COST-EFFECTIVENESS OF ALTERNATIVE WINDOW SYSTEMS IN ANCHORAGE, FAIRBANKS AND SOUTHCENTRAL ALASKA

Prepared for

Alaska Department of Community and Regional Affairs
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Cost-Effectiveness of Alternative Window Systems in Anchorage, Fairbanks, and Southcentral Alaska

SUMMARY

Compared to double-paned R-1.7 windows, more efficient R-3.1 windows are cost effective in Anchorage under a wide range of assumptions about future fuel costs and construction costs. This result holds even more strongly in Fairbanks and Southcentral, where the cost of energy is far higher.

1 INTRODUCTION

This research memorandum evaluates the cost-effectiveness of installing alternative window types in a prototype new home in Alaska. The analysis is performed for Anchorage, using natural gas as the fuel; and for the Southcentral and Fairbanks regions, using oil as the fuel.

The comparison between baseline[1] and more efficient windows is structured as an investment analysis. We look at the incremental costs and benefits of the more efficient windows relative to the less efficient. All other variables, such as the cost of the walls, floors, and ceiling of the house, are held constant and therefore "drop out" of the analysis.

2 BACKGROUND ASSUMPTIONS

Table 1 summarizes the basic assumptions common to all of the cases examined. The analysis is based on a "Portsmouth Plan" house type with a variety of windows totalling 215 square feet of glazed area. Costs and benefits of more efficient windows are analyzed for a 30 year period. The house is assumed to be financed by a fixed rate 30 year mortgage at prevailing market rates.[2]

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[1]We use the term "baseline" rather than "standard" to refer to the less efficient window option to avoid confusion arising from the fact that the thermal standards specify more efficient equipment.

[2]The figure of 10 percent is an average of quotes obtained from the Alaska Housing Finance Corp., National Bank of Alaska, Energy Rated Homes Program, and the Anchorage Daily News (3/1/91). Lower rates are available for some groups, such as first time home buyers with limited incomes and veterans.

Table 1: Background Assumptions

	Anchorage	Fairbanks	S_Central
Conditioned Temperature	70	70	70
Heating Degree Days	12,514	15,939	12,304
Heating Fuel	Gas	Oil #1	Oil #1
Furnace Efficiency	75.2%	66.4%	66.4%
Window Area (sq ft)	215	215	215
Mortgage Interest Rate	10.0%	10.0%	10.0%
Inflation Rate	5.5%	5.5%	5.5%
Federal Income Tax Rate	28.0%	28.0%	28.0%
Mortgage Term (years)	30	30	30
Analysis Period (years)	30	30	30
House Price Appreciation Rate	0.0%	0.0%	0.0%

3 INCREMENTAL PURCHASE COST OF EFFICIENT WINDOWS

Data on the actual costs of alternative window systems were provided by DCRA. These data were obtained by soliciting bids from several suppliers in the Anchorage area for a "Portsmouth Plan" house judged to be typical of new construction in Anchorage and Southcentral Alaska.[3] Total window square footage is 215 square feet. Table 2 shows these estimates. The first round of bid requests required R values greater than 2.3, but did not specify exact thermal performance. Most suppliers responded by proposing low-e and argon-filled low-e windows with R-3.1 or R-3.2. Additional bids were solicited for standard double pane windows of R-1.7.

Table 2: Window Cost Estimates (215 sq ft)

Code	Source	Frame	R-Value	U-Value	Cost	Shade Coef.	Cost Difference Dollars	Cost Difference $/Ft2
1	SBS	Vinyl	1.7	0.588	2,571	0.89		
2	SBS	Vinyl	3.1	0.323	3,085	0.70	514	2.40
3	SBS	Wood Prim	1.7	0.588	2,993	0.89		
4	SBS	Wood Prim	3.1	0.323	3,532	0.70	539	2.51
5	BMS	Wood Prim	1.7	0.588	3,644	0.89		
6	BMS	Wood Prim	3.2	0.313	4,681	0.68	1,037	4.84
7	RG	Wood unfin	2.17	0.461	5,779	0.89		
8	RG	Wood unfin	3.2	0.313	6,332	0.70	553	2.58
9	NT	Vinyl	1.51	0.662	4,315	0.89		
10	NT	Vinyl	3.85	0.260	4,778	0.70	463	2.16
11	Average of 1,3,5		1.7	0.588	3,069	0.89		
12	Average of 2,4,6		3.1	0.323	3,766	0.70	697	3.25

[3]While this plan may not be typical of Fairbanks designs, the house plan is only important in determining the cost per square foot of glass. If these costs are reasonable, then the results of the analysis are unchanged if a different glass area or configuration is chosen.

