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and Economic Research (ISER) of the University of Alaska was assigned the task by the Legislature of predicting future energy demands. From an historical standpoint, between 1940 and 1978 utility electric sales in the railbelt grew at an average annual rate of 15.2 percent, with the period in the 1970's showing a growth rate of 11.7 percent, with a trend toward a decline in annual rates during the latter years of that decade. Within the railbelt today, the utilities, national defense and self-supplied industrial demand is roughly 3.1 billion kwh (rough equivalent to half the potential of the Devil Canyon and Watana plan). For the sake of projecting Susitna's market, it was assumed that Susitna would provide all utility needs, only a third of the military demands and none of the self-supplied industrial. Based on these base case assumptions, ISER ran an econometric model that attempted to project "end use" demand. Based on various combinations of foreseeable economic growth and government expenditures, the ISER model projected thirty year annual utility growth rates ranging from 2.8 percent to 6.1 percent with 4.1 percent as the most likely. This resulted in a year 2010 low forecast of 6.2 billion kwh, a mid forecast of 8.9 billion kwh, and a high forecast of 15.9 billion kwh. These forecasts are significantly lower than forecasts devised by the Corps of Engineers and by ISER in earlier studies. As mentioned earlier, the average annual energy of Susitna is estimated to be 6.2 billion kwh. Based on the above energy demands, the life expectancy of existing and projected generation to be added before a possible Susitna, and necessary reserve margins, railbelt capacity additions required under the low, mid, and high forecasts result in 1040 MW, 1550 MW, and 3025 MW respectively for the year 2010. Year 1995 capacity requirements for the same set of forecasts result in capacity additions of 0 MW, 300 MW, and 750 MW respectively. Susitna would be developed in three stages of 400 MW each for a total of 1200 MW. Based on the above forecast of demand, it was concluded that the peak load requirements within the railbelt warranted the amount of power that Susitna could provide.

- * Although seismically active, it appears that safe structures can be built in the Upper Susitna. There are two primary sources from which earthquakes may emanate in the Upper Susitna region. These sources consist of surface faults which occur when two adjacent tectonic plates slide past one another horizontally, and deep seeded faults which occur when tectonic plates collide with one subsiding beneath the other. Within the project area there are three zones of interest. The first are the known boundary faults which isolate the plate upon which the Susitna River resides. These boundary faults are the Denali fault to the north (40 miles from either project) and the Castel Mountain fault

farther to the south. A second source of faulting is in the subduction zone 50 KM beneath the dams and is caused by the Pacific plate diving below the plate upon which Susitna rests. A third source of potential earthquakes could come from smaller surface features in the more immediate vicinity of the projects. These latter features could be the result of stress releases caused by buildup during movement along the boundary faults or subduction zone. Although of potentially lesser magnitude of energy release, the proximity of local faults to the projects could result in their controlling project design. However, based on field investigations to date, it appears that both the subduction zone and boundary faults will provide the controlling design. Of the numerous surficial "features" (not faults) in close proximity to the dam sites which have been examined, none at this point in time would appear to be "active" and thus capable of creating a more conservative design criteria than that suggested by the boundary faults or subduction zone, both of which are capable of producing 8.5 Richter magnitude earthquakes. During the ensuing field season, the major efforts within the seismic program will be oriented toward further investigation of local surface features to insure that a more stringent design criteria is not warranted. For the purposes of this study, the economic analysis has been based on a cost estimate that would reflect the added cost needed to protect against the most severe case. There is also the high possibility of "reservoir induced seismicity", which occurs primarily during the initial filling of the reservoirs. However, these events would have occurred even without the project development and would not be greater than the project design earthquake. Based on worldwide experience in dam earthquake design and the known forces at play in the Upper Susitna, it is our conclusion that both Devil Canyon and Watana can be safely constructed. The seismic risk associated with the project area, based on current knowledge is not so great that the hydroelectric potential cannot be safely developed.

- * The environmental studies to date, although preliminary at this point, have revealed no impacts of such a magnitude as to warrant abandonment of the present Susitna feasibility studies. Significant efforts are underway to fully account for the present environmental setting both in the Upper Susitna and in areas which may be impacted downstream. This includes efforts not only to identify fish and wildlife resources, but also the habitat in which they exist. The dams would not cut off any traditional spawning migration, however, changes in the character of the river below the dams may alter the habitat for survival of young salmon spawned in lower tributaries. These changes may be deleterious

or beneficial to salmon fry. Whether positive or negative, the overall change in the Cook Inlet salmon fishery, absent mitigation, will probably be slight. Although it is suspected that resident fish species in the project area are limited, the annual drawdown cycle at the Watana reservoir would be sufficiently great to preclude meaningful population enhancement there. The stable water level behind Devil Canyon suggests the possibility of enhancing and introducing new resident species. While there will be an impact on wildlife species as a direct result of the project, the loss does not appear great. Of perhaps more significant concern is the impact that could be imparted as a result of human pressures in an area of presently little use. Measures can be taken, of course, to restrict access and manage the wildlife. The upcoming field season and impact assessment will allow a better understanding of project impacts in relation to power benefits.

- * Based on conservative assumptions regarding costs of Susitna and other viable alternatives, there appears to be sufficient economic justification to warrant completion of the studies. The cost estimates used for Susitna are not the most likely costs, but instead are estimates of the highest possible costs, given the uncertainty that presently exists in this early stage of development. In fact, some of the additional costs included for this feasibility check would result in increased power from the project, yet no attendant benefits have been claimed. For purposes of comparison, the costs of a thermal plan and of a Susitna plan were projected for a sixty year period and then discounted to give a total present worth of plan costs. This comparison was made under five different sets of assumptions regarding the cost of thermal projects and fuels. Under each set of assumptions and using the upper limit cost estimate for Susitna, the Susitna development is estimated to be more cost effective than the most likely plan without Susitna. However, if there were no restrictions on either the availability or utilization of natural gas for power generation, and if the cost of gas rose at an annual constant dollar rate of 2 percent, and if the cost of coal rose no faster than the rate of inflation, then there would be little or no economic benefit in the Susitna plan. Given the known reserves, projected use rates, and estimated more likely fuel cost increases, there is little likelihood that this breakeven thermal scenario would occur. Based on this preliminary check of economic feasibility, the Susitna study program should continue.

- The present Internal Revenue Service codes make it very difficult to finance all of the Susitna project based on project security alone. Certain measures can be taken, however, to strengthen investor

confidence thus generating the necessary outside capital. The most obvious measures entail a State guarantee of Power Authority bonds, or converting the existing REA Cooperative utilities into municipal utilities, thus making the project eligible for long term power sales contracts and tax exempt financing. Other state measures could entail equity contributions or subordinate loans. No attempt has been made to evaluate the probability of total or partial state financing for Susitna. The State's ability to finance Susitna makes it possible to virtually dictate the cost of power to consumers. The effect of such a decision by the State could have both positive and adverse impacts. Not knowing what the State's posture will be toward providing additional security for Susitna, the Power Authority is working to pass a national hydropower program that will insure tax exempt financing regardless of the ultimate recipients of power. This effort may or may not be successful.

March 20, 1981

Mr. Charles Conway
Chairman of the Board
Alaska Power Authority
333 West 4th Avenue, Suite 31
Anchorage, Alaska 99501

Dear Mr. Conway:

The External Review Panel met with representatives of the Alaska Power Authority Board of Directors and its staff and representatives of Acres American in San Francisco on March 20, 1981 to discuss the feasibility studies for the Susitna Hydroelectric Project. Prior to the meeting, Panel members studied Acres reports on Review of Available hydrology Material, Review of Previous Design Development Studies and Reports and Project Overview. A first draft of the report from the Alaska Power Authority to the Governor and Legislature was reviewed before the meeting and a second draft was received during the meeting. APA staff members briefed the Panel on the draft report and the Acres representative presented an update of feasibility study events since the January, 1981 meeting.

This letter expresses the Panel's opinion whether, based on information available on four critical issues, the feasibility studies should continue to completion in April, 1982, or be terminated now. The Panel concurs that the four critical issues concern the power demand forecast, seismic risk, environmental impacts and economic feasibility. Our present opinions concerning these issues are summarized below.

The load forecasts have an inherent assumption of continued growth in the commercial market for electricity, and implied expansion in the service sector of the Rail Belt economy. If the economy develops in this manner, and real electric rates do not increase substantially and there is no major change in conservation, then the range of forecasts suggested by ISER seems reasonable.

The Susitna Project is probably competitive on a direct economic basis with power generated from coal. Insufficient information is available at this time to evaluate the attractiveness of the Susitna Project vis-a-vis other alternatives such as gas or tidal power.

Charles Conway,
Chairman of the Board
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Based on the field investigations completed to date, both the Watana and Devil Canyon sites appear to be well suited for the hydroelectric developments proposed. The initial studies have defined the general site and rock conditions at the sites and the general seismic geology of the area in which the proposed dams are to be constructed. The seismic design requirements appear to be well within the state-of-the-art for construction of facilities of this type. Important geologic features have also been recognized which merit further attention and investigation programs have been proposed which are well conceived and should provide a sound basis for feasibility design and cost estimates as well as insuring an ample level of seismic safety.

Some excellent studies are under way concerning ecologic conditions in the Susitna basin and possible environmental effects of hydro development. Above the dams there will be inundation of habitats occupied seasonally by moose, caribou, bears, and various lesser species, and there will be modification of the stream flow below the dams which could affect the habitats of salmon, moose and waterfowl. On-going studies should be continued, with amplification of hydrological studies in the Susitna River to better understand possible downstream effects on flora, fauna and the riverbed itself. Based on present knowledge however, there are no obvious environmental threats so serious as to suggest abandonment of continued planning for the hydro project.

Thus in non-economic terms, Alaska is fortunate to have the hydroelectric power potential in areas where the technical, social and environmental impacts appear to be of a manageable nature. The potential for developing renewable, non-polluting hydroelectric power has definite advantages which, though the economic implications require detailed study, are not always amenable to direct economic evaluation.

Charles Conway,
Chairman of the Board
March 20, 1981
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In summary, it appears that definite answers cannot yet be given to all of the issues involved in evaluating the geo-technical, environmental, economic and market aspects of developing the Susitna Project. However, we believe that the work accomplished to date shows sufficient promise for the future welfare and interests of Alaska and that it is clearly desirable to continue the present studies, supplemented by appropriate additional investigations, to their 1982 completion date.

Sincerely yours,

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12 March, 1981

Alaska Power Authority
Attn: Mr. David Wozniak
333 West 4th Avenue
Anchorage, Alaska 99501

Susitna Hydroelectric Project:
Continuation of Feasibility Study

Dear Mr. Wozniak:

As you are aware, I will not be able to attend the meeting in California as part of the External Review Panel because of a prior commitment. The purpose of this meeting is for the Panel to present its opinion on whether the feasibility study for Susitna should be carried to its April 1982 Phase I completion or terminated on or about the end of March 1981.

The objectives of this meeting will deal with power demand forecasts, seismicity, environmental impact, and economic feasibility. I have received a substantial number of documents from Acres, the interim seismicity report from Woodward Clyde, and APA's draft report to the Governor and Legislature. Because I will not be present for any final presentation of information in California or for the Panel's internal discussions, I would like to offer some brief comments on the geotechnical aspects of the feasibility study as well as the matter of continuation of the work. It is my intention that the sense of this letter could be used where appropriate in the Panel Report of the meeting. With regard to your letter of 5 March 1981 concerning the vehicle by which to advise the Board on the continue/discontinue issue, our panel should reference the Authority's report as being an indication that we have read all pertinent documentation on the subject. Our report will almost certainly follow the same format.

1. GEOTECHNICAL CONSIDERATIONS

Based upon the field geotechnical investigations completed to date, both the Watana and Devil Canyon sites appear to be well suited for the hydroelectric developments proposed. The initial studies have defined the general soil and rock conditions and have recognized some important geologic features that merit further attention. Acres has proposed a field program for 1981 which will provide the essential elements for feasibility design and cost estimates. Their plan is well-conceived and the results should provide a high level of confidence in the final cost estimates.

2. CONTINUATION OF FEASIBILITY STUDIES

The APA and Acres reports on continuation of the studies clearly point out the status of the work and present convincing arguments concerning the positive benefits of at least Susitna Stage I and II with regards reasonable future power demand. I also agree with their conclusion that the dams can be designed to withstand the ground accelerations caused by earthquakes generated along the Denali Fault or Benioff Zone. Such design aspects are well within the state-of-the-art.

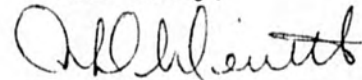
It is also recognized that the environmental studies along the river and within the proposed reservoir are still in their infancy and definite conclusions cannot be reached at this time. It is apparent that APA is conducting an extensive environmental program and I feel confident that your efforts will provide the necessary information required for a well-informed opinion upon the environmental impact of the proposed projects. With regards the economic feasibility, further information is still required. In non-economic terms, Alaska is fortunate to have the hydroelectric power potential in areas where the social and environmental impacts appear, at present, to be of a manageable nature. Certainly in these days of concern about the pollution aspects of, for example, a coal fired thermal plant, as well as depletion of natural resources, the alternative of renewable non-polluting hydroelectric power has

12 March 1981

definite advantages which are not always amenable to economic analysis.

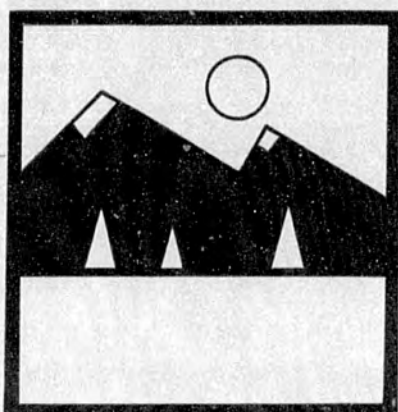
In summary, it appears that definite answers cannot yet be given to most of the items mentioned above. This is not because of a lack of priority but rather than the solution requires a complex study of many factors presently being undertaken by more than one organization. I believe that the work in progress will provide the answers required in a timely manner. It is my opinion that the feasibility study should continue to its 1982 completion date to provide sufficient time to complete the assigned tasks rather than imposing a premature halt to the project because of a lack of final conclusions to complex matters.

Yours truly,

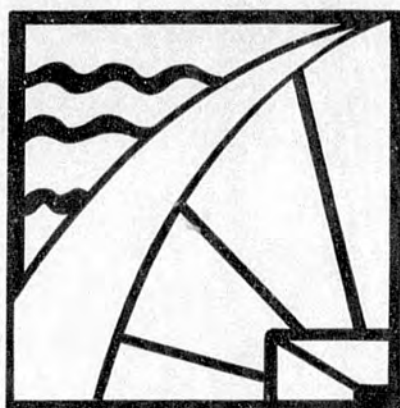


Andrew H. Merritt

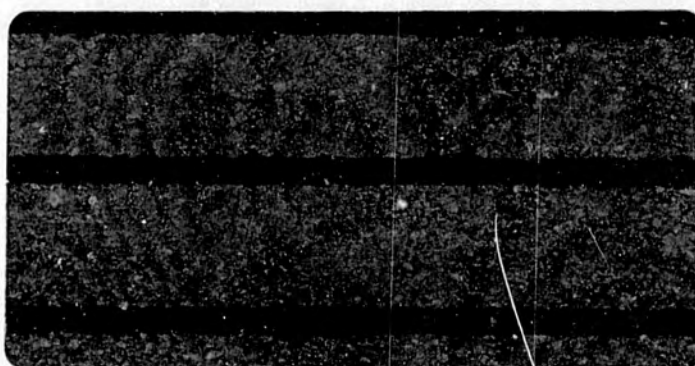
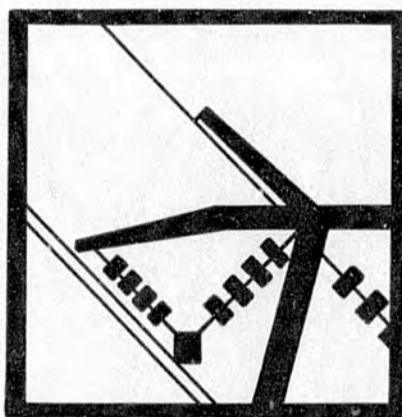
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ALASKA POWER AUTHORITY



**SUSITNA
HYDROELECTRIC
PROJECT**



ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

PROJECT OVERVIEW

MARCH 26, 1981

BY

ACRES AMERICAN INCORPORATED
LIBERTY BANK BUILDING, MAIN AT COURT
BUFFALO, NEW YORK 14202

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

PROJECT OVERVIEW

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PROJECT OVERVIEW

SUSITNA HYDROELECTRIC PROJECT

1 - INTRODUCTION

Acres American Incorporated (Acres) was commissioned by the Alaska Power Authority (Power Authority) on December 19, 1978, to conduct a detailed feasibility study of the Susitna Hydroelectric Project, evaluate the environmental consequences of any proposed development, and prepare a license application to be filed with the Federal Energy Regulatory Commission (FERC) in the event that the State of Alaska regards filing such an application as being in its best interests.

If development ever takes place in the Susitna River Basin (see Figure 1 for a basin map annotated to show potential dam sites), it is likely that extensive, costly and lengthy construction activity will occur there. Benefits of long-term and relatively low-cost electrical energy may be possible. Yet, permanent alteration of the environmental setting in the Basin will be inevitable.

