax-exempt securities, but they can borrow from the Rural Electrification Administration (REA) at 2 and 5 percent.

REA will also guarantee the ordinary bonds of electric cooperatives, most of which they sell to the Federal Financing Bank at rates one to two percentage points below market rates for private utility bonds, and cooperatives can borrow from the National Rural Utility Cooperative Financing Corporation at rates slightly below those of the private market.

Municipal utilities.

The term municipal utility refers to any utility operated by a subdivision or agency of a state or province.

In North America, most municipal utilities are distributors to a single community, and most of them are relatively small. The municipals do, however, include some large-city systems with substantial generating capacity, such as the Los Angeles and Seattle city utilities. In Alaska's Railbelt, there are municipal utilities in Anchorage, Fairbanks and Seward, and the first two, while interconnected with other utilities, generate all or most of the power they sell.

State- or county-chartered public utility districts and state or provincial power or hydro authorities (such as the Alaska Power Authority) are also regarded as municipals.

A municipal utility may be a city, county, or state agency whose accounts are consolidated with the general government accounts, and whose management serves under the direction of the general political authorities (like the Anchorage and Fairbanks municipal utilities). Alternatively, it may be an autonomous government-owned corporation with an independent board of directors and a wholly separate budget, and with the power to make its own construction and borrowing decisions (like the British Columbia Hydro Authority), or something in-between (like the Alaska Power Authority).

In some states, the retail business of municipal utilities is regulated by the state utility commission, and in others it is unregulated. The APUC regulates municipal utility rates and terms of service in Alaska only (1) outside the limits of the municipality, (2) where they compete with other utilities in the same service area (e.g., CEA and the Anchorage municipal utility), or (3) in their sales to other regulated utilities.

The Alaska Power Authority is exempt from APUC regulation, but the APUC may regulate the purchase and resale of Authority-generated electricity by utilities under its jurisdiction.

As agencies of government, municipal utilities are generally exempt from federal, state, and local taxes. The legislation that established the Alaska Power Authority, however, explicitly allows it to make payments in lieu of local property taxes, but does not state who (the local government or the Authority) decides whether or not such payments will actually be made.

Municipal utilities are empowered to issue tax-exempt securities. Most financing of municipal power projects is with revenue bonds, for whose interest and amortization the utility pledges only its own income. In some cases, however, general obligation bonds are issued, under which the full faith and credit of the municipality or state is committed to servicing the debt.

Federal power

Outside of the Tennessee Valley Authority (TVA) (a special case of little relevance to Alaska), federal power in the United States is generated in hydroelectric projects built by the Army Corps of Engineers or the Interior Department's Bureau of Reclamation. The Bureau of Reclamation or a regional subdivision of the Department of Energy (like the Bonneville Power Administration in the Pacific Northwest or the Alaska Power Administration) operates the facilities and markets the power. The Alaska Power Administration operates two projects --- Snettisham near Juneau and Eklutna near Anchorage.

Each federal power project must be approved by Congress several times during its planning, design and construction. The inevitable cost overruns create a need for further rounds of Congressional deliberation, authorization and appropriation. As a result, projects sometimes require decades from their conception to commencement of operation.

FERC reviews rates charged by federal power projects; these rates are supposed to cover operating costs, provide for depreciation, pay interest, and repay principal to the U.S. Treasury on the funds invested. Congress typically stipulates the interest rate for each project in the specific legislation authorizing it. In most cases, interest rates on federal projects have embodied a large subsidy element, because at any particular time they have been only a fraction of the rates paid on U.S. Treasury bonds.

EXISTING RAILBELT UTILITIES.

The viability of Susitna or any other large new state- or federally-operated power plant in the Railbelt depends upon the ability and willingness of the region's existing utilities to market its output. A single utility, the Chugach Electric Association (CEA), directly serves about 45 percent of the Railbelt's retail hookups; and together with three utilities (MEA, HEA, and SYS) that depend on CEA for all or most of their power supply, CEA serves about two thirds of the region's customers. Thus, Susitna probably makes sense only if CEA is willing to participate in the project or to contract in advance for its electricity on a take or pay basis for twenty years or more.