These bids were collected from Anchorage suppliers. We assume that the *difference* in cost between two window types is the same in Fairbanks, even though freight may add to the absolute cost of all windows in that region.

4 Incremental Energy Savings of Efficient Windows

Annual Btu heat loss through each window system is calculated as:

$$U * HDD * 24$$

where U is the composite U value for the window units and HDD is the number of heating degree days computed using a base of 70 degrees. Therefore the incremental heat loss avoided by the more efficient windows is proportional to the difference in U values between the two window types being compared.

Since more efficient windows are somewhat less effective at capturing incoming solar gain, we have estimated the difference in effective solar gain between each set of windows being compared. The method is based on the difference in the shade coefficients of the two window types. In some cases the exact shade coefficient data was not supplied by the bidder, so we have assumed a conservative value of .70 for the R-3.1 windows. We have also used the Anchorage solar gain parameters (Colt & Mitchell, 1989) in the Fairbanks analysis. In reality, Fairbanks receives less useable solar radiation than Anchorage[4], so this approximation is a conservative one.

5 Investment Analysis Methodology

In theory, the net dollar benefits of the more efficient windows depend heavily on two economic parameters: (1) the interest rate used to finance the extra cost, and (2) the level of fuel prices during the next thirty years. We perform all calculations using dollars of constant 1990 purchasing power. Following this logic, we assume a real (net of inflation) discount rate of 4.5 percent. This parameter value is consistent with a nominal mortgage interest rate of ten percent[5] and a future inflation rate of 5.5 percent. The 4.5 percent real discount rate is also consistent with the figure adopted by the Alaska Energy Authority for use in feasibility studies of state-funded energy projects. The tax-deductibility of mortgage interest is accounted for by actual computation of monthly mortgage payments. A set of sensitivity cases is presented in which interest is not tax-deductible.

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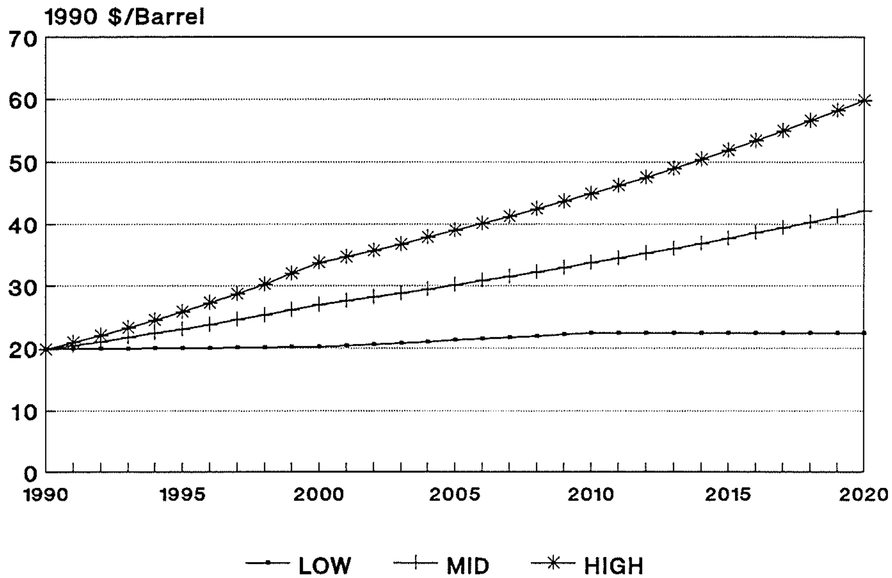
[4]Alan Mitchell, personal communication, 2 April 1991. Mitchell based his conclusion on insolation data from the Cooperative Extension Service.