The basis for a decision to proceed with the Susitna Hydroelectric Project requires that a variety of scientific, engineering, financial and economic disciplines be brought together. Investigations and analysis in each of these areas must necessarily be thorough and, further, should be consistent with state-of-the-art techniques. Documentation of these activities tends to be voluminous as well as highly technical in nature. The purpose of this Project Overview is to provide a review of all major aspects of the project and its objectives, determining in principle whether these can be met. In effect, it brings together complex issues and detailed technical results so that decision makers within the State of Alaska and interested members of the public can assess results achieved to date and determine what the future course of action should be with respect to the Susitna Hydroelectric Project.

Succeeding sections are arranged to present the framework within which the Susitna Study is conducted and the preliminary results achieved after the first full year of effort. Section 2 describes the decision process which requires two reports which the Power Authority must make to the Legislature. The nature and the role of the Power Authority are addressed in Section 3. After a brief history of the Susitna Project is presented at Section 4, Sections 5 through 13 consider technical, economic, environmental and marketing aspects. An introduction to the important public participation program follows at Section 14. Licensing and permitting is described in Section 15. Financial matters, including financial risks, are discussed in Sections 16 and 17. Section 18 describes the organizational arrangements necessary for effective project implementation. A final section (19) reviews the implications of proceeding with the work after the first decision point on March 31, 1981.

A detailed appendix to this overview has been prepared. It contains a complete chapter to correspond to each of the sections appearing herein. Copies of the detailed appendix have been furnished to the Power Authority and to its external review panel.

In addition to this project overview, a second major document bears upon the March 31, 1981, decision process. The Development Selection Report (some of which is encapsulated in Sections 7, 8 and 9 below) provides the detailed basis upon which a recommendation has been made by Acres to APA regarding the proposed site on which the 1981 program will focus.

2 - THE DECISION PROCESS

Two important decision points have been designated by HCSSB 294. This legislation requires that the Power Authority, by March 30, 1981, submit a preliminary report to the Governor and to the State Legislature "recommending whether work should continue on the project." A second decision point, also explicitly legislated, occurs in April 1982, when the Power Authority must submit a second report recommending whether work should continue on the Susitna Hydroelectric Project and other viable alternatives. It is important to note that neither of these decision points is intended to produce a commitment to construct a project. Indeed, construction of dams and other facilities in the river channel is not possible until or unless an FERC license is awarded.

In addition to work being accomplished by the Acres team, several other ongoing activities bear upon the decision making process. A separate comprehensive study of alternative means of satisfying future Railbelt energy and load projections will be accomplished by an independent consulting firm under contract to the State of Alaska. The Susitna project will represent one of many possible alternatives considered in that effort. Other alternatives include, but are not necessarily limited to, thermal energy (particularly coal fired, since Alaska is richly endowed with significant undeveloped coal resources), wind, solar, non-Susitna hydropower, and tidal power (for which a preliminary assessment of potentials and constraints is now underway). In addition, the Power Authority has contracted with a major consulting firm specializing in electrical transmission to consider an intertie between Anchorage and Fairbanks. This latter project may be beneficial irrespective of whether the Susitna River Basin is ever developed, but the results of the study will necessarily be important to the analysis of transmission facilities required for a Susitna Project.

3 - ALASKA POWER AUTHORITY

The Power Authority was created in 1976, by action of the State Legislature, as an autonomous branch of the Alaska Department of Commerce and Economic Development. The basic mission of this agency is to develop energy generation projects (excluding nuclear) in an economical manner. Governed by a Board of Directors, the Power Authority employs an Executive Director and a staff which carry out day-to-day activities. Directors of Engineering, Finance, and Public Participation assist the Executive Director in performing his functions. The

staff also includes a full-time Native Inspector, an Administrative Assistant, and Project Engineers and other supporting personnel. An organization chart is provided as Figure 2.

As of the end of 1980, the Power Authority was engaged in six reconnaissance studies, four design projects, two license application submittals, five construction projects, and eleven feasibility studies (Susitna being the largest).

Procedures adopted by the Power Authority for the Susitna study include the formation of a Steering Committee to ensure that interested State and Federal Agencies are kept informed throughout the course of the work and to provide a vehicle whereby their concerns and recommendations can be taken into account as the study progresses. Heavy emphasis is also placed on the opinions and concerns of the public, and an aggressive Public Participation Program is conducted.

4 - HISTORY OF THE SUSITNA PROJECT

Because of its strategic location between Anchorage and Fairbanks, the Susitna River has long been regarded as worthy of consideration for development of its hydroelectric potential. Shortly after World War II, the U.S. Bureau of Reclamation (USBR) did an initial Territory-wide reconnaissance, noting the vast hydroelectric potential in Alaska, and placing particular emphasis upon the perceived advantages of a Susitna Hydroelectric Project.

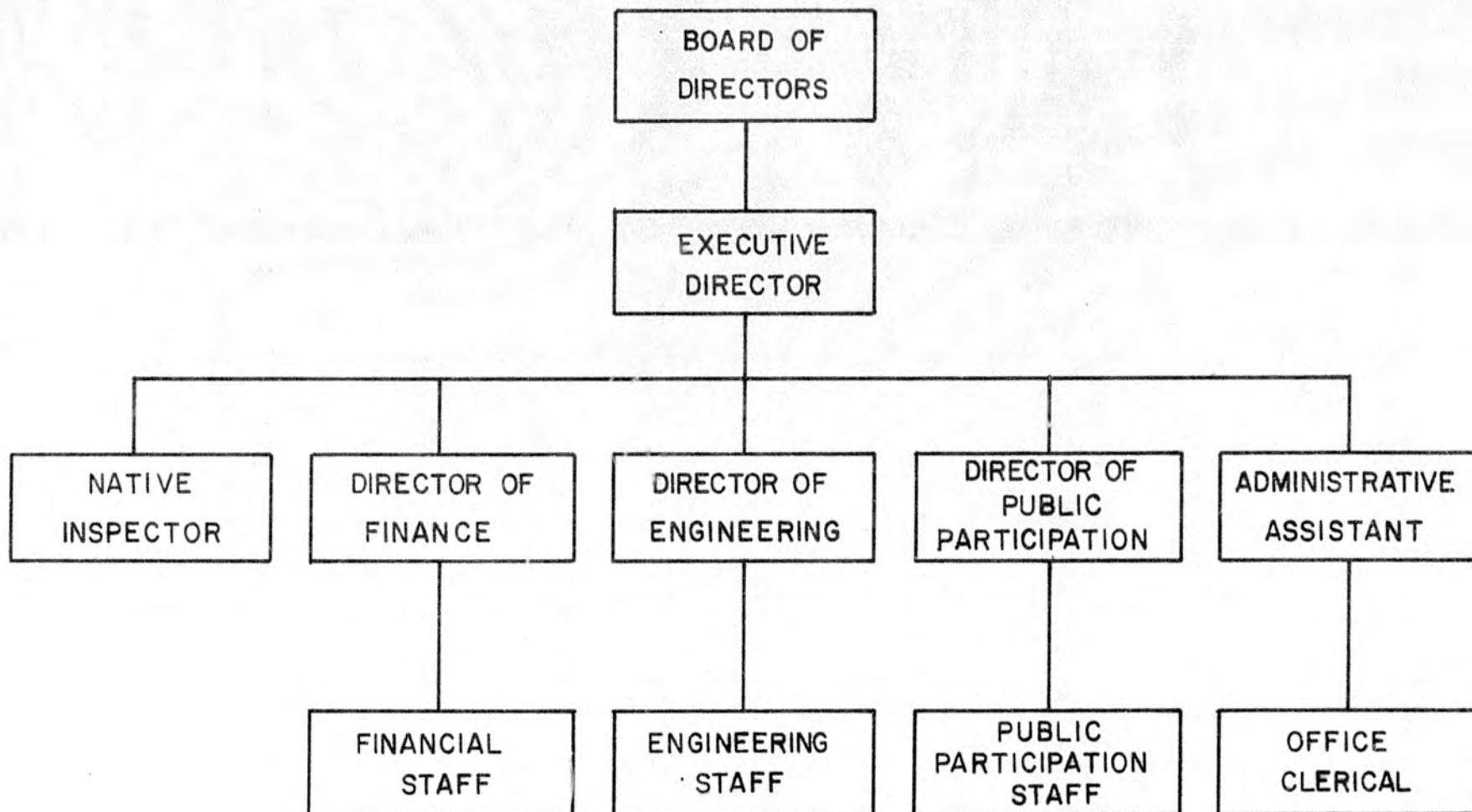
The U.S. Department of Interior (of which USBR was a part) undertook geotechnical and other field investigations and, in 1961, proposed authorization of a two-dam system on the Susitna River. This report was later updated in 1974 by the Alaska Power Administration (also then a part of DOI) and the desirability of proceeding with the project was reaffirmed.

The U.S. Army Corps of Engineers (COE) was also active in hydropower investigations in Alaska in the 1950's and 1960's. Focusing its initial attention on the Rampart Project on the Yukon River, the COE found by the early 1970's that the environmental consequences and limited market for Rampart power militated against its development. The 1973 energy crisis rekindled interest in hydropower development and the COE was commissioned by the U.S. Congress in 1974 to conduct a pre-feasibility study of the Susitna Project. The results of this effort were first referred to the Office of Management and Budget in 1976. Further geotechnical work followed and a new COE report was issued in 1979.

The State of Alaska itself commissioned an assessment of the Susitna Project by the Henry J. Kaiser Company in 1974.

Although differences appeared in the various proposed development schemes, all of the foregoing organizations were unanimous in recommending that Susitna hydroelectric potential be developed.

After the Power Authority was formed, the State of Alaska elected to proceed independently with a major feasibility study. A detailed Plan of Study was distributed widely in February 1980. Subsequent modifications, some of which



ALASKA POWER AUTHORITY ORGANIZATION

were occasioned by statements of public concerns, were directed by the Power Authority itself as well as by the State Legislature. Salient features of the Plan as it now stands are these:

- The development of electrical energy demand forecasts has been accomplished independently by the Institute for Social and Economic Research (ISER), University of Alaska.
- The study of alternatives, as noted earlier, is being accomplished separately from the Susitna Study.
- The Public Participation Program is handled by the Power Authority itself rather than by Acres as originally proposed.
- Major tasks have been designated to handle each facet of the work. These tasks include such activities as load forecasting, surveys and field support activities, hydrology, seismic studies, geotechnical investigations, design studies, environmental studies, transmission studies, development of cost estimates and schedules, licensing activities, finance and marketing studies, public participation and administration. Each task is further subdivided into subtasks so that more than 150 separately defined study activities will be completed prior to submitting a license application to FERC in June 1982--if affirmative decisions are made at the March 1981 and April 1982 milestones.

5 - ECONOMIC SCENARIOS AND PARAMETERS

The viability of a Susitna Hydroelectric Project depends to a great extent on the costs of generating electrical energy by alternative means. Thus, for example, if the cost of natural gas from the Cook Inlet area rises more rapidly in future years than the general inflation rate, it is likely that utilities will turn to sources other than gas for future expansion of generating systems. Hydropower might then enjoy a more favorable position. Conversely, if certain fuel prices rise less rapidly than the general inflation rate, hydropower may not necessarily represent an economical choice for future system expansion.

Other factors will also affect Susitna viability. For example, demographic variables, energy demand, unit labor costs, other commodity prices, overall price inflation, and interest and discount rates must be projected. An economic analysis was conducted so that, to the extent possible, logical and non-contradictory views of the world would emerge. No matter how carefully such an analysis is conducted, however, it is necessarily imprecise simply because it depends upon the prediction of an uncertain future. Thus a range of values bounding each selected parameter was selected as the basis for testing the sensitivity of a Susitna Project to possible deviations from most likely values.

Forecasts of world energy balances indicate a worldwide shortfall in oil supplies within ten years. By 1990, the United States is expected to be importing 16 percent of its energy needs (an improvement over the 22 percent level of 1978). It is likely that fossil fuel prices in the U.S. will continue

to escalate at rates on the order of two to four percent above the overall inflation rate. Gas and oil price escalation will be at the upper end of this range, with coal escalation somewhat less. Fuel prices in Alaska will generally reflect market prices in the United States and abroad, less the cost of getting Alaskan fuels to the market.

Insofar as prospects for economic growth in Alaska are concerned, three different economic scenarios were developed by ISER. The lowest assumes only modest population and employment growths at just over two percent. The highest forecasts these values at closer to four percent. If the volume of State government expenditures varies significantly from current levels, these ranges will be broadened.

Opportunity values and escalation rates in Alaska in dollars per million Btu (where a Btu is a unit of energy) were selected as follows:

	<u>\$/Million Btu Opportunity Value (1980 Dollars)</u>	<u>1980 - 2005 Escalation in Excess of Normal Inflation</u>
Natural Gas	\$2.00	3.98%
Coal	\$1.15	2.93%
Oil	\$4.00	3.58%

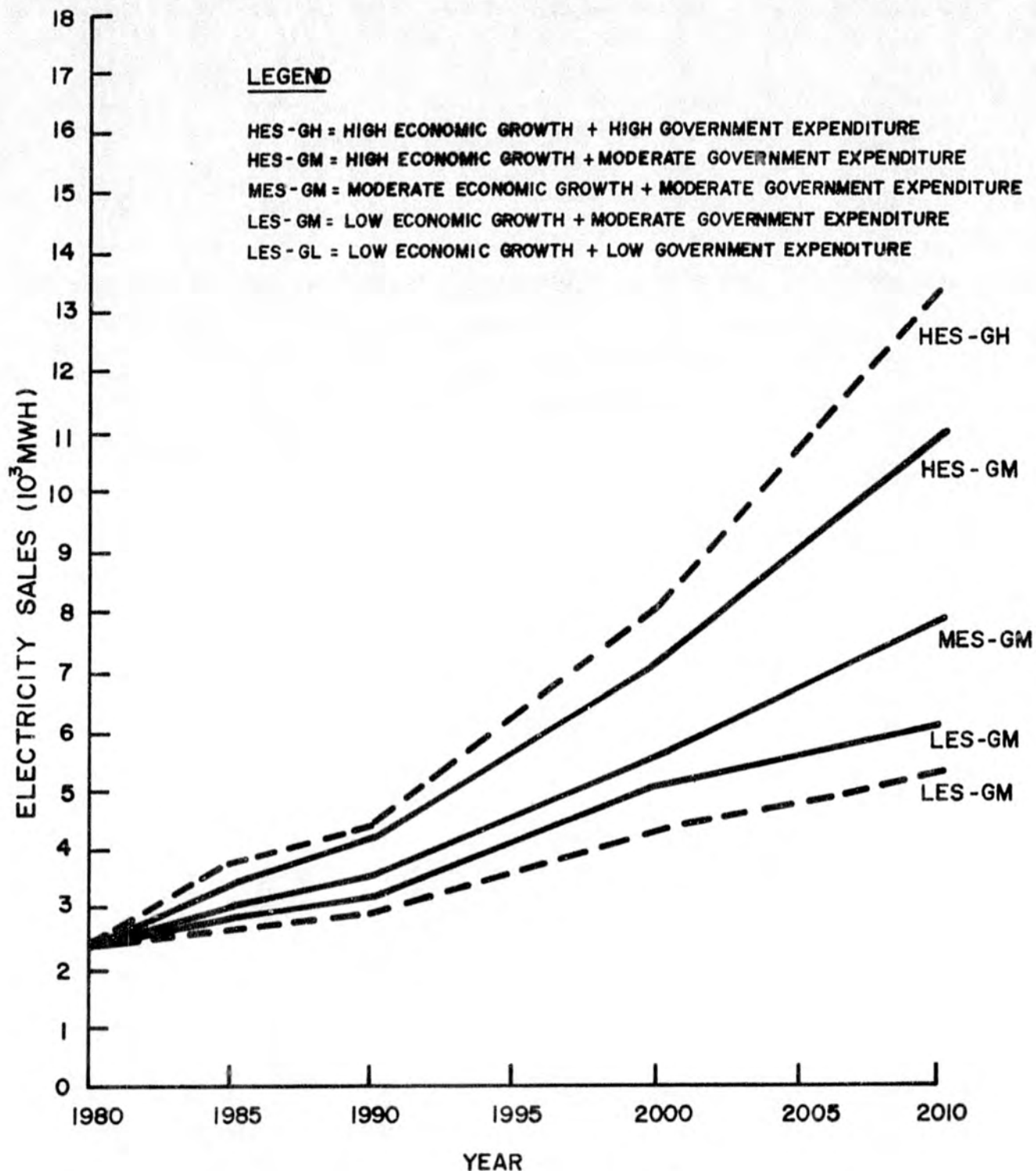
Exclusive of inflation, a real interest and discount rate of three percent was adopted as most likely.

6 - MARKET AREA AND POWER DEMAND FORECASTS

The forecasting methodology employed by ISER relied upon an end-use model rather than on the extrapolation of past trends as the basis for projecting future demand. As its name implies, an end-use model considers electricity consumption in terms of end use in various sectors of the economy. In the residential sector, for example, electricity consumption is largely attributed to space heating, refrigerators, water heaters, lights, cooking ranges, and certain other major appliances. Knowledge of the number, type, and expected changes in households can lead to assessment of future residential demand for electricity.

