Power Engineers Incorporated

Update and Reevaluation of Economic Benefits of Southern Intertie Project

Final Report

Prepared for:

Power Engineers Incorporated
3940 Glenbrook Drive
Hailey, ID 83333

Prepared by:

Stephen Haas
Ralph Samuelson

DFI•AERONOMICS™
650 Castro Street, Suite 300
Mountain View, California 94041-2055
(650) 960-3450

March 1998

W. O. E9590081

Table of Contents

List of Tables

1. Introduction and Summary

1.1 Background

In 1989 Decision Focus Incorporated (DFI) carried out an economic analysis of the benefits of several proposed transmission line upgrades or additions in the Railbelt area of Alaska. The results of the analysis were documented in a December 1989 report entitled "Economic Feasibility of the Proposed 138 KV Transmission Lines in the Railbelt". One of the lines studied in the 1989 analysis, the Southern Intertie Project (SIP) between Anchorage and the Kenai Peninsula, is currently under serious consideration, and an environmental impact statement (EIS) is being prepared for the proposed project. Because DFI's 1989 analysis helped to justify the project, it is desirable to review that analysis to determine what changes have occurred in the years since 1989, and whether they would alter the conclusions of the analysis.

The December 1989 report estimated benefits of a new Kenai-Anchorage transmission line in seven different categories:

1. Capacity sharing
2. Economy energy transfer
3. Reliability
4. Transmission losses
5. Maintenance of existing line
6. Operating reserve sharing
7. State revenue from gas royalty and severance taxes

The update focused on the key data values underlying the estimates, determined how these data values have changed, and calculated the impacts on the benefits estimates. In addition, all benefit estimates were converted to 1997 dollars for easy comparison to current cost estimates of the proposed line. Finally, two new categories of benefits were identified and quantified.

1.2 Updated Benefits Estimates

Table 1 summarizes the conclusions of this update. The dollar values shown are the net present value of benefits in each category over the expected 40-year life of the new transmission line. In 1989 the line was expected to come into operation in 1994, so the 1989 benefits values are for the period 1994-2033 with the present values in 1994; the line is now planned to come into operation January 1, 2004, so the benefits values are for the period 2004-2043 with the present value in 2004.

The December 1989 study calculated benefits for two cases representing different capabilities of the existing Kenai-Anchorage line, because it was not clear at the time how that line would be operated after the Bradley Lake Hydro facility began operating. Case 1 assumed the existing line would be rated at a maximum of 70 MW input and 61 MW output, while Case 2 assumed 90 MW input and 75 MW output. Because Case 1 corresponds to how the line is now operated, all the 1989 values shown in Table 1 are for Case 1.

The first challenge in comparing 1989 estimates with current estimates is to make sure that the numbers are all based on the same year's dollars; this eliminates the effects of inflation that make a dollar today worth less than a dollar 7 or 8 years ago. DFI's 1989 benefits study expressed all values in end of 1989/beginning of 1990 dollars. For this update all values are expressed in 1997 dollars. Therefore, before we can compare the dollar values from the previous study to the new information, we have to inflate them so that we can compare old values expressed in 1997 dollars to new values expressed in 1997 dollars. We have used the GNP Price Inflator to convert beginning of 1990 dollars to mid-1997 dollars. With this inflation rate, a value of $1.00 from the December 1989 study corresponds to $1.205 in mid-1997 dollars, which are what is used in this update.

Table 1: Net Present Value of Benefits of New Southern Intertie

Category	December 1989 Value (millions of 1990 $)	December 1989 Value (millions of 1997 $)	New Value (millions of 1997 $)
Capacity Sharing	34.6	41.7	20.9
Economy Energy Transfer	43.2	52.1	37.8
Reliability	41.0	49.4	49.4
Spinning Reserve Sharing	10.6	12.8	9.3
Reduced Line Maintenance Costs	5.0	6.0	4.0
Avoid Minimum CT Generation on Kenai (*)	na	na	10.7
Avoid Not Loading Line During Bad Weather/Construction (*)	na	na	11.4
Total	134.5	162.0	143.5

Notes:

1. Present values in 1994 for 1989 study, and in 2004 for current update.
2. All present values calculated using discount rate of 4.5 per cent, as recommended by Alaska Energy Authority.
3. Values expressed in 1989/1990 dollars converted to 1997 dollars using GNP price inflator.
4. Economy energy transfer includes reductions in transmission losses and gas royalties.
5. (*)/na indicates benefits not considered in 1989 due to different assumptions for system operating parameters prior to Bradley Lake Hydro.