Pages 9 to 11 summarize some of the more important features of the existing utility organizations of the Railbelt.

EXISTING UTILITY PLANT AND ORGANIZATION: ANCHORAGE -- COOK INLET

UTILITY	SERVICE AREA	CUSTOMERS	TYPE OF UTILITY	PRESENT AND PLANNED GENERATING EQUIPMENT	PEAK LOAD	DEMAND FORECASTS
<u>CHUGACH ELECTRIC ASSOCIATION, INC.</u> (CEA)	Greater Anchorage, Eastern Kenai Peninsula, Whittier	50,000 retail, 24,000 wholesale (via MEA, HEA) (1979)	REA coop since 1948	Five generation plants, 13 gas turbines, 2 hydro turbines (Cooper Lake). Present base capacity (including 9.0 MW purchase from Eklutna) 403 MW. New gas turbine will add 60 MW in 1980 ; 5 gas turbines to be retired in 1985. Interconnections: MEA, HEA, SES, Eklutna	310 MW peak (Dec 1979)	1985: 856 MW (1976 study) New study in 1980 will probably lower forecast
<u>ANCHORAGE MUNICIPAL LIGHT & POWER</u> (AML&P)	Anchorage municipality within and specific locations outside old city limits	16,378 retail 4,756 street lights Merrill Field (1979)	Municipal utility owned by Municipality of Anchorage	Six gas turbines, 5 simple; one waste heat. One gas turbine scheduled for installation 1980, one more in 1982-83. Interconnectionm: Emergency 20 MW connection to Elmendorf	107 MW peak (Sep 1979) 109 MW peak (1978)	1989: 225 MW
<u>MATANUSKA ELECTRIC ASSOCIATION, INC.</u> (MEA)	Matanuska-Susitna Borough including Palmer, Eagle River, Talkeetna	13,000 retail (1979)	REA coop since 1941	93 percent of power purchased from CEA; 7 percent from Eklutna. 600 KW standby diesel generator at Talkeetna. Interconnection: CEA	63 MW peak (Feb 1979) 13 MW 1970 11 MW 1969	1989: 225 MW (does not include new capital)

EXISTING UTILITY PLANT AND ORGANIZATION: ANCHORAGE -- COOK INLET (CONTINUED)

UTILITY	SERVICE AREA	CUSTOMERS	TYPE OF UTILITY	PRESENT AND PLANNED GENERATING EQUIPMENT	PEAK LOAD	DEMAND FORECASTS
<u>HOMER ELECTRIC ASSOCIATION</u> (HEA)	Western Kenai Peninsula, Port Graham, Seldovia, Homer, Soldotna	10,422 retail (1979)	REA coop	Four diesel and two simple gas turbines, 9.3 MW Balance purchased from CEA. Interconnection: CEA	55 MW peak Dec 1979 184 million KWH (1977)	1989: 100 MW 1982: 502 mil KWH (annual) 1989: 967 mil KWH (annual)
<u>SEWARD ELECTRIC SYSTEM</u> (SES)	City of Seward to mile 24, Seward Highway	1,319 retail (1979)	Municipal utility owned by city of Seward	All power purchased from CEA. Interconnection: CEA	5 MW average daily peak (1979)	
<u>ALASKA POWER ADMINISTRATION-EKLUTNA</u>	not applicable	CEA, MEA	Federal hydropower project	2 hydro turbines, 30 MW	not avail.	not applic.