The annual growth in total Railbelt Utility Sales ranged from 2.8 percent to 6.1 percent in the lowest and highest economic growth scenarios respectively. These values may be compared to an actual average annual rate of 15.2 percent for the period 1940 to 1978 and to 11.7 percent for the 1970's. Figure 3 illustrates alternate demand forecasts.

Peak load forecasts were derived by applying historical load patterns by sector to the ISER demand forecasts. Peak loads are expected to increase at approximately the same percentage as total electrical energy demand for each of the selected ranges.



ALTERNATIVE UTILITY SALES FORECASTS

If more extreme measures are taken (probably through legislative action rather than voluntary efforts), some potential for further energy conservation and for load management could lead to a lower forecast than the lowest noted above. An extreme low forecast was selected for sensitivity tests in later analysis.

7 - SUSITNA BASIN STUDIES

During the past year, a massive field data collection effort got underway. Operating primarily out of a base camp constructed at the Watana site, investigative teams were engaged in environmental data collection, survey activities, geotechnical exploration, geological mapping, seismological investigations and hydrological and climatological data collection.

7.1 - Hydrology

Gaging stations and weather monitoring stations were added to the network which had been installed and operated by State and Federal agencies in prior years. Information collected at new stations has been useful in correlating data obtained there with longer term records at older stations.

The Susitna River exhibits two distinct seasons of flow. High spring and summer flows (produced by snow and glacial melt and heavy rainfall) contribute about 90 percent of the annual total between May and October. The winter flow is relatively low and most of the smaller tributaries do not sustain flow during the coldest months. Figure 4 illustrates flow data at Gold Creek. Based on data collected to date, initial determinations have been made of probable maximum floods (the theoretical maximum which could be produced given the physical nature of the Susitna Basin) and design floods (1 in 10,000 year events) which must be safely passed by dams that might be constructed on the Susitna. In addition, of course, hydrological data was used to estimate probable average and firm energy outputs from potential developments. It is worth noting that less than 20 percent of the total Susitna River flow into Cook Inlet is contributed by the Susitna and its tributaries above Gold Creek. Significant contributions downstream occur from the Chulitna, Talkeetna, and Yentna Rivers. Figure 5 displays percentage composition of total flow by major tributary.

Ice formation, both in potential reservoirs and downstream of possible dams, continues to be studied, for it must be dealt with during construction and its impacts during operation must be determined.

7.2 - Site Exploration and Geology

The Susitna Basin has a complex geology. Studies have been made of the region in general and detailed information was collected at particular dam sites and potential sites (borrow areas) for materials with which to construct the project. Three core holes per site were drilled at Watana and Devil Canyon during 1980; 15 auger holes were placed to explore borrow

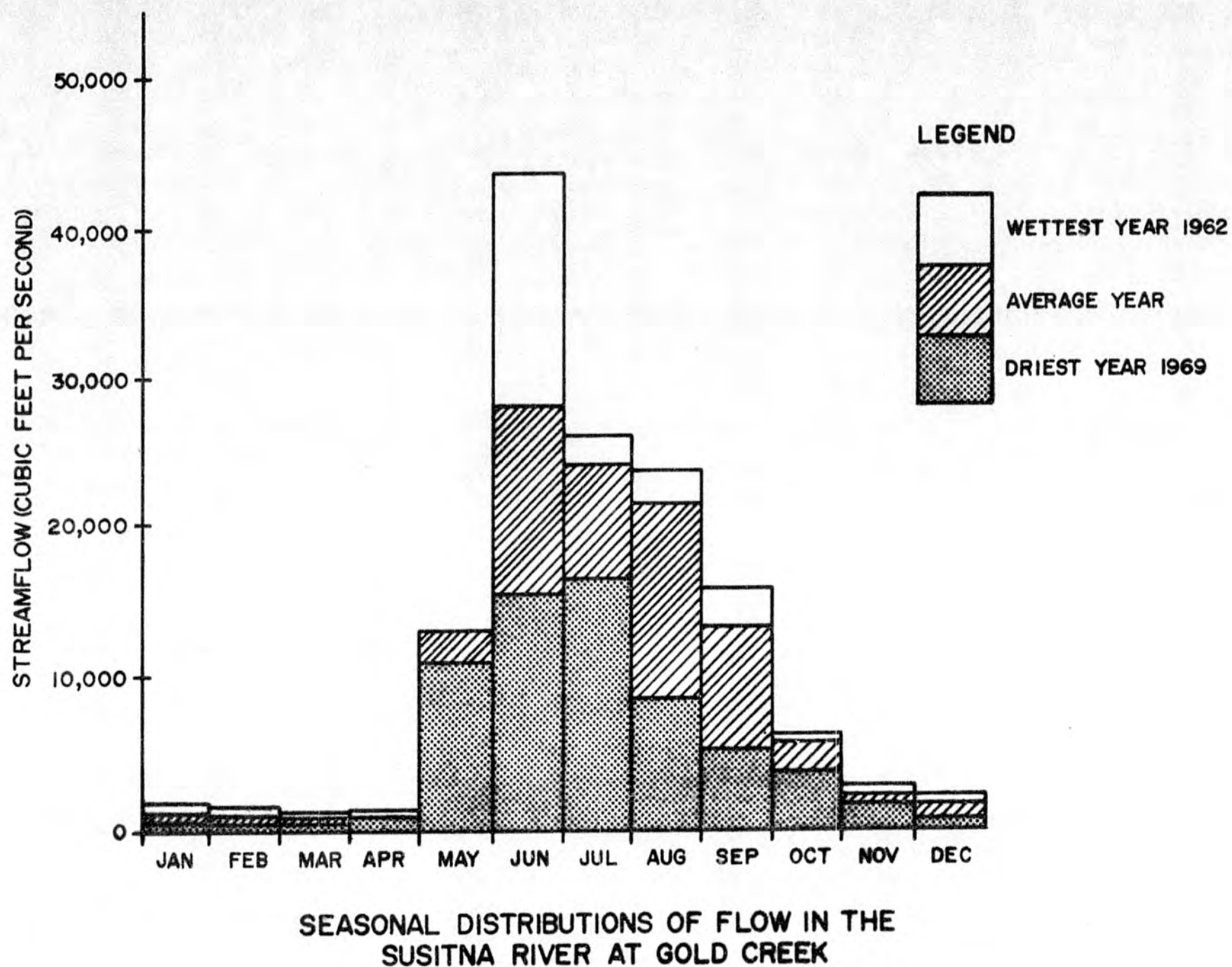
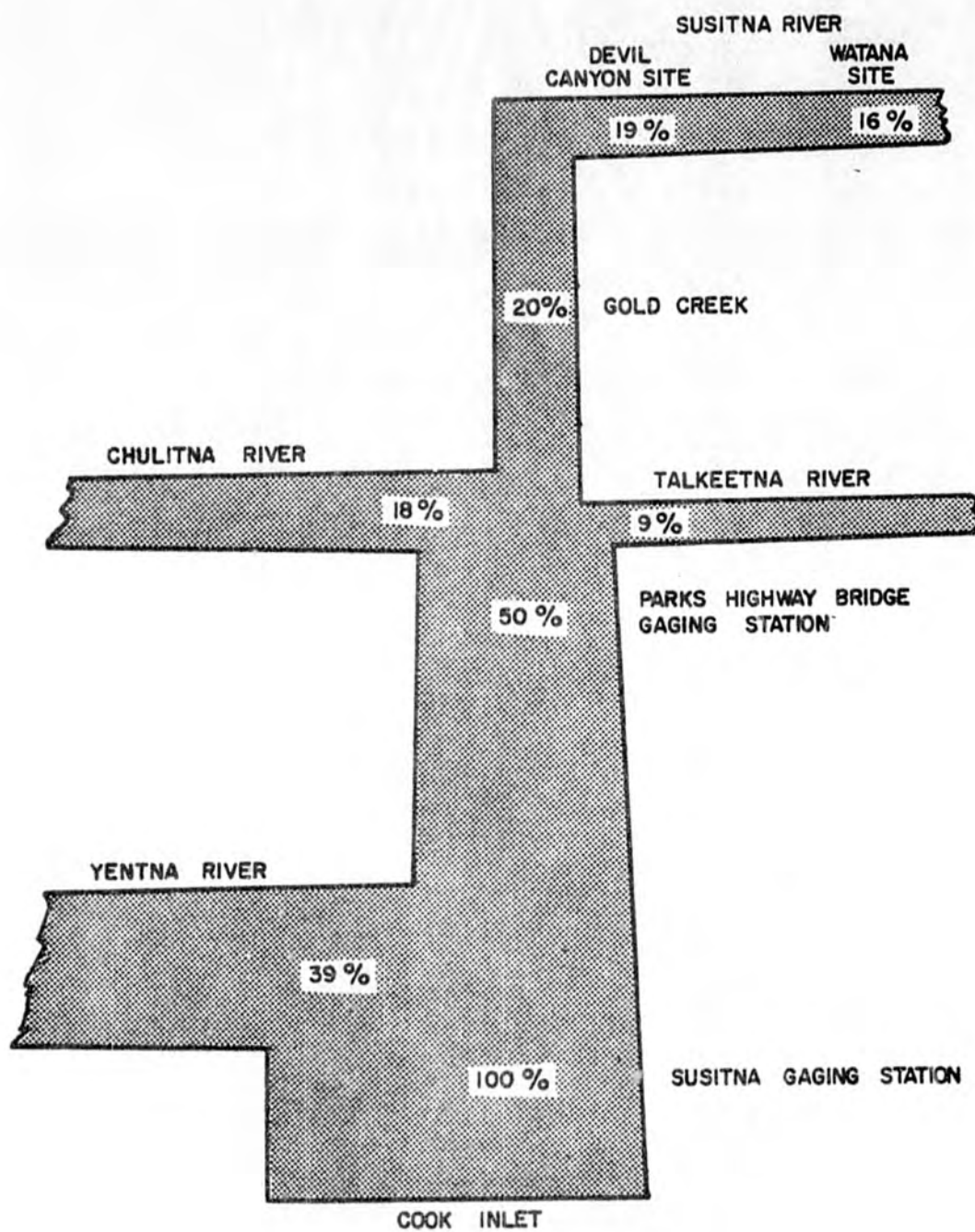


FIGURE 4



AVERAGE ANNUAL FLOW DISTRIBUTION
WITHIN THE SUSITNA RIVER BASIN

areas; and approximately 28,000 feet of seismic lines were run. While geotechnical data gathered to date has generally confirmed the suitability of Watana and Devil Canyon sites for dam construction, a geotechnical program has been designed for 1981 further to define the nature of the sites and to answer questions about certain subsurface features which could influence the type and precise location of dams and other project features.

7.3 - Seismic Considerations

The Upper Susitna River Basin is a seismically active area. Thus, a major seismic program was started in 1980. A microseismic network of 10 stations was installed and operated to collect microearthquake data for the region. Potential faults and lineaments were identified by air and ground reconnaissance, satellite imagery, airborne remote sensing and aerial photography. A detailed screening of all identified features resulted in the selection of 13 for further study in 1981.

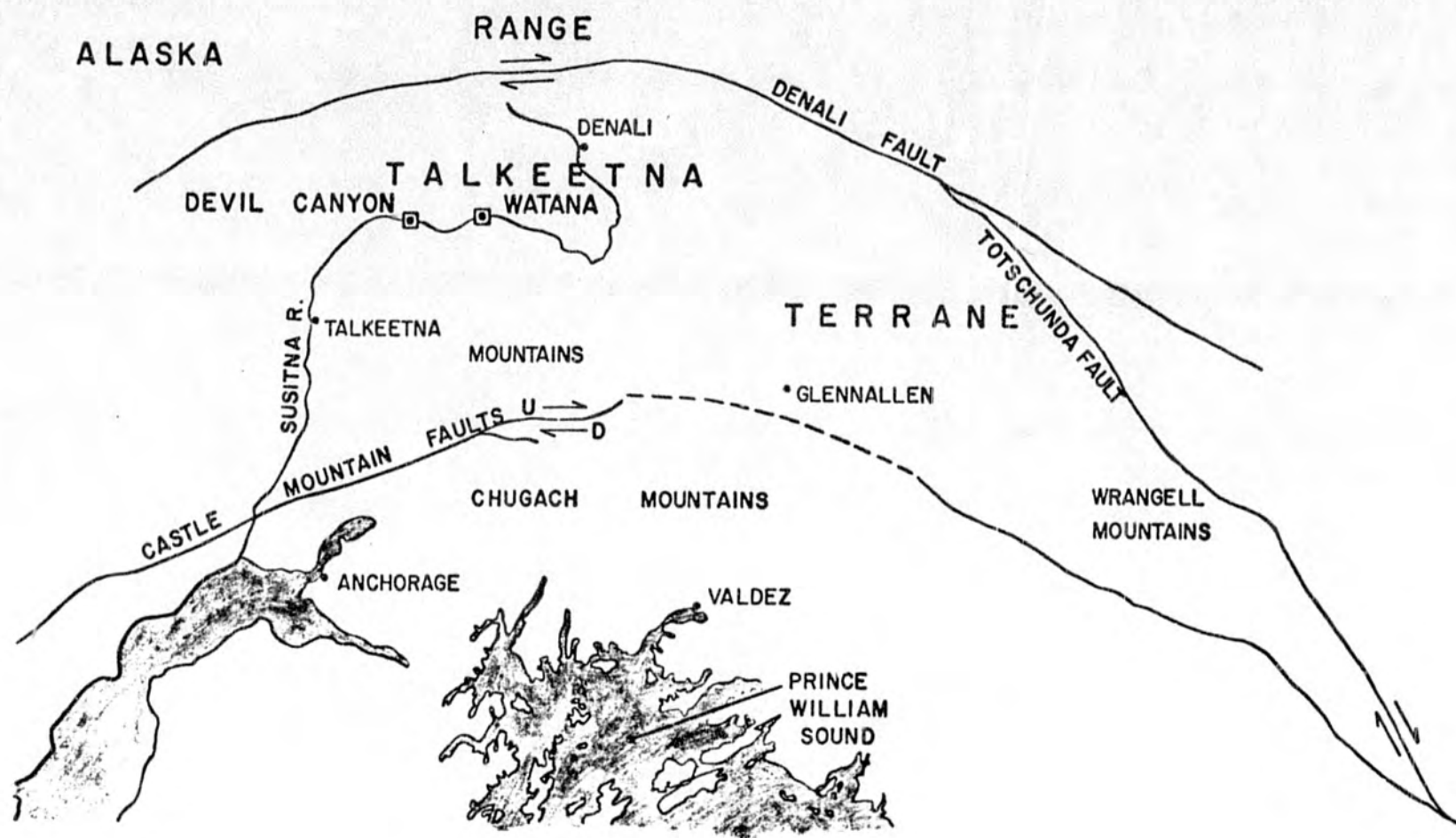
On the basis of the current state of knowledge, the Denali Fault (65 km north of the sites) and the Benioff Zone (60 km underground below the sites) are regarded as the most likely severe seismic hazards. Figure 6 illustrates the seismic setting. Initial estimates of maximum credible earthquakes from these features suggest a magnitude of 8.5 on the Richter Scale. Dam design to safely withstand ground accelerations associated with such an event is within the state of the art.

A study of Reservoir Induced Seismicity (RIS) was also initiated in 1980. RIS may be caused by the increased weight of water in a new reservoir or by lubrication and hydraulic action upon highly stressed rock. Based on evidence gathered to date, an RIS event will not exceed the maximum credible earthquake that could be associated with a fault. Thus, RIS is not likely to affect the determination of design earthquakes.

7.4 - Dam Site Selection

A total of 12 dam sites was considered in the site selection process (See Figure 1). By combination of two or more sites as a system, the total basin potential can be developed in a variety of ways. A detailed screening of individual sites and logical combinations of sites permitted elimination of those whose relative costs were high or whose obvious environmental disadvantages were large. Preliminary layouts were developed for each of the most promising sites.

Candidates selected for further analysis in generation planning and for more thorough environmental consideration included (1) the Watana and Devil Canyon dam sites (the combination found most suitable by the COE in the 1976 and 1979 studies); (2) High Devil Canyon (favored by Kaiser in 1974) and Vee; and (3) a combination of a Watana dam, a relatively low re-regulation dam midway between Watana and Devil Canyon and a tunnel from the low dam with a downstream portal near Devil Canyon. Within these groups, further



SUSITNA PROJECT SEISMIC SETTING

FIGURE 6

variations were studied in terms of alternative dam types and heights and possible schedule variations.