The new total benefits estimate is substantial, but is somewhat lower than for the 1989 study, when expressed in the same year dollars, due primarily to lower forecasts of fuel prices, life extension of existing generating units, and a lower cost of new generating capacity. The changes in benefits and the reasons for them are explained in Sections 2 and 3.

The biggest reductions are for capacity sharing and economy energy transfer benefits, which are significantly lower for the reasons just listed. However, these reductions are partially offset by the addition of two new categories of benefits not considered in 1989, due to different assumptions about how the system would be operated once Bradley Lake Hydro was in operation.

We should also point out that, in general, we have updated the 1989 calculations rather than start from scratch. In some cases this has led to benefits levels that could be considered too conservative. In particular, some Railbelt utility staff believe that the economy energy and spinning reserve numbers shown in Table 1 are too low.

1.3 Range of Benefits

Estimating the future benefits of a project like the SIP is difficult because it depends on numerous factors that can not be predicted or measured with precision, ranging from future fuel prices to how much consumers would pay to avoid an outage to how the Railbelt utilities will choose to operate their interconnected systems in the future. As a result, there is necessarily a great deal of uncertainty and imprecision in the benefits estimates presented here. The December 1989 study showed a range of values within which the benefits were expected to lie. This review takes the midpoint of that range (for Case 1 existing line capability; see discussion above) as a starting point, but does not try to update the range. This should not be interpreted as a failure to recognize the uncertainty and lack of precision; if anything, the range of possible benefits may be even wider than presented in the December 1989 study. (See page 6-1 of the Railbelt Intertie Feasibility Study – Final Report, prepared by the Alaska Energy Authority, March 1991, for further discussion of this point.)

1.4 Major Changes Since 1989

There are four major factors contributing to the differences between the new benefits estimates and those developed in 1989:

1. Projected fossil fuel prices are substantially are substantially lower now, in real terms.
2. The price of new combustion turbine generating units has dropped, in real terms.
3. A number of existing Railbelt generating units that had been scheduled to be retired by the turn of the century or soon after have had their planned operating lives extended.
4. The Bradley Lake hydro facility on the Kenai Peninsula started operating in 1991. Bradley Lake's size relative to other generating units on the Kenai and relative to the existing transmission line, and the resulting implications for the stability of the electrical system, have required some changes to operating policies for the existing line that were not anticipated in 1989.

2. Benefits Estimation Methodology

This section outlines the methodology used for calculating the numerical estimates in each category, summarizing the key assumptions and listing the major data items affecting the estimates.

2.1 Capacity Sharing

There are two types of capacity sharing benefits:

1. As load grows in a region, enough capacity must be available to meet the peak load in that region plus a required reserve margin. Increased transmission capacity increases access to generation capacity in regions with surplus capacity, thus making it possible to defer adding generation capacity in the first region, even if only for a limited time. For the Railbelt, the SIP would allow Anchorage to rely on the Kenai Peninsula generation capacity surplus for a greater portion of the Anchorage capacity requirement, thus deferring the need to build new generation capacity in Anchorage.

2. The larger and more interconnected a system, the lower the reserve margin required to provide the same level of reliability. Increasing transmission capacity increases the level of interconnectedness for the Railbelt, allowing utilities to permanently avoid building some of the capacity that would have been constructed to maintain the desired reserve margin.

Construction of the SIP would produce both types of capacity sharing benefits.

Demand growth, taken together with available capacity, determines the timing of any capacity sharing benefits. Demand tends to grow over time while, unless new generating units are installed, capacity holds steady or shrinks somewhat due to retirements. Therefore, capacity sharing benefits tend to first grow over time as surplus is eliminated in relatively capacity-poor regions, then fall as surplus also disappears in the relatively capacity-rich regions.

The capacity sharing benefit in a year is the amount of capacity avoided or deferred in the year, measured in kilowatt-years, times the cost of a kilowatt-year of capacity. For the latter we use the annualized fixed cost of a new combustion turbine, including both the installed capital cost and the fixed operation and maintenance cost; this is a standard yardstick for measuring the value of capacity.