EXISTING UTILITY PLANT AND ORGANIZATION: FAIRBANKS -- TANANA VALLEY

UTILITY	SERVICE AREA	CUSTOMERS	TYPE OF UTILITY	PRESENT AND PLANNED GENERATING EQUIPMENT	PEAK LOAD	DEMAND FORECASTS
<u>GOLDEN VALLEY ELECTRIC ASSOCIATION INC (GVEA)</u>	Fairbanks North Star Borough, including part of Fairbanks city; North Pole, Ester, Delta Junction, Healy, Clear, Anderson, Cantwell, Rex, McKinley Park, Ft. Wainwright, Eilson AFB. Will extend to Summit	15,000 retail	REA coop	Coal-fired steam turbine (Healy) 25 MW; Six oil-fired gas turbines 179 MW; 10 diesel 22 MW --- Total 226 MW Interconnections: FMUS, Fort Wainwright, Eilson AFB, U. of A.	850 KWH/mo/cxustomer (1979)	1983: 900 KWH/mo/customer 1988: 1000/kwh/mo/customer
<u>FAIRBANKS MUNICIPAL UTILITY SYSTEM (FMUS)</u>	Fairbanks city limits	5,615 retail (1979)	Municipal utility owned by city of Fairbanks	Four steam turbines 8 MW Two oil-fired gas turbines 32 MW; three diesel 8 MW --- Total 68 MW Interties: GVEA, U of A	28.7 MW (1979)	n.a.

REGULATION OF THE ELECTRIC POWER INDUSTRY

The distribution of electricity is a natural monopoly, in that the economic cost of service (sometimes called resource cost --- the value of labor, materials, and capital actually consumed) tends to be lowest when only one firm serves each market area. Thus, the public is not necessarily better off when there are competing firms, but unregulated private monopolies tend to charge excessive prices for insufficient service.

There are two general ways to deal with this dilemma: public utility regulation and government enterprise. The United States and the state of Alaska use both approaches in dealing with the electric power industry. In either case, public authorities have to deal with three broad types of decision:

- *** franchising (sometimes certification or licensing) --- designation of an entity to operate in a given service area;
- *** certification (sometimes licensing or permitting) of new facilities; and
- *** ratemaking --- setting or approving charges to customers.

Regardless of the type of utility involved, construction of new facilities typically requires approval from several federal, state, and local agencies, with respect to safety, environmental and other concerns. The term regulation is often reserved, however, to decisions regarding the three economic issues just listed.

For municipal utilities and other government enterprises, the franchising decision is made when the city council,

state legislature, or Congress authorizes the utility or agency's establishment or expansion, while the budget approval process serves the function of certifying new projects. The utility itself may have complete discretion over its own rates (perhaps within some statutory guideline), or rates may be made or reviewed by the general political authorities (e.g., the city council) or regulated by a state public utility commission or the Federal Energy Regulatory Commission (FERC).

Rate regulation.

The various forms of utility organization use significantly different accounting concepts, and different regulatory commissions and government agencies define and measure the several elements of utility cost somewhat differently. Nevertheless, the basic principles of utility ratemaking are essentially the same for regulated private utilities and government enterprises. Rates are generally designed to cover the utility's cost of service, which is composed of ---

- *** operating costs, such as the costs of fuel, labor, materials, and purchased services;
- *** interest on debt;
- *** amortization (repayment) of debt;
- *** depreciation (to the extent not covered by amortization of debt);
- *** taxes (if any); and
- *** a fair and reasonable return (or a competitive return) to the owners' equity investment.

The Alaska Public Utilities Commission.

The Alaska Public Utilities Commission (APUC) has jurisdiction over service areas, licensing of new facilities, and both retail and wholesale rates and terms of service for all Alaska private utilities, including cooperatives.

The APUC also has authority to regulate municipal utilities ---

*** where they compete with another utility in the same service area; (Chugach Electric Association and the Anchorage Municipal Utility, for example, have overlapping service areas.)

*** where they operate outside municipal limits; and

*** in their wholesale electricity sales to regulated (i.e., non-municipal) utilities. (This authority has apparently never been exercised.)

The APUC has no direct jurisdiction over the Alaska Power Authority (state) or the Alaska Power Administration (federal), but it may approve or disapprove electricity purchase contracts that Alaska regulated utilities propose to sign with either agency.

The Federal Energy Regulatory Commission.