8 - GENERATION EXPANSION PLAN

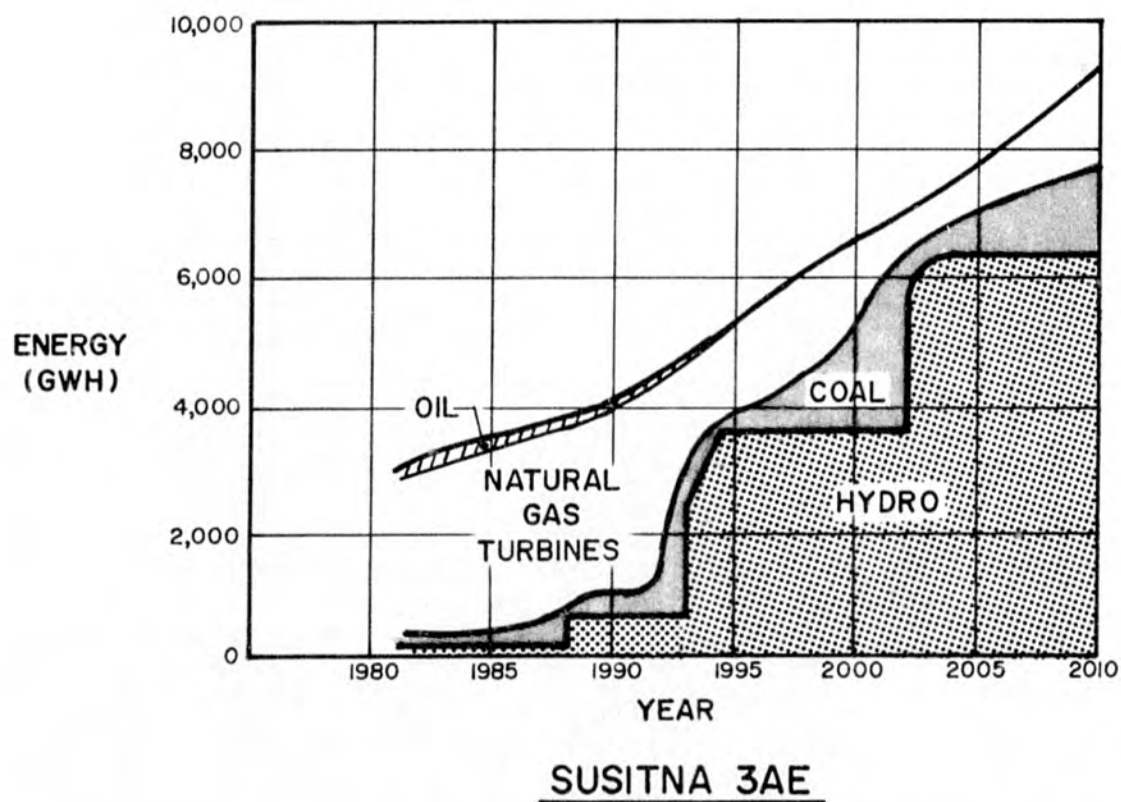
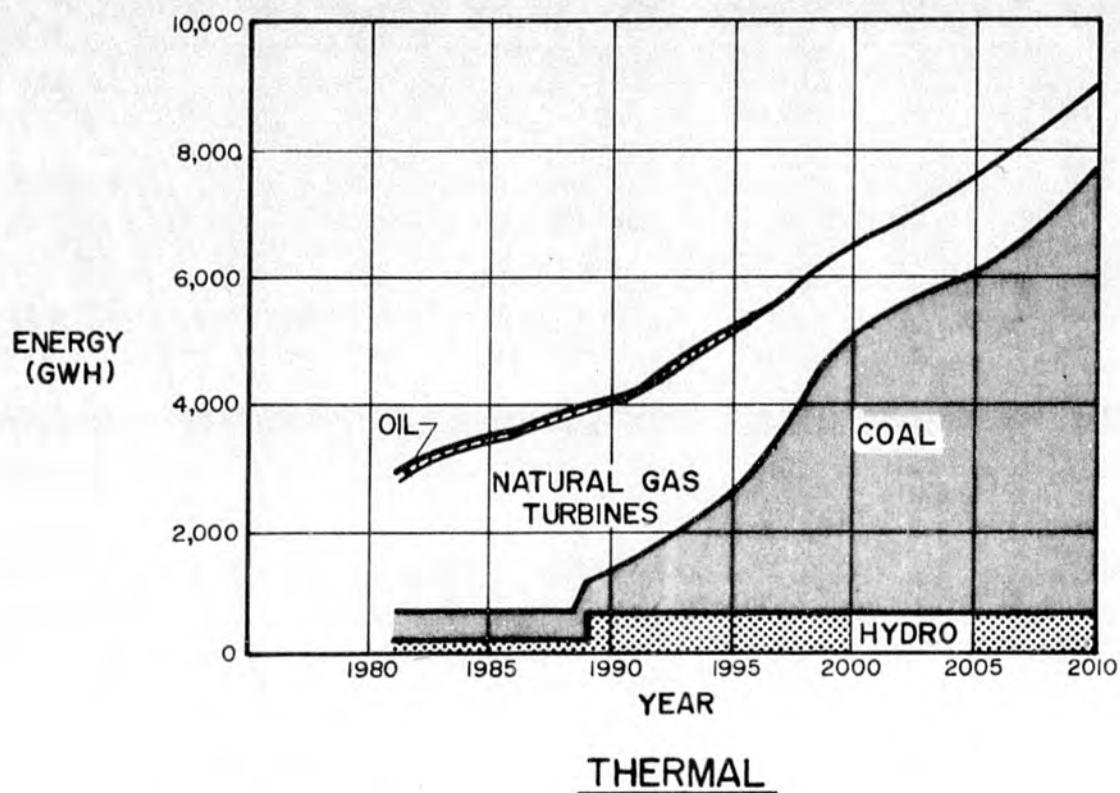
The current generation system in the Railbelt is primarily based upon thermal power. Natural gas is used heavily in the Anchorage area, oil fired units predominate in Fairbanks, and several small coal-fired plants operate at Healy and in the Fairbanks area. Hydroelectric energy, primarily from the Eklutna project, also contributes a small portion of the current Railbelt electric generation.

The present system will evolve in future years as demand increases and as old units reach the end of their useful lives. Regardless of whether or not a Susitna Project is ever developed, new system additions will be needed. For planning purposes, it was assumed that the Bradley Lake Project (now being pursued by the COE) and certain thermal units now under construction will be on line by the early 1990's. New capacity is necessary after 1992, but the amount and type to be added in any particular year will vary as a function of the demand and peak load forecasts.

A generation planning exercise was conducted to determine how each of the potential Susitna developments might fit into future Railbelt generation systems. The General Electric Optimized Generation Program (OGP) was the primary tool used for this purpose. In addition to Susitna and present and planned capacity, major alternatives including coal-fired plants, gas turbines, gas-fired combined-cycle plants, and the ten best non-Susitna hydroelectric sites were considered as candidates for future expansion. On an economic basis, it was determined that Watana/Devil Canyon, High Devil Canyon/Vee, and Watana/Tunnel all produced total generation system present worth costs which were less than the least cost system without Susitna. Of the total sets considered, the Watana-Devil Canyon combination was favored economically. In the case of the most likely ISER forecast, the most appropriate time to bring an initial 400 MW Watana project on line was found to be 1993. Figure 7 provides a system energy comparison for the mid-load forecast for a base case thermal system and for a Watana/Devil Canyon development (Susitna 3AE).

Although somewhat higher in cost and lower in total energy production, the Watana-Tunnel combination was found to be a viable option in comparison to the best non-Susitna system. Some environmental advantages may be ascribable to the tunnel project, particularly since it offers an opportunity to preserve the Devil Canyon gorge essentially in its natural state. It is important to note, however, that the Watana dam project is a necessary first stage in the tunnel concept just as it is in the Watana-Devil Canyon combination.

Preliminary studies of tidal power potential have commenced. Tidal power development, if found feasible, would necessarily lag the earliest possible Susitna development simply because time-consuming detailed environmental and engineering investigations would have to be undertaken before a license application could be submitted to the FERC. Tidal power characteristics and



SYSTEM ENERGY COMPARISON
MID LOAD FORECAST

costs will be available by mid-1981 as an input to the independently conducted Railbelt Alternatives Study. For generation planning purposes in the Susitna study, it has been assumed that tidal power generation is not available in 1993 when Watana could be brought on line economically.

A series of sensitivity tests was run to determine how variations in key parameters would affect the choice of favored plans. These tests generally demonstrated that the Watana-Devil Canyon development is the most cost effective alternative among Susitna Basin plans through a reasonable range of fuel costs, fuel escalation rates, real interest rates, and the like.

9 - SUSITNA HYDROELECTRIC DEVELOPMENT

Based on the generation planning studies and preliminary environmental analysis, the developments selected for primary study and design activities during 1981 are at Watana and Devil Canyon. Should continuing analysis of the tunnel, particularly in the environmental area, confirm clear advantages which in the opinion of the State of Alaska offset the higher costs and lower energy associated with that scheme, a shift to that plan can be accommodated because the Watana development is a common first stage for both plans.

The conceptual design for Watana presently consists of a rockfill dam with maximum height of 870 feet and with upstream and downstream slopes sufficiently flat to withstand the maximum credible earthquake. The spillway arrangement must be such as to discharge design floods (1 in 10,000 year events) without damage. It must also permit safe discharge of the maximum probable flood. In addition, spillway design must be such that nitrogen entrainment downstream is kept within acceptable limits for fish survival.

The conceptual design for Devil Canyon currently includes a thin-arch concrete dam approximately 650 feet high. Spillways at Devil Canyon must meet the same criteria as noted above for Watana.

Alternative arrangements for the major dams and spillway structures remain to be studied further to optimize the design of each development.

Intake structures at both dams will be designed with multi-level draw-off arrangements to facilitate selection of desired downstream water quality. Underground powerhouses are currently planned at both dams, though surface facilities can be accommodated if geotechnical and economic investigations indicate that such facilities are preferable to underground caverns. As currently conceived, the initial installation at Watana will develop about 400 MW of power and the facility will be planned to permit installation of an additional 400 MW after downstream regulation is provided (either by a Devil Canyon reservoir or by construction of a somewhat smaller dam midway between Watana and Devil Canyon, as is required in the tunnel concept).

Alternative access routes have been defined and public workshops were held in March, 1981, to solicit comments. One of the routes under consideration would

offer controlled access since its terminus would be at the Alaska Railroad rather than at an existing highway.

Current studies indicate that it is possible to complete the Watana dam by 1993 if both an FERC license to construct the dam and access roads are available by 1985. Alternatively, construction equipment may be brought into the site overland from the Denali highway in the winter of 1985 and access road work may parallel on-site construction with some cost penalty.

The Devil Canyon dam can be brought on-line within about 6 1/2 years after the start of construction if access routes exist at that time.

A transmission line study is currently underway. This work is being coordinated with the study team involved in the ongoing intertie study. As currently envisaged, transmission facilities would parallel the Susitna River from the dam sites to Gold Creek, at which point lines would extend north and south to Fairbanks and Anchorage, respectively.

10 - ENVIRONMENTAL PROGRAM

A major environmental investigation program got underway in 1980. In addition to necessary exhaustive field data collection, effort was devoted in particular to two other major components: (1) addressing major environmental concerns including those expressed by government agencies (at Federal, State, and local level) and the general public, and (2) environmental participation in the design process with a view toward avoiding or minimizing impacts by making design decisions which account for environmental concerns from the start.

The environmental studies are divided into nine specific study components:

- Fisheries
- Wildlife
- Land Use
- Archaeological (Cultural Resources)
- Recreation
- Plant Ecology
- Corridor Selection
- Socioeconomic (See paragraph 11 below)
- Management and Coordination

At least one more year of data must be collected in each area before detailed impact statements can be prepared and proposals developed as appropriate for mitigative measures. Even so, no evidence has been discovered to date to indicate environmental impacts which are so severe as to conclusively rule out the possibility of developing the Susitna River for hydroelectric power production.

Certain environmental impacts on fisheries experienced at other major hydroelectric projects will be absent from or less severe at the Susitna Project if it is ever constructed. These include:

- (a) No direct blockage of fish migration or escape will result from the dam itself.
- (b) No significant river diversions resulting in low flows in the diverted river will occur for the Watana-Devil Canyon combination.
- (c) Regulation is being factored into design to eliminate significant daily fluctuations in flow.
- (d) Nitrogen entrainment will not be increased by numerous sequential reservoirs such as are found on the Columbia River. In addition, design studies will incorporate the latest available technology to reduce the occurrence of such phenomena.

11 - ANALYSIS OF SOCIOECONOMIC IMPACTS

A major socioeconomic study program was launched in 1980 with the objectives of describing existing socioeconomic conditions, forecasting future conditions if no Susitna Project is built, and determining which conditions are most likely to be impacted by a Susitna development.

Major efforts have been devoted to development of socioeconomic profiles during 1980. The 1981 work will focus upon preliminary assessments of impacts which implementation of the recommended development plan could cause.

12 - ECONOMIC FEASIBILITY AND NET ECONOMIC BENEFITS

The analysis of the net economic benefits of the recommended development plan is being developed within the framework of traditional methodology. The general procedure considers the total costs associated with the project (construction, operation, maintenance, transmission, etc.). Benefits are the avoided costs of providing the equivalent power and energy from the next best alternative generating source.

A preliminary life-cycle cost analysis has been conducted for the recommended development plan as well as for other alternatives surviving the initial site screening process. This economic analysis assumed a three percent discount rate in real terms (i.e., the cost of money is assumed to be three percent higher than actual inflation rates during the planning period). In 1980 dollars, the present value costs of the recommended hydroelectric development (operated in the Railbelt System during a 60 year period for economic analysis) were less than the costs of the best thermal generation alternative.

More precise values for life-cycle net benefits will be determined as cost estimates are developed in detail for the optimized development plan in 1981.

13 - POWER AND ENERGY MARKETING

Whereas it can be shown that the Susitna Hydroelectric Project would be economical in the long term, it is nonetheless true that the relatively high capital cost of a major hydroelectric power development can lead to difficulties in financing the project or in marketing power and energy during the first few years of operation.

Preliminary financial studies have been conducted to determine the probable nature and extent of the problem of high front-end loading as well as to identify potential strategies for alleviating this. These studies will continue in 1981. Insofar as marketing is concerned, it must be assumed that the maximum price which Railbelt Utilities would pay at any given time for Susitna power and energy is equal to or less than the avoided cost of producing power and energy by the best available alternate means.

In the initial year of operation deliveries from Susitna will replace power and energy generated by existing thermal power plant and the avoided cost will be related to fuel, operating and maintenance expense. Only when the existing capacity reaches the point of needing replacement or new demand emerges, with which this existing capacity cannot cope, will it be possible to edge the Susitna price of energy up to the full cost.

The ongoing studies will deal with practical arrangements which can be made with the Railbelt Utilities to achieve equitable marketing terms under which Susitna energy can be introduced to meet a substantial portion of future system needs.

14 - PUBLIC PARTICIPATION PROGRAM

An aggressive public participation program was initiated for the Susitna Hydroelectric Project. Conducted directly by the Power Authority, major objectives are:

- To distribute information to the public,
- To solicit information from the public, and
- To ensure that public input is fully considered in the decision-making process.

Community meetings, workshops, an action system to ensure that response is provided to every comment or question written by the public, newsletters and mailing lists are vehicles by which these objectives are satisfied.

Of particular note is the fact that public comment and concern has directly influenced the course of the Susitna study. Such major changes from original study plans as the commissioning of a separate and independent alternatives study, the addition of a sociocultural study and an increased level of study for alternative developments in the Susitna Basin were largely prompted by public concerns.

The high level of activity in the Public Participation Program is expected to continue throughout the course of the study.

15 - LICENSING AND PERMITTING PROCEDURES

Regulatory requirements at Federal, State and local levels tend to be voluminous, complex, and time-consuming for any major power development. For the first several years, satisfaction of regulatory requirements will be the controlling factor on the schedule for final completion of a Susitna project.

The most significant initial regulatory requirement is the necessity to obtain a license from the Federal Energy Regulatory Commission (FERC). Should project feasibility be established and a decision made to proceed with the work, current plans call for submittal of an application in mid-1982 and for receipt of a license by 1985.

A detailed analysis of licensing and permitting requirements was conducted early in the course of the work in 1980 and a blueprint was drawn up to ensure that critical regulatory schedules can be met.

16 - FINANCIAL FEASIBILITY ANALYSIS

Financial analysis and risk assessment has been initiated but only carried forward to a limited extent pending the selection of the preferred development plan and the availability of appropriate capital costs of construction. One purpose of the preliminary financial feasibility analysis has been to establish the "envelope" within which the staging, design and operating configurations of Susitna are amenable to market financing based upon reasonable assumptions concerning financial markets and the inclinations of investors over the next 20 to 30 years.

A computer model, developed earlier for financial analysis of major capital intensive projects, has been tailored specifically to meet the unique requirements of Susitna. Using this model, it is possible to analyze the effect on financial feasibility resulting from variations in input assumptions. These inputs include phasing of major project stages, scheduling of construction outlays, energy and power production during initial years, pricing and revenues, returns on investment, contingency provisions, debt requirements, taxes, and financial market conditions. There has been close correlation with work carried out on generation planning, employing the OGP-5 modeling capability (as described in Paragraph 8).

Preliminary financial analysis indicates that viable options do exist for funding the project with various levels of involvement of the State of Alaska. Work during 1981/82 will focus on financial feasibility of the optimized development selection and will proceed in close collaboration with the financial consultants selected by the Power Authority at the end of 1980.