Key Data Items:

- Total generating capacity available
- Peak demand growth
- Required reserve margin
- Fixed cost of new combustion turbine

2.2 Economy Energy Transfers

There are two primary situations in which this type of benefit occurs. First, it occurs when high cost energy in one area, usually expensive thermal, is displaced by lower cost energy from another area, either hydro or low-cost thermal. Second, it occurs when access to certain kinds of resources, especially hydro, makes it possible to operate thermal units more efficiently even if their total output is unchanged.

In the Railbelt all available hydro energy, which uses no fuel and for which the variable cost is essentially zero, will be used with or without the proposed new transmission line. Thus the first situation mentioned above involves displacing electricity generated from thermal units (gas-fired or oil-fired) with electricity from other thermal units with lower variable costs. These lower costs may result from access to less expensive fuel or from some units being more efficient (converting a greater fraction of the energy content of the fuel to electricity) than others. The economy energy benefit is equal to the increased amount transferred between Kenai and Anchorage (as a result of the new line) times the difference in marginal variable operating costs between the two regions. This benefit occurs to a limited extent between Anchorage and Kenai.

A far greater benefit occurs from the second situation: improved hydro-thermal coordination. Greater access to Bradley Lake hydro would allow thermal units in Anchorage to be operated for fewer hours, but at higher levels of output where they are more efficient. Whereas hydro units can operate cost-effectively at any level, operating thermal units at levels well below their maximum capacity reduces their efficiency, sometimes substantially.

An additional benefit is closely linked to the first two: in addition to increasing the maximum amount of power that can be transferred between the Kenai and Anchorage, adding a second line reduces the transmission losses associated with such transfers, improving the economics for both situations described above.

The variable costs of producing electricity, i.e., costs of economy energy, are roughly proportional to fuel prices. This means that higher fuel prices translate directly to a higher level of economy energy transfer benefits; a percentage increase in fuel prices translates to roughly the same percentage increase in economy energy benefits if all fuel prices in both regions are increased by the same percentage. Similarly, a reduction in price forecasts for all fuels translates directly to reductions in economy energy transfer benefits.

Changes in load growth forecasts since 1989 may impact economy energy amounts transferred, also impacting the benefits in this category, but this is a smaller effect and has not been estimated.

Key Data Items:

- Fuel price projections
- Load growth projections
- Transmission losses

2.3 Reliability

Reliability is determined by the number, magnitude, and duration of customer outages. Reliability benefits occur if customer outages are reduced as a direct consequence of constructing a new transmission line. The proposed SIP is expected to reduce both the frequency and duration of generation- and transmission-related outages, i.e., outages related to unexpected loss of generating units or the existing Anchorage-Kenai transmission line.

In the event of an outage, unserved energy is defined as the electricity that would have been consumed if the outage had not occurred. The reliability benefit is equal to the expected reduction in unserved energy as a result of the proposed line times the value of each unit of unserved energy. Several studies have shown that the value per unit of unserved energy depends on the customer class affected, the duration of the outage, and whether or not customers receive advance notice of the outage.

Key Data Items:

- Reduction in unserved energy as result of new line
- Value of unserved energy

2.4 Spinning Reserve Sharing

Spinning reserves provide quick response to failures in the generation and transmission system. While sometimes referred to as "spinning capacity", maintaining spinning reserves imposes operating costs, not capacity costs. While they improve reliability, they can be expensive. The hydroelectric capacity on the Kenai can provide a less expensive source for some of the spinning reserves that would otherwise be provided by thermal units in Anchorage. The new transmission line would increase the ability to access these low-cost reserves.

Key Data Items:

- Capacity of existing line and new line
- Fuel prices

2.5 Reduced Maintenance Costs for Existing Anchorage-Kenai Line

The existing Kenai-Anchorage line is scheduled for incremental line replacement over a multi-year period. A second line would allow the deferral of some of the scheduled maintenance and allow the maintenance to be carried out more cost-effectively.