The Federal Energy Regulatory Commission (FERC), formerly the Federal Power Commission (FPC), is an independent agency housed in the U.S. Department of Energy. FERC's jurisdiction includes:

*** Licensing of all power facilities (1) on navigable rivers, and (2) on federal lands.

Any Susitna power project will need a license from FERC, because the upper Susitna is a navigable river for purposes of the Federal Power Act. The damsites and their surroundings are now on federal lands, but by the time any license could be granted, they will have been conveyed to the Cook Inlet regional corporation under the Alaska Native Claims Settlement Act.

*** Review of rates and terms of service on wholesale electricity sales in interstate commerce.

The federal courts have repeatedly upheld FPC claims of jurisdiction over wholesale electricity sales in the Lower 48, even within a single state, on the theory that almost all commerce is at least indirectly interstate commerce. Alaska's geographical isolation and the absence of electrical interties with other states may make a difference, however. Thus far, anyway, FPC and FERC have not tried to assert jurisdiction over wholesale electricity sales by Alaska utilities.

*** Review of rates and terms of service for electricity sold by federal power projects --- including the Alaska Power Administration's Snettisham and Eklutna hydroelectric projects.

*** Transportation of natural gas for resale in interstate commerce.

FERC might use this authority to restrict shipment of Prudhoe Bay natural gas for use as electric utility fuel in Alaska. The federal courts have upheld FPC prohibitions of shipment of gas on an interstate pipeline even within a single state and even for direct sale (that is, not a sale for resale), for an "inferior" purpose --- electric utility boiler fuel.

The Economic Regulatory Administration.

The Economic Regulatory Commission (ERA) of the U.S. Department of Energy administers the Powerplant and Industrial Fuels Act of 1978 (PIFUA), which generally prohibits use of oil or natural gas as fuel for new electrical generating plants. The Act provides several grounds on which ERA may waive the prohibition.

Other licensing, permitting, and regulatory provisions.

Pages 17 to 22 list the principal state and federal agencies with licensing, permitting, or other regulatory or supervisory authority over new electrical generating plants and associated transmission lines. In most cases the tables designate where in the United States Code or Alaska statutes each agency receives its jurisdiction over power projects.

This list is not complete, either with respect to the agencies involved, or with respect to the responsibilities of the listed agencies.

FEDERAL AGENCIES HAVING JURISDICTION OVER NEW ELECTRICAL
GENERATING AND TRANSMISSION FACILITIES IN ALASKA

AGENCY	AUTHORITY	PERMIT OR JURISDICTION
DEPARTMENT OF ENERGY (DOE)		
Federal Energy Regu- latory Commission (FERC)		Licenses power facilities on navigable waters and on federal lands. Regulates wholesale elec- tric rates and service in interstate commerce (See p. 15.) Reviews electric rates on federal power projects. Regulates natural gas sales and transmission in inter- state commerce. (See p. 15.)
Economic Regulatory Administration (ERA)		Administers PIFUA, grants exceptions allowing new gene- rating facilities to burn oil or gas. Establishes and administers price ceilings, entitlements treatment, and allocation of petroleum, including electric utility fuel. This author- ity reverts to standby emer- gency power only on October 1, 1981.
Alaska Power Adminis- tration (APA)		Constructs and operates fede- ral power projects in Alaska,, as authorized by Congress.

FEDERAL AGENCIES HAVING JURISDICTION OVER NEW ELECTRICAL
GENERATING AND TRANSMISSION FACILITIES IN ALASKA (CONTINUED)

AGENCY	AUTHORITY	PERMIT OR JURISDICTION
DEPARTMENT OF THE INTERIOR (DOI)		
Office of the Secretary	30 USC 185 (Title I), 1701, <u>et seq</u>	Administers overall policy.
Geological Survey (USGS)	43 USC 31	Advises on geological, seismic, geotechnic, and hydrological criteria and design.
Fish & Wildlife Service (FWS)	16 USC 661-669, 715(k), 742, 777	Protection of fish, wild- life, and migratory birds; anadromous fish; endangered species.
Bureau of Land Management (BLM)	16 USC 4,5; 43 USC 657, 659,661	Grants rights-of way for electrical transmission lines across public lands.
National Park Service (NPS)	16 USC 1; Executive Order 11593 (1971)	Supports BLM and USFS in protecting archeological and palentological remains under Antiquities Act.
Bureau of Indian Affairs	25 USC 13 <u>et seq</u>	Advises Alaska Native orga- nizations on lands, employ- ment, etc.
Mining and Safety Enforce- ment Administration (MESA)	30 USC 721	Approves gravel removal from federal lands.
DEPARTMENT OF AGRICULTURE		
Forest Service (USFS)	16 USC 473-478, 528-531 1601-1610, 1761, 1763	Grants rights-of-way, per- mits for use and occupancy in national forests.