17 - SECURITY OF PROJECT COST AND REVENUE STRUCTURE

Decision makers responsible for public policy and for action within the financial and credit markets, as well as those at regulatory agencies, must be confident that the probability of unforeseen events seriously distorting the objectives of the Power Authority and its planners is sufficiently remote that government and private investors should commit substantial financial resources to the Susitna Project. A detailed risk analysis will be made of the various influences and possibilities, no matter how remote, that might impact the security of the project cost structure and its revenue flow. In particular, consideration will be given to risks, and to the formulation of contingency plans, applicable to:

- Potential variations in capital costs
- Cost escalation
- Cost overruns
- Delays
- Events leading to noncompletion
- Serious outages during operation
- Failure of revenue from power resources
- Regulatory issues

Arising from the study of project cost and revenue structure will be consideration of the need for completion and/or other guarantees and revenue assurance requirements. The aim will be to develop strategies and procedures which will minimize risk in each category and provide for an acceptable balance of residual exposure and benefit for the financing entities which might be involved in the Project.

18 - ORGANIZATION AND MANAGEMENT

Project control structures, policies and procedures have been developed and put in place to ensure that continuing project activities are in the best interests of the State of Alaska and its populace. The Executive Director of the Power Authority serves as Project Manager for the State of Alaska. He is assisted in turn by a project staff which includes Assistant Project Managers for Technical Output and Schedule and for Budget and Finance. A Project Engineer within the Power Authority devotes his full-time attention to monitoring and coordinating project work.

Within the Acres organization, a Project Manager is responsible for direction of the activities of a large group of technical personnel. He is assisted by a Deputy Project Manager, a Technical Study Director, and a Resident Manager (in Anchorage).

External Review Panels have been established both at the Power Authority's level and at Acres' level to provide an independent check on the adequacy and accuracy of completed and proposed study activities.

Major subcontractors assisting Acres in the performance of its work include:

- R&M Consultants, Incorporated
- Cook Inlet Region Incorporated in association with Holmes and Narver
- Terrestrial Environmental Specialists
- Woodward Clyde Consultants
- Frank Moolin and Associates
- Robert W. Retherford Associates
- Other Alaskan firms providing transportation, supplies, and logistical support

19 - IMPLICATIONS OF PROCEEDING

The Governor of Alaska and the State Legislature will receive a report on or before March 30, 1981, wherein the Power Authority must recommend whether work should continue on the Susitna Hydroelectric Project. The Power Authority has selected four particular issues for detailed consideration. Conclusive proof that any one of these issues presents an insurmountable barrier would lead to a recommendation by the Power Authority to terminate the study. Briefly summarized, the issues are as follows:

- Are the forecasts too low to require any major generation additions over the next 30 years?
- Are seismic risks so great that safe development cannot occur?

- Are anticipated environmental losses unacceptable?
- Is there a significantly lower-cost set of alternatives which will satisfy demand forecasts through the year 2010?

No barriers have been discovered during the initial year of study which would lead to an affirmative answer to any of the listed questions. Even so, definitive answers have not yet been developed for all of the issues. Continuing the study would provide the State with an opportunity to make sound decisions in the future as to whether Susitna hydroelectric potential should ultimately be developed. Terminating study efforts at this time would result in avoiding the significant costs of further investigation and analysis on Susitna.

SCOMM

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PLEASE NOTE: THE FOLLOWING PAGES WERE TREATED
AS A UNIT IN THE ORIGINAL DOCUMENT.

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the National Center for Appropriate Technology

P.O. Box 3030 Butte, Montana 59701 (406) 494-4572

APPROPRIATE TECHNOLOGY NEEDS ASSESSMENT CHECKLIST

Instructions: The purpose of this checklist is to assess your needs in order to determine how NCAT might better serve you. As the only research and development organization in this country focusing on the technology needs of low-income communities, it is important for us to accurately target our research and development activities. Please take the time to read this questionnaire and give some thought to your responses. You will be contacted by phone between October 9 and October 12. The interviewer will ask you the same questions you have before you. **NOTE: DO NOT RETURN THIS FORM - we will be asking for your responses by phone.**

1. To get an idea of the size of your organization, could you state the approximate annual budget of your Community Action Agency? **Check one:**

☐ Under \$1 million

☐ \$8-12 million

☐ \$1-2 million

☐ \$12-16 million

☐ \$2-4 million

☐ Over \$16 million

☐ \$4-8 million

2. Are the programs of your CAA geared *primarily* to problems that are URBAN or RURAL in character? **Check one:**

☐ Urban problems

☐ Rural problems

☐ Both equally

3. Following is a list of some problems that various CAA programs generally address. Please state whether your CAA has an active program addressing these problems, or whether they are presently being addressed by another community-based organization in your area. **Check a response for each:**

	YES	NO	OTHER CBO
a. Access to nutritious food			
b. Food costs			
c. Lack of job training			
d. Availability of decent jobs			
e. Ability to pay energy costs			
f. Lack of conservation measures, and/or information			
g. Access to transportation			
h. Cost of transportation			
i. Availability of decent housing			
j. Cost of decent housing			

	YES	NO	OTHER CBO
k. Access to health care			
l. Cost of health care			
m. Youth delinquency			
n. Problems of Aging			
o. Family social services (such as child abuse)			
p. Alcohol and drug abuse			
q. Lack of community organizing and advocacy			
r. OTHER (specify)			

4. Of these same problems, which three are the most serious and pressing problems on a year-round basis in your community? Refer to the above list. **Specify three:**

a. _____

b. _____

c. _____

5. Following is a list of program areas in which appropriate technologies have been developed. Please indicate for each whether you have a program — plan to expand your program — or need improved technologies.

	HAVE A PROGRAM	PLAN TO EXPAND	NEED IMPROVED TECHNOLOGIES
a. Housing rehabilitation and self-help programs.			
b. Using solar heating systems to cut home energy costs (solarization).			
c. Home weatherization			
d. Consumer conservation education			
e. Attached solar greenhouses to produce food and cut heating costs.			
f. Local, and/or cooperative systems for food production (such as processing and marketing).			
g. Production and use of alternative fuels such as gasohol, alcohol and methane to reduce fuel costs or increase availability.			

HAVE A PROGRAM

PLAN TO EXPAND

NEED IMPROVED
TECHNOLOGIES

i. Community health-care delivery and nutrition education programs.

j. Job training

k. OTHER (specify):

6. Of the program areas in which appropriate technologies have been developed (listed above), which has the greatest potential for helping the poor in your community. Specify one:

7. Following is a list of appropriate FOOD technologies that may help low-income people. Please indicate for each whether you have a program — plan to expand your program — or need improved technologies:

HAVE A PROGRAM

PLAN TO EXPAND

NEED IMPROVED
TECHNOLOGIES

a. Community gardening

b. Training in food production methods.

c. Food-producing solar greenhouse or coldframe construction.

d. Nutrition and diet guidance.

e. Local food processing, canning and production.

f. Alternative food marketing systems (e.g. cooperatives).

g. Small-scale animal production (such as fish farms, chickens).

h. Food stamp outreach and advocacy.

i. OTHER (specify):

8. Of the appropriate FOOD technologies listed above, which has the greatest potential for helping the poor in your community? Specify one:

9. Which types of assistance listed below do you feel are most needed in addressing FOOD problems in your area? Check a response for each:

BADLY NEEDED

SOMEWHAT NEEDED

NOT NEEDED

a. Funding for local demonstration projects.

b. Information on successful or unsuccessful programs.

c. Consumer self-help materials.

d. Improved or expanded training materials for CAP personnel.

e. Information on new technical developments and program possibilities.

f. Technical assistance on CAP projects.

g. OTHER (specify):

10. Following is a list of appropriate HOUSING technologies that may help low-income people. Please indicate for each whether you have a program — plan to expand your program — or need improved technologies:

HAVE A PROGRAM

PLAN TO EXPAND

NEED IMPROVED
TECHNOLOGIES

a. Passive solar retrofits for space heating (such as Trombe wall, solar wall panels, sunspaces).

b. Attached solar greenhouses.

c. Alternative low-cost building materials and methods, (such as recycled materials).

d. Development of low-cost modular housing.

e. Low-cost housing designs.

f. Housing cooperatives and homesteading.

g. Housing rehabilitation/home repairs (such as self-help projects).

12. Which types of assistance listed below do you feel are most needed in addressing HOUSING problems in your area? Check a response for each:

BADLY NEEDED SOMEWHAT NEEDED NOT NEEDED

- a. Funding for local demonstration projects.
- b. Information on successful or unsuccessful programs.
- c. Consumer self-help materials.
- d. Improved or expanded training materials for CAP personnel.
- e. Information on new technical developments and program possibilities.
- f. OTHER (specify):

[illegible]

HAVE A PROGRAM PLAN TO EXPAND NEED IMPROVED TECHNOLOGIES

- a. Low-cost solar space heating.
- b. Low-cost solar hot-water systems for homes.
- c. Attached solar greenhouses.
- d. Optimal weatherization.
- e. Furnace retrofitting.
- f. Crisis resource supply (such as heaters, blankets, clothing, wood, coal).
- g. Wind-generated electricity.
- h. Small-scale hydroelectric power.
- i. Wood heat or wood substitutes.
- j. Alcohol fuel (such as gasohol).
- k. Methane gas production.
- l. OTHER (specify):

[illegible]

15. Which types of assistance listed below do you feel are most needed in addressing ENERGY problems in your area? Check a response for each:

BADLY NEEDED SOMEWHAT NEEDED NOT NEEDED

- a. Funding for local demonstration projects.
- b. Information on successful or unsuccessful programs.
- c. Consumer self-help materials.
- d. Improved or expanded training materials for CAA personnel.
- e. Information on new technical developments and program possibilities.
- f. OTHER (specify):

[illegible]

16. Does your CAA have an active weatherization program?

- ☐ YES (if yes, answer question 17).
☐ NO (if no, skip question 17 and go to question 18).

17. Of the following, which are most needed to improve your weatherization program? Check a response for each:

	BADLY NEEDED	SOMEWHAT NEEDED	NOT NEEDED
a. Better home audit techniques (such as work estimation, instrumentation, and analysis.			
b. Professional weatherization schooling.			
c. Development of improved weatherization materials.			
d. Better information on performance, quality, safety and use of weatherization materials and techniques.			
e. Better availability of CETA labor.			
f. Regulations permitting use of Non-CETA labor.			
g. Broadened income eligibility standards.			
h. Modified regulations and codes.			
i. Consumer education.			
j. Information and training on furnace efficiency.			
k. Information and training on modification for alternative fuels.			
l. OTHER (specify):			

18. Of the weatherization program needs you have listed above, which areas need technical development? Specify one or more:

19. Do you feel that attached solar greenhouses have greater potential value in your area primarily as a HEAT PRODUCER or as a PROTECTED ENVIRONMENT TO GROW FOOD? Check one:

- ☐ Heat producer.
☐ Food-producing environment.
☐ About equal value.

20. Below are listed some primary methods of assisting the poor. Please rank their importance to the poor in your view. Rank 1 (highest) through 5 (lowest):

- Advocacy for the poor.
— Employment for the poor.
— Self-reliance for the poor.
— Services for the poor.
— Transfer payments for the poor.

21. As you know, NCAT is funded by CSA in large part to provide assistance to Community Action Agencies such as yours, by researching, developing and helping implement "appropriate technology" programs addressing problems of low-income people. What information or services would you like to see NCAT provide in the future?

technology

What are the signs of an established corporation? In the world of research and development, success is measured by a large and qualified staff, a maximum number of contracts awarded, healthy and continual growth, a record of efficient performance and constant diversification into new ventures of national scope.

In three short years, MERDI has established itself and has in fact displayed remarkable growth. In the Technology Department, this success can in part be attributed to the effective and flexible use of specialized expertise through a matrix theory of organization among the five Technology divisions—Engineering, Environmental, Socioeconomics, Applied Research and Computer Support.

Within these divisions, a standard matrix method of planning a specific project both vertically (a division as a whole) and horizontally (across several divisions, selecting needed expertise) assures the best technological support is provided to all levels of Institute activity. Expertise is used only as required, each employee is usually involved in a number of projects and the most efficient application of MERDI talent is made.

Environmental, chemical, electrical and mechanical engineering knowledge is supplied to the MERDI/CDIF Department and the rest of the Institute using this matrix system. Specific research efforts, engineering skills, social and economic expertise and computer capabilities are available and can likewise be directed to such MERDI Projects as the National Center for Appropriate Technology (NCAT).

The Technology divisions are intricately involved in every aspect of Institute work. For the MERDI/CDIF Department, for example, assistance is provided in assessing any social and environmental impacts of the Department

of Energy Component Development and Integration Facility (CDIF) being built south of Butte.

Seeking work on new and independent ventures, however, is as important a goal to the Technology Department as providing support to existing projects. While present efforts in the Environmental Division are contained in matrix-organized support to the rest of MERDI, planning is underway for work with the Environmental Protection Agency (EPA) on a variety of its pollution-related programs.

This goal of expansion is shared with the Computer Support and Applied Research managers, who are enlarging their present staffs so as to possess the capability to take on original, outside contracts. The work of the Applied Research Division for the Department of Energy on materials for molten-carbonate fuel cells is already recognized as a viable contribution to the national program on second-generation fuel cell power plants.

Providing in-house support, pursuing outside contracts for research, recruiting to complement the existing staff—these are the immediate concerns of the Technology Department to assure continuing Institute growth and establishment. Throughout all policy and plan-

ning, however, is a desire for MERDI to fulfill an increasingly important role in conducting national research programs; work currently being done at home in Montana and finding success in state applications benefits energy concerns nationwide.

MERDI Technology studies of the environmental and socioeconomic impacts of the CDIF are setting a standard for planning future MHD power plants in this country. The siting methodology being prepared and the unique siting of MHD plants defined could have national implications.

Results of Institute research in Montana can be applied appropriately to similar problems in other states. Technology support in writing the Glasgow base EIA will enable MERDI to produce a reference document and guideline for re-use studies on any other national program or institution that has outlived its usefulness. Likewise, future Institute efforts to examine the feasibility of using geothermal sources to heat buildings around Montana will save fuel expense in addition to promoting interest in geothermal energy elsewhere.

MERDI is a Montana born and bred entity, a research and development firm proud of its location and its staff, more than half of which are Montana natives. The establishment of the Institute and many initial successes have been accomplished inside the state. MERDI has enjoyed healthy growth since its founding, and this growth assures that the ever-present company goal to expand the scope of research and development work beyond state and regional boundaries shall continue.

computer support

In the long journey from an idea to a proposal to a contract, through technical work, field work and final conclusions, the evolution of a MERDI project is defined by its use of various Institute resources. Through the flexible matrix organization among divisions and Departments there are experts in many disciplines, assistance available in planning and management, a technical library, and one essential service used in every facet of Institute activity — Computer Support.

The outstanding computer capabilities MERDI has acquired and the experienced staff of analysts and programmers often helps assure the success of Institute functions; projects requiring computer support range from attitudinal surveys to wind velocity studies. With computer assistance in field data analysis and aid in studying existing research in specific fields, these projects can reach the most timely and accurate completions possible.

Computer capabilities at MERDI currently include teletype terminal access to the time-share system of the DEC 11/70 computer at the Montana College of Mineral Science and Technology in Butte. In addition, a Data General computer system is operated at MERDI, coupled with various data sets that are used to accessing large IBM or CDC computer systems.

The Data General Eclipse C330 computer system is also used primarily as an analysis tool by the technical and engineering staff. As presently configured, the system includes a 256 KB

central processing unit supported by various peripherals including a line printer, card reader, operator's console, large disk and magnetic tape units.

Day-to-day computer time and expertise is in high demand throughout the Institute, with support to the MERDI/CDIF divisions and other divisions doing work related to MHD being a major responsibility of the computer staff. An extensive pre-operational data base is being organized for MERDI/CDIF which will be used in the continuation of information collection after start-up of the Department of Energy Component Development and Integration Facility (CDIF) in late 1979.

Much MERDI attention is being focused on the areas where a potential impact of the CDIF is possible — environmental conditions, numerous social and economic factors — and it is the Computer Support Division that is providing access to baseline information for 1977-78 so that future impacts can be measured accurately.

In addition, computers are helping to store gathered data, organize sampling and monitoring schedules and define results on the current impact measurement efforts of the Water

Quality/Biological and Air Quality/Trace Elements tasks in the Environmental Division. For the MERDI/CDIF Meteorological Data Station, information is being compiled on ambient temperature, wind speed and direction, solar radiation and barometric pressure. Similar data organization and interpretation has been given to the Socioeconomic Division's Community Attitudinal Survey and CDIF Construction Worker Profile to assure full benefit of these impact studies.

A MERDI/CDIF Data Acquisition System is also being readied by computer engineers for the scheduling and flow of real-time analog and digital data, the recording and presentation of this data and the evaluation of test performance.

While MHD-related programs demand much of the MERDI computer staff attention, the division's expertise is applied in many other areas. The Engineering Division used computers to tabulate results of the 1978 Home Energy Survey conducted in Butte. For the MERDI involvement in the re-use studies for the Glasgow Air Force Base, computers are helping to determine whether wind measurements at three different altitudes are sufficient to support a wind power generation facility there.