Key Data Item:

- Cost savings of greater flexibility in scheduling and carrying out maintenance

2.6 Avoiding Minimum Combustion Turbine Generation on the Kenai

Because of the power transfer limitations of the existing Kenai-Anchorage line, current practice is to maintain a minimum of 25 MW of combustion turbine generation operating on the Kenai Peninsula at all times. With the new transmission line, this practice would no longer be necessary; whatever generating units could serve load most economically would be used.

Key Data Item:

- Difference in operating costs between combustion turbines on the Kenai and units in Anchorage

2.7 Avoiding Not Loading the Existing Line During Bad Weather and Construction

The existing 115kV Anchorage-Kenai line is at times operated at zero electrical flow, in anticipation of possible storm or construction-related outages. During such periods, higher cost generation sources must be used. The new line would allow power transfers to continue during such conditions, since the second line could continue to transfer power even during an outage of the existing line.

Key Data Items:

- Frequency of zero loading conditions
- Increase in operating costs resulting from not utilizing the existing line

3. Updates Of Key Data Items

The major factors that went into determining the various benefit categories in 1989 are:

- Demand/load forecasts
- Generating capacity: planned additions and retirements and characteristics of each unit
- Cost of new generating capacity
- Fuel price projections
- Existing transmission capacity
- Level of customer outages (number, size, duration) and outage causes
- Value of customer outages

Each of these is discussed below, followed by a qualitative discussion of the impact on benefits estimates given the new information.

3.1 Demand/Load Forecasts

Table 2 compares the demand forecast used in the 1989 study with current demand forecasts, by looking at the forecast for the year 2010.

Table 2: Comparison Of Peak Demand Forecasts For 2010 (MW)

	Anchorage	Kenai	Fairbanks
1989 Study			
Low	403	76	143
Mid	474	96	151
High	511	106	171
Current Update	509	128	256

For Anchorage and the Kenai Peninsula, the new forecasts for 2010 are not too different from the 1989 forecasts. However, the newer projection for Golden Valley/Fairbanks is substantially higher. Because of the limited transmission between Anchorage and Fairbanks, this change has little impact on the economics of the new Kenai-Anchorage line.

3.2 Generating Capacity: Planned Additions and Retirements

There have been a number of changes since the 1989 study. Life extensions and postponing the retirement of several units, particularly Beluga, result in a substantially higher projection of available generating capacity, reducing the need for new capacity and pushing capacity sharing benefits further into the future.

3.3 Cost of New Combustion Turbines

A new combustion turbine is assumed to cost $600 per kilowatt installed, with fixed operations and maintenance cost of $8 - $9 per kilowatt per year (per discussion with Power Engineers Incorporated, for a unit in the 50 megawatt size range, at an unspecified site; a larger unit at an established site would cost less). Levelizing the capital cost over 20 years at 4.5% and adding the fixed operations and maintenance cost yields a value of $55 per kilowatt per year, in 1997 dollars. The 1989 study used a value of $51 per kilowatt per year, in 1990 dollars. When both are expressed in the same year dollars, the new value is about 15 per cent lower.

3.4 Fuel Prices

Lower fuel prices reduce the value of the benefits from economy energy transfers, from reduced transmission losses, and from spinning reserve sharing. However, without detailed system modeling (i.e., determining how each generating unit would be operated over the 40-year time horizon, with and without the proposed new transmission line), it is impossible to say precisely how much the benefits are reduced. We can say, however, that if all fuel prices are reduced by some percentage, then the benefits in these categories will go down by about the same percentage.

New estimates for benefits in these categories were determined by calculating an aggregate ratio of current fuel price projections to 1989 projections, and then scaling the 1989 benefits by this aggregate ratio. The ratio was calculated by:

1. Obtaining today's fuel prices
2. Assuming that gas prices would escalate at the same rate as world oil prices
3. Calculating for each comparable year of operation of the new line the ratio of the current projected price of gas at two locations (anchorage and the beluga generating station) to the price projected in 1989 (for example, the ratio of the gas price now projected for 2004 to the price projected in 1989 for 1994, 2004 and 1994 being the planned first year of line operation now and then.)
4. Combining the ratios for the two locations and for all forty years into a single aggregate ratio, accounting for the fraction of gas used at each location and discounting future years.