FEDERAL AGENCIES HAVING JURISDICTION OVER NEW ELECTRICAL
GENERATING AND TRANSMISSION FACILITIES IN ALASKA (CONTINUED)

AGENCY	AUTHORITY	PERMIT OR JURISDICTION
DEPARTMENT OF THE ARMY Corps of Engineers (COE)	33 USC 403, Executive Order 11988	Issues permits for construction in and affecting navigable waters as designated by COE; floodplains management. Builds hydroelectric and other river basin developments as authorized by Congress.
DEPARTMENT OF LABOR Occupational Safety and Health Administration (OSHA)		Establishes and enforces safety and health standards for workers.
DEPARTMENT OF TRANSPORTATION Federal Aviation Administration (FAA)		Reviews construction affecting airspace use, control and safety.
DEPARTMENT OF THE TREASURY Bureau of Alcohol, Tobacco & Firearms	18 USC 843; 27 CFR Part 181	Issues permits for use and storage of explosives (if not overseen by OSHA or Alaska Department of Labor)

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FEDERAL AGENCIES HAVING JURISDICTION OVER NEW ELECTRICAL
GENERATING AND TRANSMISSION FACILITIES IN ALASKA (CONTINUED)

AGENCY	AUTHORITY	PERMIT OR JURISDICTION
DEPARTMENT OF COMMERCE National Oceanic and Atmospheric Adminis- tration	16 USC 1451, <u>et seq</u>	Coodinates and/or advises on administration of Coastal Zone Management Act (CZM), particularly with reference to protec- tion of anadromous fish.
ENVIRONMENTAL PROTECTION ADMINISTRATION (EPA)	33 USC 1151 <u>et seq</u> , 1157 <u>et seq</u>	Administers air and water quality standards. Grants permits for discharge into navigable waters. Grants exemption from noise con- trol standards.
COUNCIL ON ENVIRONMENTAL QUALITY (CEQ)	43 USC 432 <u>et seq</u>	Advises DOI, DOE, COE, EPA, <u>et al</u> , and the President on environmental issues.

ALASKA STATE AGENCIES HAVING JURISDICTION OVER
NEW ELECTRICAL GENERATING AND TRANSMISSION FACILITIES

AGENCY	AUTHORITY	PERMIT OR JURISDICTION
DEPARTMENT OF COMMERCE & ECONOMIC DEVELOPMENT		
Division of Energy & Power Development		Forecasts electricity de- mand; plans facilities.
Alaska Power Authority (APA)	AS 44.56.010-240	Review and approve construc- tion plans; oversee design, construction, acquisition, financing, and operation of hydroelectric and other power generation projects; lend money to utilities.
Alaska Public Utilities Commission (APUC)	AS 46.44, 43.03 18 AAC 60, 72, 75, 90	Grants and amends authority to operate generation and transmission facilities. Oversees rates, classifica- tions, practices, services, and facilities of utility companies.
DEPARTMENT OF ENVIRONMENTAL CONSERVATION (DEC)	AS 43.03, 44.46 18 AAC 60, 72, 75, 90	Grants permits for water and waste water discharge. Reviews facility plans for compliance with air and water quality standards. Issues permits, variances, and/or exemptions under safe drinking water stan- dards; for disposal of con- struction spoil.