Not all computer efforts are directly contract-related, however. Plans are being made to use computers in-house at MERDI for a Management Information System that will not only include data on the payroll and accounting departments but on personnel, technical document files and property control as well. Computer engineers will also soon be helping streamline MERDI/CDIF inventory control.

In this manner, the work of the Computer Support Division will continue to be an essential contribution to Institute growth and success.

SOCIOECONOMICS

One of MERDI's original goals was to establish a Rocky Mountain regionally based research and development capability for energy development. Initially, MERDI concentrated on problems associated with large-scale systems, including MHD. The interrelation between such large-scale systems and regional economic development quickly became apparent to MERDI management; thus, the Socioeconomic Division was established to analyze the problems associated with regional economic development and to provide assistance and data to federal, state and local agencies. MERDI considers socioeconomic factors to be prime issues in energy development.

The philosophy of the Institute which the Socioeconomic Division now helps to enact also involves a general desire to make projects adaptable to society, from a social as well as economic standpoint. MERDI's socioeconomicists are charged with the task of analyzing and examining the implications of Institute undertakings upon the human environment.

The overall goal of making technology more responsive to society is reflected in all Socioeconomic Division activity. One key element is determining the attitudes of a project's affected population; recently, specific attitudinal surveys and studies have been administered and results combined with baseline data to measure the social and economic impacts of projects.

Socioeconomic studies have been a major element in the process of siting, planning and designing the Department of Energy Component Development and Integration Facility (CDIF) in Butte's Industrial Park. First, detailed information about the economic atmosphere (employment and income) in Butte was gathered and analyzed in order to establish an economic profile of the community. As a result, economic

variables can be measured both prior to and during the construction of the CDIF.

Next, the Socioeconomic Division administered a Butte-Silver Bow Community Attitudinal Survey to determine how residents feel about the existence of the CDIF. Finally, a Construction Worker Profile is being conducted in three phases during 1978 to learn about the local/non-local composition of the construction workers and other pertinent information in order to allow quantification of the work force impact on the area.

Several other MHD-related projects have received Socioeconomic support. In conjunction with the Environmental Division, a siting methodology for an American MHD plant is being prepared; the previous work in power plant siting is being reviewed and combined with studies to learn if and how MHD plants differ and what the best siting approaches would be.

As part of MERDI's Environmental Development Plan (EDP) to the Department of Energy, socioeconomicists are making recommendations concerning social and economic impacts and mitigating measures unique to MHD generation.

In another level of activity, working with the Glasgow Project, MERDI socioeconomicists are preparing portions of the Environmental Impact Assessment (EIA) on the various development alternatives being considered for the inactive Air Force Base in northeastern Montana.

Each alternative being posed requires specific socioeconomic analysis and a study of its impact on the human environment. To determine the perceptions, desires and attitudes of Glasgow area residents relating to economic development, the socioeconomicists are conducting an attitudinal survey to complete the full examination of the Glasgow re-use issue from a socioeconomic point of view.

In the future of the Institute, the work of the Socioeconomic Division to examine the humanistic implications of projects will increase in importance and scope, both as support to other divisions and in administering contracts of its own. Work will be expanded to include participation in the many socioeconomic programs in the federal Departments of Housing and Urban Development (HUD); Health, Education and Welfare (HEW); and Transportation. This may also involve exploring aspects of the human condition — health care, the arts and humanities, and human behavior.

Environmental and Engineering

Official policy of MERDI and the Department of Energy states that environmental research be conducted hand in hand with the development of new technologies. Concern for the environment is a relatively new concept in the industrial world; little consideration was given to environmental protection when the technologies in use today were being developed. It is now obvious to industry that incorporating a study of environmental effects into all technology development will assure environmental protection, excellence in engineering and savings of dollars.

MERDI's Environmental Division helps the Institute fulfill its role in energy development by providing expertise for all environmental considerations to be made; MERDI has the largest MHD environmental research staff in the country.

Baseline information on water and air quality is being gathered by the division as part of its effort to monitor possible impacts of the Department of Energy Component Development and Integration Facility (CDIF) in Butte.

As part of the national MHD program, the Environmental staff travels to MHD laboratories and facilities across the country for review of other MHD test results. Emphasis is presently being placed on research of trace elements and sub-micron particles, with a study planned on nitrogen oxide emissions.

The division is also helping to prepare MERDI input to the Department of Energy Environmental Development Plan (EDP) for MHD generation. This work will assess potential environmental problems arising from the MHD process.

MERDI environmental specialists were also largely responsible for an MHD Engineering Test Facility (ETF) screening process recently completed on environmental, economic and social impacts of an MHD facility as they relate to the siting of future American plants.

Technical assistance is being supplied for the Environmental Impact Assessment (EIA) MERDI is compiling on the inactive Glasgow Air Force Base in northeastern Montana. Engineers use sophisticated multi-sensor instrumentation to monitor air quality and meteorological parameters at the base.

MERDI's environmental experts are interested in expanding their work into such areas as waste treatment and disposal processes and the environmental impacts of geothermal energy. As MERDI addresses new and alternative energy technologies, appropriate environmental measures shall continue to be a high priority.

Facilitating the most effective use of the nation's renewable energy sources, with emphasis on the resources of Montana, is the primary objective of the Engineering Division research and development program. Closely associated with this is a continuing effort to increase the efficiency of present uses of non-renewable energy sources; new technologies must be pursued and conventional technologies improved.

MERDI engineers currently supply support to other divisions as an ongoing activity, including engineering assistance to MERDI/CDIF and other projects in general MHD work, written evaluations of inventions submitted to the Center for Innovation (CFI) on such criteria as technical feasibility and structural integrity, and assistance to the Glasgow Project on reviewing alternative re-uses for the base.

The Engineering Division is also actively pursuing work on other forms of energy conversion. One project under consideration is a development of the geothermal sources at the Montana State Hospital at Warm Springs, where geothermal energy could complement the existing fossil-fueled hot water heating facility.

As fuel cell technology develops, the Department of Energy is building units for operational tests. These 40 kw systems will be provided to gas utilities as continuing funding is allocated; MERDI engineers are working with several Montana-based utilities on this program.

Future activities in energy conversion will enlarge the overall scope of projects to include such areas as electric, active thermal and passive solar energy, generation of power from wind sources, and biomass conversion from agricultural and wood products.

Perhaps the most prominent goal of MERDI engineers is to provide assistance to the state of Montana in its efforts to improve its energy source position. For example, the division plans to actively participate in the siting efforts for the Northern Tier Pipeline program, which will bring much-needed crude oil to Montana's landlocked refineries.

applied RESEARCH

Ceramics materials research and development is an important part of the effort of the Applied Research Division in determining the best materials for use in MHD components and fuel cell systems. A small but impressive ceramics laboratory at MERDI hosts the main activities of this division — studying ceramics applications for use in an MHD channel, and working on advanced fuel cells — and research is conducted by a highly-skilled core staff of engineers and technicians.

The development of ceramics materials is an extremely old field which was a refined art during the construction of the pyramids in Egypt. The technical understanding of ceramics, however, is of recent origin as significant progress has occurred primarily in the last two decades.

Ceramics efforts at MERDI stem from a need for new materials to line the MHD generator walls, for the extremely high temperatures required in the MHD process restrict the use of metals, which cannot withstand the heat without excessive cooling — resulting in a loss of efficiency. Ceramic materials can accept high temperatures, but must also be developed to resist the corrosion and erosion from the coal slag which shortens the life of components.

The seeding of potassium into the MHD channel is also detrimental to the life and performance of whatever material is used.

In MERDI's Applied Research Division, laboratory samples are made with a highly pure form of aluminum oxide, which when fired are close to the theoretical density — the density of a perfect single crystal. Ceramics fabrication is an important function of the laboratory, which contains dry and isostatic presses, several furnaces and delicate weighing and measuring apparatus. Samples are tested for wet-ability, conductivity and diffusivity.

The fuel cell materials work being accomplished addresses a similar problem as that of MHD channel components, namely, finding materials that can withstand heat and last a significant amount of time in a corrosive atmosphere.

The fuel cell is an electrochemical energy conversion system that operates on the same principle as an electric storage battery. However, the electrodes are exhausted in a battery, whereas oxygen from air and processed fuel are continuously fed to the fuel cell electrodes, which act only as a catalyst support and current carrier. The fuel and oxygen are electrochemically combined via separate electrodes in an electrolyte atmosphere, producing an electron flow through an external load connecting the electrodes. Water and carbon dioxide are by-products.

Fuel cell energy systems have the potential to provide nearly pollution-free energy with a high and constant efficiency level. The first generation, phosphoric acid fuel cell systems, may be used commercially within three to five years; the second generation, molten-carbonate and solid electrolyte systems of higher efficiency and temperature, may be available within 10 to 15 years.

Applied Research work is addressing both molten-carbonate and solid electrolyte systems; and although as yet a relatively small effort, this work has placed MERDI as one of three independent agencies in the country studying molten-carbonate fuel cells. The Institute plans to participate in the application of the 40 kw fuel cell feasibility units being built by the Department of Energy, the production of which could benefit many remote areas of Montana as well as throughout the United States.

The division is also planning to expand operations into photovoltaics research to generate electricity from solar and thermal energy sources. Another new program in Applied Research is an extension of work done previously for the United States Office of Naval Research (ONR) and ongoing MHD work. Sponsored by the OWR, this contract calls for MERDI to evaluate thermal transport properties and relate these to the microstructure of various engineering ceramic materials.

The MHD activities of this division in assessing the materials for MHD channels are related to the university research programs the Institute coordinates at the Montana College of Mineral Science and Technology (Montana Tech) and Montana State University (MSU).

Coordinating with other Institute programs and working in areas of its own, the Applied Research Division is helping to make advanced technologies — such as MHD and fuel cells — into practical realities.

the ENGINEERING test facility

The national magnetohydrodynamics (MHD) program includes many levels of experimental MHD work, ranging from small laboratory tests to test facilities large enough to eventually operate competitively with other power plants and demonstrate the commercial viability of MHD electrical power generation. Butte is the location of one of the first large test facilities that will operate for substantial periods of time; the Department of Energy Component Development and Integration Facility (CDIF) is scheduled to begin operating in late 1979, with MERDI acting as the managing contractor.

Existing law specifies that a second larger facility, the Engineering Test Facility (ETF), be located in Montana. Construction of the ETF will probably begin in three to five years; it will be the first facility in this country designed from its inception as a completely integrated, coal-burning electrical generator with an MHD topping cycle and a conventional steam power plant bottoming cycle — the normal manner for applying MHD to electrical generation.

The goals of the ETF will be to scale data from small facilities up to a size near commercial demonstration, to establish a data base for such a scaling up in size, and to integrate the MHD topping and steam bottoming plants at the smallest size that can safely be expanded to commercial plant scale.

This incremental building of MHD systems is required because the MHD process, like most physical phenomena, is so complex that theory cannot reliably expand the small-scale experimental data to the very large sizes required for commercialization. Building intermediate-sized facilities such as the CDIF and ETF is cheaper than risking major errors in going directly from laboratory scale to commercial size.

The CDIF will have a peak capacity of 50 megawatts thermal (MW_t); the latest plans for the ETF set its capacity at between 250 and 1000 MW_t . Test results from the CDIF and laboratories across the country will be combined to design the ETF MHD topping plant.

MERDI hopes to participate in the future design, construction and operation stages of the ETF. Present activities at the Institute related to the ETF are coordinated within the Projects Department. The ETF Coordinator manages those tasks pertaining to the ETF and acts as a focal point for all other work within MERDI that is applicable to ETF study. Key tasks include ETF siting methodology, MERDI's MHD Environmental Development Plan (EDP), the MHD trace elements research and emissions minimization studies, and the Montana State University (MSU) subcontract task for MHD plant control studies.

The direct ETF work at MERDI relates to facility siting. MERDI is now completing a siting methodology that is applicable to fossil fuel electrical

generation facilities in general, but is intended specifically for the proposed ETF. The method involves applying several steps of screening which will progressively narrow the area of interest from an entire state to a small number of specific sites of the size required for the power plant.

MERDI has also implemented a study of local, state and federal laws and regulations that might affect MHD plant siting decisions. This effort has defined a framework of permits and applications that must be obtained before construction, identified the most expedient order in which to obtain these permits, and established the time requirements for complying with the complex maze of approvals. This study applies directly to Montana and forms an excellent starting point for determining the needs in other states.

When the siting methodology has been completed and all information submitted to the Department of Energy MHD Division, the site selection committee may use this information in selecting a location for the ETF. Once a site is selected, an Environmental Impact Statement (EIS) will be prepared.

Through the management of future tests at the CDIF site and planning more advanced facilities, including making site recommendations to the Department of Energy, MERDI is actively fulfilling its role in the national MHD research and development effort

GLASGOW

What do you do with a \$200 million, nearly 6,000-acre inactive military base in northeastern Montana that is complete with housing for 5,000 people, churches, recreational facilities, a supermarket and hospital, extensive commercial and industrial buildings and a 13,500-foot runway?

The answer is not an easy one. While Glasgow Air Force Base has outlived its original, intended usefulness, it certainly displays great potential for the development of any one of a variety of exciting re-uses beneficial to the area residents. MERDI, under contract to the Old West Regional Commission, is contributing its expertise to help the Glasgow community and all of the region of Valley County examine this potential from a number of different approaches, from an integrated agricultural facility to a complete coal gasification plant to a modular solar home manufacturing center.

The Glasgow base was built in 1955 as an Air Defense Command Base. When Air Force operations were phased down in 1968, the community faced economic instability and a drastic drop in employment; since that time the base has housed an alcoholic rehabilitation clinic, some small manufacturing activities and a Family Development Center.

But the potential for something larger, permanent, more economically attractive and innovative exists — if the right combination of resources and community support can be found.

Determining the most appropriate and sound re-use of the Glasgow base is a goal MERDI shares with the Montana International Trade Commission and the Valley Industrial Park. It is the residents themselves, however, who are fulfilling the most active role in helping decide the base's future.

It was these 14,000 Valley County residents, many of whom are employed in agricultural-related occupations, who were the target of an attitudinal survey conducted by MERDI to learn the peoples' feelings on each of the proposed re-uses as well as on economic growth itself. The results of this survey will be combined with other sociological, economic and environmental studies MERDI has done in Valley County and incorporated in the Environmental Impact Assessment (EIA) the Institute is compiling on the base and the advantages of each of its proposed development concepts.

A 300-foot meteorological tower was erected to measure air and climatological conditions on a daily basis. This and other research will be

used in the development of a data base characterizing such factors as wildlife habitat, vegetation, aquatic life and general human environment in the area.

Each proposed re-use is different and requires a unique set of feasibility examination criteria. One idea capitalizes on the natural attributes of northeastern Montana by producing fuel alcohol from the area's rich grain crops. Methane derived from feed lot wastes can be used in the gasohol production, and by-products in the form of distillers dried grain can be returned to the feedlots as hog and cattle feed.

Manufacturing concepts under consideration include the modular solar homes; wind electric generation equipment and the operation of a wind electric turbine facility; or a general alternative energy development, demonstration and manufacturing center to distribute energy equipment and information to both private and public segments of the population.

The recent boom in Montana coal production and exports has created a demand for rail cars for coal shipment. In conjunction with the Montana Trade Commission, MERDI is also investigating the possibility of a rail car maintenance and repair operation at the base.

Another interesting alternative being discussed is the construction of a Peace Base, which would serve as an international disaster relief organization to respond to national and international disasters and provide assistance to lesser-developed countries. The Glasgow Peace Base would also serve as a model for developing countries to organize their own relief organizations.

A final decision on the base re-use will probably be made and announced in early 1979. The activity to study the Glasgow base and resolve the best possible development may serve as an example for other institutions in the country requiring re-use consideration.

PLEASE NOTE: THE PRECEDING PAGES WERE TREATED
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PROPOSED MONTANA RENEWABLE ENERGY PROGRAM

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PROPOSED MONTANA RENEWABLE ENERGY PROGRAM

from

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January 28, 1979

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INTRODUCTION: MONTANA RENEWABLE ENERGY PROGRAM

Montana, through state government leadership and state policy, leads the United States in its commitment to financial support of alternate renewable energy resource development and utilization. Public support of this program is widespread and based upon a sophisticated understanding of the logical match between the values and lifestyles of Montana with the positive social, economic, and environmental impacts of extended development of those renewable energy resources of sun, wind, water, and plant residues that already contribute so much to Montana's agriculture and lifestyle. It is recognized that the on-going national energy problem offers a great opportunity to integrate new energy production systems into the economy of Montana in such a way that they will enhance job opportunities for labor, expand economic opportunity for old and new businesses, and enrich the people by providing new technical, scientific, and business challenges. The colleges, universities, technical organizations, and businesses, as well as the emerging generation of young men and women will participate in and benefit from this program. The Montana Renewable Energy Program represents an unique way to simultaneously develop and enrich the state without compromising the quality of life or degrade the environment.

The Montana Department of Natural Resources and Conservation (DNRC) has had a very active program since 1975 which has supported numerous research, development, and demonstration projects throughout the state. To date, the key accomplishments of this program have been the creation of a very healthy public awareness, understanding, and support of alternate

renewable energy, widespread demonstration of the potential of solar space heating throughout the state, and the initiation of limited research and development activities in other renewable resource areas.