[5]AHFC currently lends money at rates ranging from 8.2 to 10.2 percent (Personal communication, 14 March 1991. National Bank of Alaska lends money at rates ranging from 7.25 to 11 percent (Personal Communication, 15 March 1991). Eligibility for the lower rates is a function of income, principal amount, first-time buyer status, and Veteran status.

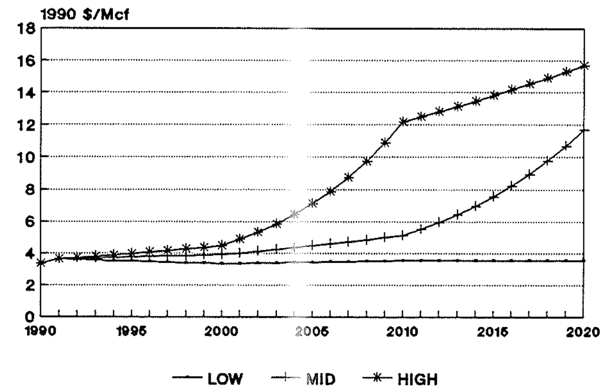
Energy Price Projections

World Crude Oil Price Projections



source: ICF 1988

Anchorage Natural Gas Price Projections



Fairbanks Heating Oil Price Projections

(Southcentral Price is 3 cents lower)

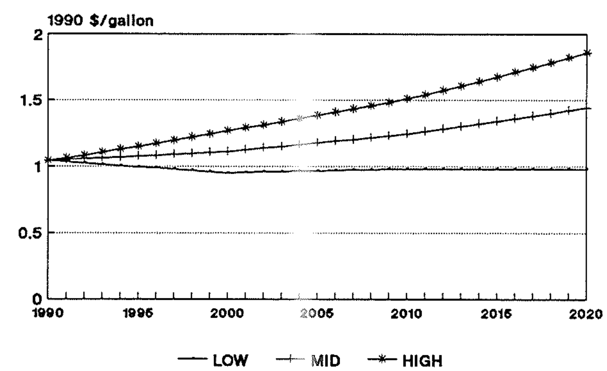


Figure 1: Energy Price Projections

Future fuel prices over the next thirty years are highly uncertain. The computational details behind the fuel price forecasts are presented in Appendix A. We have adopted LOW, MID, and HIGH case fuel price forecasts for natural gas in Anchorage and for oil in Fairbanks and Southcentral Alaska, as shown in Figure 1. The fuel price projections are ultimately based on projected world market prices of crude oil. After reviewing more recent work, we adopted the 1988 crude oil price forecasts developed by ICF, inc. (ICF 1988) for the Alaska Energy Authority. These forecasts span the range of informed thinking about the prospects for the world market and have the additional advantage that they are linked to consistent forecasts of wellhead natural gas prices and delivered fuel oil prices.

Finally, we account for three incidental economic effects of more efficient windows. First, the annual insurance payments are higher for the more efficient windows, being based on their higher replacement cost. Second, annual property taxes are higher, being based on a higher market and assessed property value. Finally, we assume that there is zero additional maintenance required for efficient windows. Actually, it is most likely that more efficient windows require less maintenance expenditure due to lower condensation buildup.

6 RESULTS OF CASH FLOW ANALYSES

We have made no attempt to choose a "most likely" fuel price forecast. Therefore, each window comparison is reported for all three fuel price scenarios.

6.1 Base Case Comparisons

As a base case, we have chosen an average incremental window cost of $697 (see window codes 11 and 12 in table 2). Depending on fuel price scenarios, the present value of energy savings ranges from 1,033 to 2,110 in Anchorage; from 3,377 to 4,582 in Fairbanks, and from 2,404 to 3,290 in Southcentral. After factoring in all costs of the efficient windows, the present value of net cash flows from the investment ranges from 527 to 1,603 in Anchorage; from 2,874 to 4,079 in Fairbanks; and from 1,893 to 2,778 in Southcentral. These numbers represent the "bottom line": if they are greater than zero, then the investment is cost-effective and the overall life-cycle cost to the homeowner is reduced. These net benefits numbers can also be expressed as benefit/cost ratios. If the net benefits are positive, the benefit/cost ratio is greater than 1.0.