ALASKA STATE AGENCIES HAVING JURISDICTION OVER
NEW ELECTRICAL GENERATING AND TRANSMISSION FACILITIES (CONTINUED)

AGENCY	AUTHORITY	PERMIT OR JURISDICTION
DEPARTMENT OF FISH AND GAME (ADFG)	AS 16.05, 20, 39	Reviews and issues permits for work in, near, or af- fecting anadromous fish streams.
DEPARTMENT OF LABOR (DOL)	AS 18.60.010-105, 580-660, 670-695; AS 23.05.060; AS 44.31	Enforces fair labor stand- ards, OSHA, labor relations, and local hire laws; Inspects work places for compliance; Investigates job-related accidents and illnesses.
DEPARTMENT OF NATURAL RESOURCES (DNR)		
Division of Lands	AS 38.05; AS 41.15, 20; AS 46.15	Issues land leases, rights- of-way and use and occupancy permits. Issues permits for taking of mineral material (gravel, <u>et al</u>) and merchantable timber; for burning of slash; for use of water resources.

HISTORY OF THE SUSITNA PROPOSAL

During the first half of the Twentieth Century hydro-electric generation, with its high reliability and its freedom from recurring fuel costs, was the preferred source of electricity wherever suitable damsites existed, and one of the chief missions of the Interior Department's Bureau of Reclamation was to identify potential hydropower sites, particularly on the Western federal lands.

Origins of the Susitna project.

Alaska's rivers were included in the federal site identification program, but they were too remote from the continent's population centers to be affected by the federal dam-building program of the 1930's, which resulted in major developments on the Tennessee, Columbia, Colorado and other Lower 48 river systems. The push for large hydro projects in Alaska seems to date from the late 1940's.

[In 1950,] the Department of the Interior provided \$150,000 to be used by the Bureau of Reclamation to update its Alaskan investigations of 1948. The results of these studies were to be used as a basis for legislation authorizing the development of the territory's water resources.

In its final report, published in 1952, the Bureau of Reclamation identified a large number of possible hydro-electric power sites throughout Alaska. The Bureau pointed out that, among all the potential rivers, the Susitna River was the most strategically located of all Alaska streams because of its proximity to Anchorage and Fairbanks and the connecting railbelt. The Susitna River basin occupies the northern half of the Cook Inlet area. It is bounded on the west and north by the Alaska Range, and on the east by the Copper River Plateau. The Susitna River enters Cook Inlet 25 miles west of Anchorage. The main stream originates in a series of glacier-bearing peaks some 90 miles south of Fairbanks and 200 miles north of Anchorage of which Mt. Hayes at 13,940 feet is the highest.

For the first 50 miles the river meanders generally southward over a broad alluvial fan and plateau after which it turns sharply westward for 75 miles through a practically continuous canyon incised in a high-level broad valley; it then travels southwest for 125 miles in a broad lowland. The Susitna has five principal tributaries: the Maclaren River originating in the Alaska Range, the Tyone River from the Talkeetna Mountains, the Chulitna River from the Alaska Range in Mt. McKinley National Park, the Talkeetna River from the Talkeetna Mountains, and finally the Yentna River system which drains a large portion of the Alaska Range. [Naske & Hunt, 1978]

The Bureau of Reclamation report identified three Susitna River damsites as having special potential --- Vee, 17 miles below the mouth of the Tyone; Watana, 36 miles downstream; and Devil Canyon, 28 miles further downstream. In view of the still-limited demand for electricity in the region, however, Congress instead authorized construction of the Eklutna River project, completed in 1955, which was much smaller and much closer to the load center in Anchorage.

Bureau of Reclamation interest in the Susitna continued, with release of a feasibility study in 1960 that favored a two-dam project at Devil Canyon and Denali, a fourth identified site about 30 miles above Watana and 10 miles below the Susitna River bridge on the Denali Highway. In 1961, the Interior Department recommended Congressional authorization of this project and the transmission lines required to move Susitna power to the Anchorage and Fairbanks areas.

Rivalry from the Army Engineers' Rampart proposal.

About the same time, however, a rival project promoted by the Army Engineers and the Alaska Congressional delegation began to draw off much of the political support for