Montana has made a significant contribution to the overall United States energy R&D activities through the DNRC program. In turn, the state program has received considerable benefit from the national programs; however, the national program by its very nature will not satisfy all of Montana's needs. There are unique economic and environmental problems in Montana which must be addressed before full use can be made of national program information and results. Furthermore, the national energy R&D effort has received the benefits of Montana's developments that with various degrees of adoption can be used in other states and regions. Much of the past state program support has had this as one of its objectives. Now, however, is the time for a significant expansion, integration, and extension of the program. A properly structured, funded, and managed plan of research, development, demonstration, and commercialization is necessary in order for the state to fully benefit from the renewable resources available.

The Montana Alternative Renewable Energy R&D program must be more fully and formally integrated into the national U.S. Department of Energy programs. (It must also be extended to include a strong commercialization effort and be expanded in terms of resources devoted to the total program activities.)

This document contains seven specific subprograms for wind, biomass (agriculture and forest products and residues used for direct combustion, the production of alcohol, and the generation of methane), geothermal, solar,

and small scale hydroelectric renewable energy sources. The proposed duration of each of these subprograms is six years if the funding level requested is provided. [At the end of this time, the technologies and supporting Montana business structure will have been developed for those renewable energies which have proven to be economically viable.] State support beyond the six years will be minimal and will be limited mainly to coordination and information exchange. No large scale funding of development or demonstration projects should be necessary.

[The support for this program is based upon a match of almost five federal dollars for every state dollar contributed.] This match is not arbitrary but is based upon the concept that there is at least five times as many opportunities to use the results of this program outside Montana as within the state. Simple equity dictates that the division of funds for support be based upon the probable benefits to be obtained by each of the parties participating in the program.

✓ The long range objective of this proposed Renewable Energy Program is to ensure the proper place of these resources in Montana's future economy. Diversification of energy sources will be just as important in the future as it is now. The utilities and their electric distribution system will become more valuable. Eventually, replacements for natural gas and liquid fuels must be found either by a complete energy form replacement or from gases and liquid fuels derived from biomass or from coal for some finite time period. / Here again, the large energy companies and their distribution systems will continue to play a leading role. A new and important member of the energy team, the farmer/rancher and communities, is developed by this program.

Montana is an agricultural state with very little in-state processing of the products of beef and grain. Furthermore, our ranchers and farmers pay high transportation costs to get these products to the processing points and markets. The proposed program will provide some energy self-sufficiency and a significant extension of the agricultural activity into the processing area. The economic diversity of the farm, ranch, and forest communities will be expanded by energy "crop" growth and processing. The program provides Montana the opportunity to produce new, needed energy products and to participate in the processing of the products--a double economic impact.

The proposed subprograms are to be integrated into the Montana Department of Natural Resources and Conservation, Energy Division's "Montana Alternative Renewable Energy Sources Program Plan" published in January 1979. This present DNRC plan is for a two year program using funds from the coal severance tax as provided under the present allocation scheme.] The DNRC plan projects funding of approximately \$800 and \$1,100 thousand for the next two years and will require additional funding in future years, before all objectives are met. What is proposed here is a significant expansion in effort of the DNRC plan while maintaining its program philosophy, management, and control. This expanded effort will answer the question of the usefulness to Montana of its renewable energies and, at the same time, will develop the necessary Montana businesses so that future state energy planning can be based upon technical and economic experience in renewable energy sources.

A primary motivation for the continuation and significant expansion of the present DNRC program is based upon the projected economic return to the people of Montana. [The great majority of the important renewable energy resources are owned or controlled by individual land owners in Montana, e.g., biomass, solar, wind, and geothermal.] A statewide program using these resources will, in addition to directly benefiting the resource owner, create the supporting businesses and manufacturing activity. Thus, one objective of the Renewable Energy Program is increased economic activity within the state at the individual and small-to-intermediate business level. This program is not dependent upon large corporations moving into the state, but rather, the creation within Montana of new businesses. By the year 1985, this expanded program has the potential of generating business activity in the millions of dollars which will directly benefit the citizens of Montana. ✓

Agricultural/forest products and residues (biomass), geothermal, and wind are the three renewable resources with major subprograms that will be fully developed and commercialized under this plan. Farm and forest residues will be used for production of alcohol and methane and for direct combustion to produce heat and possibly electricity. Wind will be used for electricity generation. Geothermal resources will be used for space and industrial/agricultural heat. Full commercialization means to perfect the applicable technologies for Montana, establish the economics of utilization, create the supporting industrial base, and finally manufacture/build and install the system/facilities throughout the state. Montana capital and Montana citizens can do this via indigenous internal growth and with only a relatively minimum initial funding from the state and national government. |

One element of the biomass portion of this program is directed to community- or county-size alcohol plants of a nominal 10^6 gallons/year output which would be fully integrated into the local community. A plant of this size can be built, owned, and operated by the community or individuals with minimal outside assistance. The initial market for the alcohol and the by-products would be the community and surrounding region. Support for five plants is proposed.

The second major element of the biomass program is the direct combustion of forest or farm residues in community-size heating plants and for individual residential-size heating units. Many regions within the state have residues which because of climate, soil, or harvesting practices must be disposed of frequently at some expense to the land owner. These residues can be converted into an additional cash crop. Support for four plants is proposed.

During the six years of the program, alcohol plants and direct combustion plants will be partially funded, and testing and evaluation of home-size furnaces and stoves will be continued. The degree of state financial support will be limited to design and 90 percent or less of the construction costs of the facilities. At the end, the technology and operating costs will be established to such a degree that the succeeding plants established in the state can be fully financed by private funds.

The last element of the biomass program is biogas generation. Three sizes of biogas (approximately 65 percent methane) facilities will be developed under the biogas subprogram. One community waste, supplemented with agriculture or forest residues, biogas generator facility will be designed and constructed. Two dairy farm or feed lot size facilities will be installed, and finally a smaller farm or ranch size model will be developed. Three design iterations are provided for in the small size and a total of nineteen units will be purchased for ranch and farm testing and evaluation.

The integration of a community-size biomass program will also include appropriate supporting agricultural activities. For example: alcohol production creates high protein feed which can be used to feed cattle, and the manure from the cattle can be used to generate methane which in turn can be the heat source for the alcohol production.

The wind element has two major portions--first, the individual land owner wind generation concept and secondly, the large utility-owned wind farm concept. The land owners in Montana possess an enormous wind energy potential which, with the development of properly scaled and designed wind electric or direct mechanical generators, can be "harvested" for farm and ranch use. In addition, it can be fed back into the electric grid system. The farmers would be paid for any excess electricity they generated by the utility company; hence, the land would provide a second cash crop. Support for 60 farm-size (20 KW) wind generators is proposed. In addition to the siting of individual wind generators, Montana possesses numerous prime sites, some in conjunction with hydroelectric generation facilities that could be used for large wind farms with a generation capacity of as high as a few hundred megawatts. The Bureau of Reclamation, Corps of Engineers, and the utility companies will be encouraged to establish wind farms with a generating capacity of 250 MW by 1986, an amount equal to that to be generated on farms and ranches. Besides this electric generating capacity, this commercialization plan will create the manufacturing, erection, and maintenance industries in the state to support this renewable energy re-use.

The geothermal hot water resources of the state will be evaluated for community and industry-size facilities for space heating and industry/agricultural applications. A prime site in the state will be developed to provide a central community heating system. If an appropriate user can be identified,

a program will be developed that will demonstrate the use of geothermal heat in industry or agriculture. Support for two geothermal sites is proposed.

The solar and small scale hydroelectric subprograms are funded at less than one million dollars each for the four year period. These subprograms require less state support because of state-of-the-technology due to past state and federal funding. Three tasks remain to be completed in the solar subprogram. [These are: the evaluation of the solar demonstrations that have been funded, assistance in providing commercially available low cost solar panels for homes, and assistance in the design of solar heating systems for commercial buildings, apartments, or communities. The small scale hydroelectric subprogram will provide for the design and cost analysis of up to twenty hydroelectric generation sites in the state and funding to support up to 90 percent of the construction for ten sites. The electricity output from these sites will be limited to no more than 20 KW. *Bradley Lake - 70KW*

It is recommended that the Energy Division of DNRC continue the management of this expanded renewable energy program with assistance from major subcontractors for each of the renewable energy resources. By properly structuring the contractual responsibility and work, this program can be managed without an increase in the permanent staff of DNRC. One program objective is to establish within the state the technology and management capability for renewable energy sources. This is to be done by building up Montana private industry and business and not by an expansion in the number of state employees. The major portion of the work will be performed competitively in response to "Requests for Proposals" (RFP) and only a limited amount will be by unsolicited proposals. During the first three years, three or four temporary staff personnel will be needed in the Energy Division to

start the program, establish office operating procedures and policies for the expanded effort, and provide the necessary close subcontractor direction required during the initial phases of the subprograms.

The key to program control in this plan is the annual in-depth total program review by subprogram element performed by a review team composed of legislators, DNRC subcontractors, and nationally renown experts. All activities will be reviewed, and any necessary budget adjustments will be proposed to the Montana state legislature and the U.S. Department of Energy for the coming year. It is vital that the program remain dynamic and that adjustments in expenditures be allowed and encouraged in a public policy directed manner so that advantage can be taken of unexpected program accomplishments or opportunities. In the same respect, expenditures should be cut or terminated in any subprogram that does not meet the projected economic pay off for the state.

The total funding recommended for these programs is \$46,800 thousand. This is the amount obtained by adding all the subprogram totals in this plan plus an additional \$5,225 K for DNRC management during the six years of the program. Montana's share is \$8,600 K and is based upon projected return from the coal tax revenue. It is recognized that the state legislature can only make a two year commitment, and that is all that is necessary from the state and the U.S. Department of Energy to start the program. If successful, the remaining funds would be requested from the 1981 and 1983 legislature and the U.S. DOE. For full funding of the first two years, the state must provide \$900 K in 1979 and 1,100 K in 1980 and the federal government \$2,700 K and \$4,400 K in each of the two years. The funding level requested is significant, but the program is structured so that each succeeding year's budget is spent only if the prior year's activities were successful.

The program will be coordinated with the Department of Agriculture and Small Business Administration Energy Loan programs. The USDA Business and Industrial loan program can become a vital part of this program in supporting the development of the required industrial base in Montana. In addition, the products developed must be "approved" by the USDA so that the farmers and ranchers can obtain FHA loans in support of purchase. Public Law 95-315 changes the Small Business Act to provide funds for energy related activities and facilities.

This document details a flexible, diverse but integrated expanded alternative renewable energy program that simultaneously addresses major national needs as well as the unique requirements of Montana. This program is designed to serve the broad public policy needs of Montana through stimulation of development in the private sector. Furthermore, this program recognizes and addresses the needs for new community scale technology that will allow the communities to have at their command technology that will not be imposed from outside the state by organizations that have optimized the production for their benefit. Moreover, these technologies and energy sources will reverse the long term trend of Montana's economy of being based upon exporting unprocessed agricultural and natural resources. Unlike coal, where processing involves significant environmental impacts with existing technology, the development of alternate renewable energy resources can be developed with minimal negative impacts.

COMMUNITY SIZE ALCOHOL PRODUCTION SUBPROGRAM

Introduction

As our petroleum supplies decrease, energy will become a larger portion of living costs if we maintain our current life patterns. The farmer is aware of this since he depends on gasoline, fuel oil, and electricity. The costs of these resources have been escalating much more rapidly than farm products. Today, the farmer is an importer of energy. The future could be different--as these "conventional" resources decrease, other energy sources will become cost competitive.

The Great Plains of the United States is the largest and most productive area of renewable energy sources in the world. This region represents by far the most significant asset of our country; and in the future, in addition to food, it will become an energy producer.

It has been estimated that 75 quads of electricity could be generated from wind in the United States without affecting the present weather patterns.¹ This is equivalent to the present yearly total energy consumption in the U.S. The wind energy subprogram section describes in detail how Montana's farmers and land owners will benefit from this resource. Wind is only one new farm crop; the other two important new Montana farm or forest energy crops are liquid fuel and biomass residues for direct combustion. This section will present a program for liquid fuels.

¹ "Wind Energy Resource Parameters," M. R. Gustavson, Proceedings, National Conference, American Wind Energy Association, March 1978.

With the present technology base, the most appropriate liquid fuel from farm and forest products is alcohol. Certain European and South American countries have had extensive active alcohol production facilities for 30 to 40 years which use farm and forest products. Experience has shown that anything up to 20 percent alcohol has no effect on a vehicle's engine performance,² and with engine adjustment, 100 percent alcohol can be used. Sometime in the near future, depending upon OPEC pricing policy, gasoline could reach a price where large scale production of alcohol from farm products will become a reality. No new technology is required; however, improved total system plant operation and by-product utilization will hasten the date that alcohol becomes competitive. In addition, it is possible that new farm crops may be developed that will yield a higher alcohol return per acre.³

There is the possibility that new environmental laws covering gasoline additives could greatly benefit the use of alcohol in gasoline. The price paid by petroleum companies for gasoline is a closely guarded secret; therefore, the real value that alcohol might have is difficult to determine. Tests have shown that for 80 percent octane base stock gasoline, each one percent of alcohol improves the octane by about one percent. For higher octane base stocks, the improvement is less.⁴ Alcohol also might have other qualities, such as suppressing pre-ignition. Any government requirement to use other additives, or alcohol specifically, in gasoline would have a great impact on alcohol consumption.

² Public presentations at Annual National Gasohol Commission Meeting, Chicago, Illinois, November 1978.

³ "Alcoholic Fermentation of Jerusalem Artichokes," L.A. Underkofler, et. al, Industrial and Engineering Chemistry, Vol. 29, No. 10.

⁴ Private communications, Cenex and Conoco refinery personnel, December 1978.

Of course, the interest of the Montana rancher or farmer is to raise the sale price of his current products, i.e., \$4.00 or \$5.00 per bushel for wheat rather than the current price. In some areas of the U.S., this may not be a simple economic problem because if the price is increased, more marginal regions can be converted or returned to farming resulting in larger production and a lower price paid per bushel.

The real farm objective is to increase the cash return per acre while maintaining or decreasing farm expenses of time and money. The average cash return on wheat acres during the past couple of years has fallen from a high of \$111.00 to a low of about \$75.00 per acre per year.⁵ The return might be increased in the future by introducing a new second major crop that would be grown on some of the present grain acres and would be used to produce alcohol. This new crop would reduce the wheat output and, hence, raise the price paid for wheat; as a result, the wheat acres would produce a higher price per acre. Under the present petroleum costs, what must be the characteristics of this new crop? Assume the alcohol could be sold in large amounts at 80¢ per gallon, this amounts to 40¢ per gallon with current federal tax credit, and produce a profit for the distiller. In order to obtain \$120.00 per acre, the farmer would need a new crop that would produce about 240 gallons of alcohol per acre compared to the typical current wheat production of about 65 gallons per acre. These numbers assume an inexpensive community-size batch plant and sale of the protein by-product as feed at 30¢ per gallon of alcohol produced.

⁵ Montana Agricultural Statistics, Vol. XVI, Montana Department of Agriculture and U.S.D.A.

The weakness in the previous case is that there is no established or fully characterized farm crop that can be raised in Montana, with the same or less farm inputs, that will produce four times the alcohol output as wheat. An extensive effort by agricultural researchers has not been made to develop such a crop. This problem certainly merits considerable attention. Hopefully, as the price of gasoline increases, the development of a new crop and supporting farming practices with increased alcohol yield per acre will be successful; and a portion of the Montana acreage can be converted to this alcohol crop.

The immediate objective of the proposed alcohol subprogram is to establish alcohol plants in Montana which use Montana-grown feedstock and produce at least the same economic return to the farmer as the current return from food production. There is a probability that a near term increased return is possible; however, this is dependent upon economic factors and markets outside of Montana which are very difficult to predict and control. With the present price of gasoline in the U.S., the best that can be expected is an equal return; however, as gasoline prices increase, an increase in farm revenues will be received. This program will develop the facilities, management, and technology in Montana communities so that Montana farmers and businessmen will be able to select their own role in the future liquid fuels industry in the U.S. The farmers and their communities are knowledgeable of and competitive in the role of food production. This program will extend that competitive advantage to alcohol production.

The long term objective is to significantly raise the dollar return per acre through the best combination of energy and food production on the farm. This will be possible with the local know-how established under this program.

The two key elements in the economics of alcohol production are marketing of the protein remaining from the feedstock and minimizing the energy required to produce each gallon of alcohol. Significant advances have been made in reducing the energy requirement from 200,000 Btu to 40,000 Btu and less per gallon.⁶ Even at this lower level, the question remains as to whether or not the total process from crop planting to alcohol production is energy positive. The protein market is a problem that can be solved on two levels. First, protein can be sold on a local basis for cattle feed; in which case, this will probably limit the amount of alcohol that can be economically produced and consumed within each community. The second possible solution is to establish a national or international market for human consumption of the protein; in which case, a much larger quantity of alcohol could be produced. The identification of this possible large market will be pursued continually throughout the program.

The above discussion has centered on crops raised for alcohol production. Forest waste products have been used in Oregon to produce alcohol, and much research is being conducted in converting farm wastes (e.g., straw) to alcohol. If this becomes technically and energy efficient, the possibilities for greater economic return per acre are significantly increased. In addition, by using biomass wastes and a low energy intensive process, a net positive energy return is assured.