Following this procedure, the ratio derived was 0.725; i.e., currently projected gas prices for corresponding years of line operation are almost 30 per cent lower than in 1989. The actual reduction is even greater than this, because the gas prices used in the December 1989 study were wellhead prices excluding delivery charges. This update follows the practice used in the 1989 Reconnaissance study, which was to include gas delivery charges in the total gas prices, since this is what is paid by the Railbelt utilities to gas suppliers.

To illustrate the extent to which fuel price projections have changed and need to be updated, Table 3 shows the fuel prices projected for 1997 in the 1989 analysis, converts them to 1997 dollars, and compares the forecasts to today's actual prices, which were provided by Anchorage Municipal Light and Power, Golden Valley Electric Association, and Chugach Electric Association. The actual prices today are substantially lower than the forecast, when both are expressed in 1997 dollars.

Table 3: Comparison of 1997 Fuel Price Forecast with Today's Prices [$/million Btu]

Fuel	Plants	1989 Forecast of 1997 Price (1990 $)	1989 Forecast of 1997 Price* (1997 $)	1997 Actual Price** (1997 $)
Gas 1	Beluga	$1.98	$2.38	$1.50
Gas 2	Anchorage	$2.28	$2.75	$2.04/2.27
Oil 4	North Pole	$4.29	$5.16	$2.90
Coal 1	Chena	$2.79	$3.36	$3.60
Coal 2	Healy	$1.44	$1.74	$1.34

*gas prices at wellhead
**gas prices including delivery charge

The December 1989 study assumed that gas prices would escalate at the same rate as world oil prices, because of market linkages between the two fuels and because the contracts between the Railbelt utilities and the gas suppliers directly link the price paid for gas to oil prices. At that time oil prices were expected to escalate about two per cent per year in real terms. For the current update we maintain the underlying assumption, have assumed that gas prices will escalate at the same rate as the United States Department of Energy's Energy Information Administration reference projection of crude oil prices, which is almost exactly one per cent per year, from now until 2020. Because of the difficulty of forecasting prices that far into the future, we have assumed prices remain flat after 2020.

3.5 Existing Transmission Capacity

When the 1989 study was carried out, the Bradley Lake hydro plant was not yet in operation, and it was not clear how heavily the existing Kenai-Anchorage line could be loaded, since up to that time there had been little or no need to transfer the levels of power that are now available from Bradley Lake. As a result, two cases for the transfer capability of the existing line were examined in the 1989 study. One case assumed that the line could handle up to 70 MW input, corresponding to about 61 MW after losses; the second case assumed 90 MW input and 75 MW after losses. Current operating policies for the line correspond to the first case, so only that case has been used in this update.

3.6 Level of Customer Outages

Two key assumptions about the impact of the new Kenai-Anchorage line were made in the 1989 study:

- The new line would reduce outages (unserved energy) in the Kenai by about 55 per cent from historical levels (1986-1987); this assumption took into account the fraction of time that energy was flowing in each direction, and the likely impact of an outage for each direction of flow.

- The new line would reduce outages in the Anchorage area by 30 to 60 megawatthours; this is based on avoiding 1 to 2 outages of 30 MW and one hour duration per year.

The current update uses these same assumptions. Some new outage data has been provided, but that is only one element of the reliability benefits calculation; completely redoing the reliability benefits component was beyond the scope of this update.

3.7 Value of a Customer Outage

Except for converting to 1997 dollars, we used the same assumptions as the 1989 study. About 88 per cent of outages are industrial or commercial, with the remainder residential. The outages that would be impacted by the proposed line range from a few minutes to a few hours in duration. Based on the distribution by customer class and duration, the average value of each kilowatt-hour of unserved energy avoided is about $21 (1997 dollars).

4. New Data Items

4.1 Cost of Maintaining Minimum Generation on the Kenai

Chugach Electric Association studies project that by 2003 the annual cost of maintaining a minimum of 25 MW of combustion turbine generation in operation at all times on the Kenai will be about $490,000 for the entire Railbelt.

4.2 Frequency of Zero Line Loading Conditions

Chugach Electric Association staff estimate that without a new line, the existing line will be operated at zero load an average of 20 days per year in the winter due to weather conditions and avalanche danger, and another 20 days per year in the summer due to activities such as highway construction adjacent to the line.

4.3 Cost Of Zero Line Loading

Chugach Electric Association studies have shown a cost of $13,000 per day, for the entire Railbelt, from taking the existing line out of service.