⁶ Public presentations at Annual National Gasohol Commission Meeting, Chicago, Illinois, November 1978.

Community Size Plants

In the past few years, much has been written about alcohol produced for fuel from agricultural products or wastes.^{7,8} The almost universal conclusion of these reports has been that alcohol cannot be produced at today's price for grain and be competitive with gasoline. In reaching this conclusion, certain basic assumptions were made about the price of grain, plant size, and market; and given these assumptions, the conclusion drawn seems to be correct. The plant and operational concept for alcohol production in this renewable energy subprogram is different from that proposed by any previous alcohol study, and under certain conditions can produce alcohol that is competitive with gasoline in Montana. There appears to be a very high probability that the range of conditions under which alcohol production is economical can be expanded significantly once operational experience is gained from an alcohol production plant which is integrated within a local farming community.

The concept of this program is to locate the first plants in communities that have the most favorable economic position. As experience is gained and construction and operational costs are lowered, communities with a smaller economic edge can be included and successful plants constructed. The typical factors which enhance the economics of a plant for a community are: use of existing facilities, high local gasoline costs, continued excess farm produce, high transportation costs for farm produce, local cattle feeding, and high cost for protein feed supplement.

⁷ Grain Alcohol in Motor Fuels, J. G. Kendrick and P. J. Murray, Report No. 81, Department of Agricultural Economics, University of Nebraska, April 1978.

⁸ Feasibility of Ethanol from Grain in Montana, R. Stroup and T. Miller, Research Report No. 118, Montana State University, January 1978.

The first plants will be designed with flexibility in mind to operate using existing farm produce; in Montana, these are primarily grain products. Later, other crops producing a greater return of alcohol could be grown on a portion of the available acreage after research had verified the economics of such crops. The United States Department of Agriculture (USDA) will be encouraged to support this type of research during the program.

At the present time, Brazil has over 400 operational alcohol plants and is supporting the construction of additional plants. International construction companies are supporting the Brazilian program; in addition, some of the major construction firms in the U.S. have built, or are interested in building, alcohol plants. To date, the designs proposed by these companies for the U.S. have been the large capacity plants of 10 to 20 million gallons per year. Vulcan Inc. has proposed a two million gallon per year plant for \$12 million for the USDA loan program. There is one small company in the U.S., ACR Processing Corporation, who has joined with the Grain Processing Corporation to design smaller plants which use either a batch or continuous process approach. They have designed plants of a few hundred thousand to a few million gallons per year which require less than 40,000 Btu of energy per gallon of alcohol produced and which are operated by a small staff.

A recent ACR design was submitted for the \$15 million USDA loan program plant in southeastern Colorado. This design was for a continuous process plant with significant automation, and the projected total construction cost was a few million dollars; i.e., a couple of dollars per gallon per year.

The variation in plant costs can be seen when this is compared to the Vulcan design also submitted under the loan program for a group of potatoe farmers in eastern North Dakota.

Under an Old West Regional Commission contract, MERDI, in participation with a group from Glasgow and ACR, have performed a conceptual design for a batch plant which is more suitable to the Glasgow needs than these more expensive continuous process plants. The plant and the integration of alcohol production at the community level which is being proposed in Glasgow is the concept that is recommended for the first plants under this program. Tables I, II, and III provide some of the preliminary characteristics and costs for the Glasgow plant. During the next month these numbers will be further refined.

For the Glasgow plant, the grain supply will come from the plant owner's fields. There is indication that ranchers in the area will purchase the distillers grain as feed at the price indicated. The remaining question is what will be paid for the alcohol produced? Discussions have been held with the Montana Petroleum Association and distributors in Montana to determine the extent of interest. This, of course, is the key to selling alcohol. Studies⁹ have shown that there is support for gasohol as a better product at a higher price than regular gasoline. There is also an indication of a projected increase in demand for premium unleaded gasoline. Adding 10 percent alcohol to unleaded regular gasoline will produce a product almost equivalent to unleaded premium. Given the economics of Table III, the 4¢ per gallon federal tax reduction, funding support for capital and operating expenses from this program of 21¢ per gallon, then unleaded regular/alcohol mixture

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Iowa Development Commission, "Consumer Acceptance and Market Potential of Gasohol," October 1978.

TABLE I

Preliminary
Specifications for Glasgow
Alcohol Plant

Type:	batch
Capacity:	120 bushels per cook (960 bu/day)
Cycle:	3 hours per cook, 36 hours fermentation
Feedstock:	Barley (2.0 gallons ethanol per bushel)
Fuel:	Coal (Montana; 10,000 Btu/lb)
Boiler:	Low pressure (atmospheric pressure cooking)
Beer still:	3 feet diameter
Production rate:	1920 gallons and hydrous ethanol per 24 hour day.
Grain storage:	30 days supply (30,000 bushels)
Product storage:	33 days operation (21,000 gal.)
Coal consumption:	6.25 lb/gal. (50,000 Btu/gal; 10,000 Btu/lb) 6 tons/day
Stillage production:	13,400 lbs/day (14 lb/bu)
Fermenters:	12, 10' d x 12' overall height
Fermentation house:	32' x 96'
Boiler house:	24' x 32'
Distillation house:	30' d x 72' height
Boiler:	200# tri-fuel (coal, oil, or gas)
Coal storage:	Undetermined
Waste water disposal:	Undetermined

TABLE II

Preliminary Cost Estimate
for Glasgow Alcohol Plant

Grain Handling and Preparation	(Undetermined)
Cooking, Fermentation and Distillation	\$247,500
Boiler	90,000
Fermentation and Boiler Buildings	45,000
Distillation Column Enclosure	30,000
Grain Storage	(Undetermined)
Coal Storage	(Undetermined)
Product Storage	19,000
Gasoline Storage	7,000
Erection and Piping (20% of equipment & boiler)	<u>67,500</u>
	(\$506,000)

TABLE III

Preliminary Cost of Production
for Glasgow Alcohol Plant

	<u>\$/gal.</u>
Feedstock (Barley at \$160/bu.)	0.80
Energy (Coal at \$38/ton plus 10% for electricity)	0.13
Labor (\$10/hr. 2 men each shift)	0.25
Cost of Working Capital (See footnote 1)	0.0735
Management (All components, \$30,000/yr.)	0.0435
Interest and Debt retirement (See footnote 2)	<u>0.137</u>
Total	1.434
Sales of Distiller's Grains and Solubles (7 lb/gal. @ 0.075/gal)	0.525
Net Cost per Gal.	0.91

No Allowance for Taxes or Profit.

¹ Working capital, 6 months of feedstock, energy, labor, and management at 12% (.12 x 50,800 = 0.073).

² Capital investment of \$550,000; a mortization of 12% loan in 10 years.

would sell for 3¢ per gallon more than the regular. The proposed \$2 per barrel government rebate, or 5¢ per gallon subsidy, has not been included in these calculations.

The Glasgow plant would require about 30,000 Btu's per gallon of alcohol if the distiller's grain is not dried. The significantly reduced energy requirement is not the result of any new technology but rather a very complete coupling of all energy generated and needed. This same approach is possible in the larger plants designed by other engineering companies in the U.S. The problem is that there has not been a great need in the past to reduce energy consumption in the conventional alcohol plants designed by these companies. ACR has been working on reduced energy consumption for ten years, primarily in small plants, and has thus worked up the right combination of system tradeoffs.

In essence, there is the possibility of two general size plants for Montana. The larger 20 million gallon size plant, costing \$20 million, must have a strong national or international market secured for the alcohol and by-products before construction would be feasible. Five plants of this size would use about one-third of the annual Montana grain production; however, any success would certainly encourage the corn growers in the East to do the same; thereby, developing strong competition. This is not an impossible objective, but it is one where we do not have control over all of the critical elements. As mentioned, this avenue should be continually pursued; however, caution is necessary.

The smaller community size plants appear to be best in Montana, with the market in the surrounding area. Initially, this approach will not impact grain prices. A source of feedstock must be secured, possibly by the grain farmers owning the plant. Then, a market must be secured for the alcohol and distiller's grain. This market information is essential for finalizing the plant design and operation, and this is an iterative process that is dependent upon the condition in each community.

With the present price of gasoline and the use of wheat or barley as the feedstock to the plant, alcohol production will not be a big money maker. The proposed program will provide the feasibility study, plant design, market identification, partial construction cost, and initial start-up and operation to the selected communities who have expressed an interest in such a facility. In addition, the program develops in Montana farm communities the technical and managerial know-how to enter into large-scale liquid fuel production in the 1990's. Any new high-alcohol producing crop or new technology for processing biomass waste will advance the date when alcohol production contributes significantly to farm and forest income.

Technical Program

A technical and management alcohol plant team will be formed which includes personnel experienced in farm products and operation, alcohol production plant design and construction, marketing, and plant management and operations. This team will prepare briefing material on all aspects of the program to be presented to interested communities. The information and experience gained in the Valley County alcohol project will be valuable to this team.

The next step in the program is for interested communities with the appropriate farm or forest product to form a private or community government affiliated organization that is a single point of contact. This organization will contact the state and express an interest in an alcohol plant. The alcohol plant briefing team will come to the community and conduct educational type meetings to explain the state support, possible plant size, operational considerations, funding requirements, typical economic return, etc. Printed material will be made available. The community organization will then decide if it would like to be considered as a possible plant site under the state program.

Members of the alcohol plant team will return to the community and assist them in preparing a detailed proposal to the state for support. Information on feedstock, market potential, plant size and location, operational and management concept, expected dollar return, and desired financial assistance will be generated. The community organization is responsible for submitting the proposal to the state. The state will select at least five communities to be supported during the program. Depending upon the level of funding requested, additional plants could be supported.

Hopefully, at least one large size plant (20 million gallons) can be established during the program. The same initial assistance will be provided for a community desiring a large plant; however, design and construction must be provided by private financing.

For the selected small plant communities, the next assistance step is the detailed engineering design of the plant and firming up the feedstock supply and product marketing commitments from farmers, gasoline dealers, and cattle feeders. A construction bid will be obtained from the plant design and the responsible community organization will finalize their construction funding support request to the state. It is desired that some community funding or in-kind contribution of at least 10 percent be included in each plant.

Construction supervision assistance will be provided by the plant team, and training of key plant operations will begin as soon as practical. The team will provide assistance throughout the check-out and during the first year of plant operation.

The five or more plants will not be constructed all at once but will be staggered a few months so that experience can be gained from plant to plant. A period of 18 to 24 months will be required from the time the alcohol plant team begins working with a community until a small size plant is operational.

A specific in-state ongoing crop research program is important to identify better crops for alcohol production in Montana. This research should be done at Montana State University. Much work is being done on a national level for waste or residue alcohol production which would have a great impact on the economics; the results of this research will be closely watched. The sooner wheat or barley can be replaced by a less expensive and higher alcohol producing plant, the sooner the farmer will receive greater economic returns. Any agricultural research program is long term so it is important to begin working with the communities with the alcohol plants as soon as possible on a gradual and experimental basis.

The alcohol plant team will provide technical and management support to the communities for the full four years of the program. A n important function will be exchanging information among the Montana plants and in assessing and disseminating research efforts that will benefit these plants. The team also will be available to provide information to communities who might desire to construct their own plant without state assistance. At the conclusion of this four year program, the construction and operational costs of the plants and the supporting in-state technical knowledge will be available so that interested communities can develop alcohol plants using consultants and commercial financing at minimum risk.

Additional Issues

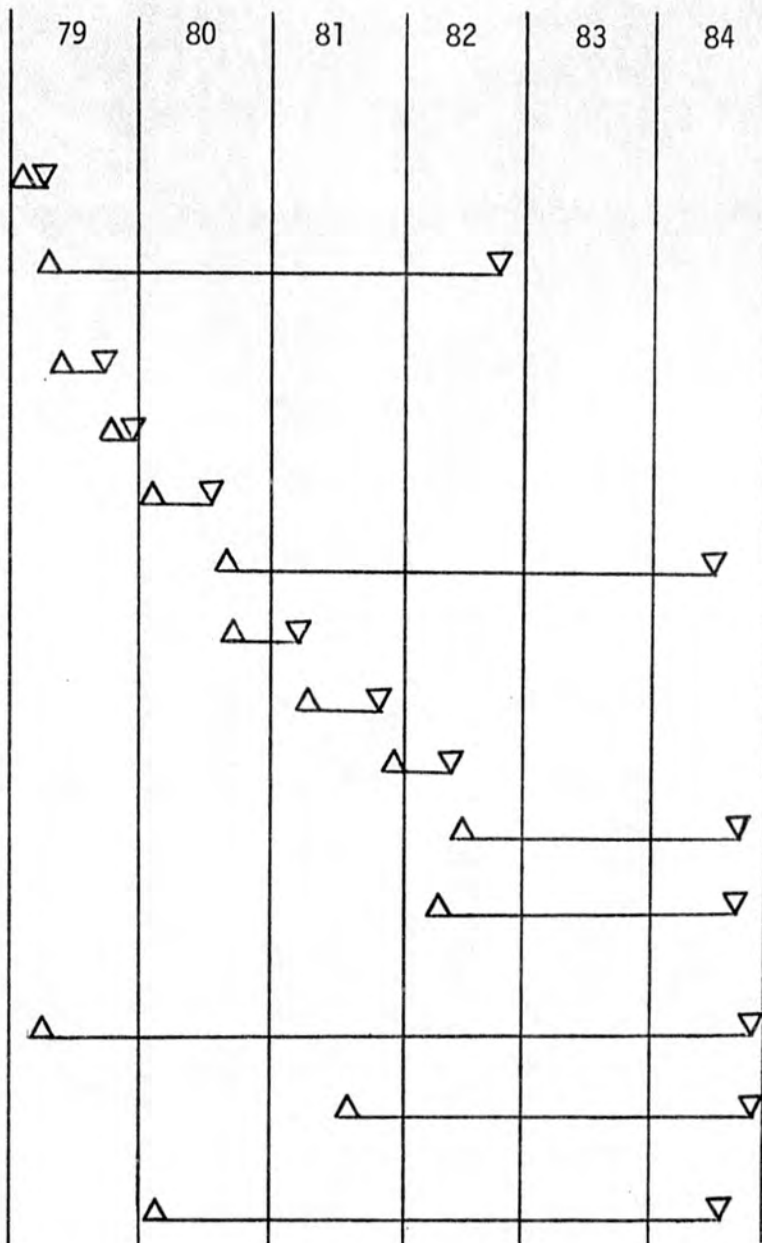
The price of gasoline or any EPA ruling on gasoline additives could have a very significant impact on alcohol economics. The probability is that the impact will be favorable. Other states have considered a reduction in the state gasoline sales tax during the first few years of a plant. This lost income would have to be made-up from some other source, and this sales tax reduction is not recommended for Montana. Another possibility is requiring that alcohol be added to all gasoline used in the state--this is a forced subsidy to alcohol production. Property tax relief could be considered for the first few years of a plant.

There is consideration of using a few cents "check off" on wheat to generate a fund which could provide financial assistance for construction. This concept would support this proposed program.

Schedule and Cost

Schedule of Program Elements

- . Formation of plant team and briefing document preparation
- . Briefings to interested communities, as requested
- . Selection of 1st community for support
- . Support to 1st community
- . 1st plant construction
- . 1st plant operation
- . Selection of 2nd and 3rd communities
- . Support to 2nd and 3rd communities
- . 2nd and 3rd plant construction
- . 2nd and 3rd plant operation
- . Selection of 4th and 5th communities and support, construction, and operation
- . Crop research support in Montana
- . Information exchange and dissemination
- . Support to communities desiring a large size plant if requested



Major Cost Categories by Years (Dollars in Thousands)

	79	80	81	82	83	84
. Alcohol plant team	700	700	550	400	300	200
. Plant design and construction assistance	300	550	200	600	1050	1150
. Initial operation direct support	0	100	150	200	200	250
. Instate crop research	150	150	200	200	250	200
Total cost	1150	1500	1100	1400	1800	1800

It is proposed that these yearly total costs will be shared by state and federal by a one to five ratio.

DIRECT COMBUSTION OF BIOMASS SUBPROGRAM

Introduction

Montana is a state with plentiful resources of biomass waste from farm and forest activities. These residuals have a Btu content per pound between Montana lignite and bituminous coals. One use of these resources is in the production of liquid fuels which is covered in another section. In this section, a program is proposed for the direct combustion of biomass for the production of heat and, possibly in some limited community-initiated uses, for the generation of electricity. For heat production, two sizes of combustion are to be supported; one is a community-size central heating plant distributing hot water in towns, and the other is for individual stoves or furnaces for homes or small businesses. This latter combustion program couples directly with the active and passive solar heat research and demonstrations that have been funded previously throughout the state. Community-size electrical generating plants will not be supported in the program. This would be a secondary benefit that might be considered by any community or rural cooperative once a central heating plant has been established. The electrical generating technology and cost trade offs between local generation with MPC and MDU back-up, and MPC and MDU full time power costs, can be determined without additional development or demonstration. Communities with central heating plants may or may not wish to consider this additional option which, if selected, would be at their own expense. This program does not contain funding in support of studies, development, or demonstration for electric generation.