These base case comparisons are reported by region as the top panel, labelled "Avge Window Costs" in tables 3,4, and 5. These tables present benefit/cost ratios as well as net benefits estimates.

6.2 Sensitivity Cases

Three additional sensitivity cases are presented in tables 3,4, and 5. The first, labelled "Low window costs", assumes that the incremental cost of the R-3.1 windows is $514, vs. $697 in the base case. As expected, lowering the cost differential increases the net benefits of the efficient windows.[6]

The second sensitivity case, "Highest window costs," uses the highest observed value for incremental window costs: $1037. This case reduces net benefits substantially, but the efficient windows remain economic under all fuel prices and in all regions.

In the final sensitivity case, we assume that mortgage interest is no longer tax-deductible. This case offers results which would hold when the investment is financed purely out of pocket by the homeowner. Net benefits are reduced in this case by slightly less than they are in the "Highest window cost" case.

Figure 2 shows a summary of the net benefits of R-3.1 windows.

6.3 Discussion

This analysis shows that under a broad range of assumptions about future fuel prices and the actual cost of R-3.1 windows, these windows are cost-effective relative to baseline double pane R-1.7 windows. Even if Anchorage's cheap gas prices stay absolutely constant *and* the incremental construction cost is almost 40% higher than the average of the bids received, the efficient windows pay off in Anchorage. In Fairbanks and Southcentral, with vastly higher fuel prices, the investment makes overwhelming economic sense.

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[6]This difference in cost does not translate one for one to increased net benefits, because some of the difference is shared with the federal government in the form of reduced interest deductions.

Table 3: Anchorage Results Summary

SUMMARY of WINDOW COMPARISONS for the ANCHORAGE REGION

Comment	Case ID	Window Comparison: R-Values Basic	R-Values Effic.	Cost Basic	Cost Efficient	Extra Cost	Energy Savings (MMBTU/yr): Gross Savings	Reduced Gain	Net Savings	Cost-Effectiveness Measures: Fuel Cost	Tax-Deductible Interest?	Energy Savings ($, PV)	Net Cash Flow ($, PV)	Benefit/ Cost Ratio	Simple Payback (years)
Avge Window Costs	AN111211	1.7	3.1	3,069	3,766	697	17.12	3.07	14.04	LOW	YES	1,033	527	1.8	12
	AN111221	1.7	3.1	3,069	3,766	697	17.12	3.07	14.04	MID	YES	1,428	922	2.3	11
	AN111231	1.7	3.1	3,069	3,766	697	17.12	3.07	14.04	HI	YES	2,110	1,603	3.3	10
Low Window Costs	AN010211	1.7	3.1	2,571	3,085	514	17.12	3.07	14.04	LOW	YES	1,033	660	2.3	8
	AN010221	1.7	3.1	2,571	3,085	514	17.12	3.07	14.04	MID	YES	1,428	1,055	3.1	8
	AN010231	1.7	3.1	2,571	3,085	514	17.12	3.07	14.04	HI	YES	2,110	1,736	4.4	7
Highest Window Costs	AN050611	1.7	3.2	3,644	4,681	1,037	17.77	3.40	14.37	LOW	YES	1,057	303	1.3	19
	AN050621	1.7	3.2	3,644	4,681	1,037	17.77	3.40	14.37	MID	YES	1,462	708	1.7	16
	AN050631	1.7	3.2	3,644	4,681	1,037	17.77	3.40	14.37	HI	YES	2,159	1,405	2.4	14
Interest not Deductible	AN111210	1.7	3.1	3,069	3,766	697	17.12	3.07	14.04	LOW	NO	1,033	371	1.5	13
	AN111220	1.7	3.1	3,069	3,766	697	17.12	3.07	14.04	MID	NO	1,428	766	2.1	11
	AN111230	1.7	3.1	3,069	3,766	697	17.12	3.07	14.04	HI	NO	2,110	1,447	3.1	10

Table 4: Fairbanks Results Summary

SUMMARY of WINDOW COMPARISONS for the FAIRBANKS REGION

Comment	Case ID	Window Comparison: R-Values Basic	R-Values Effic.	Cost Basic	Cost Efficient	Extra Cost	Energy Savings (MMBTU/yr): Gross Savings	Reduced Gain	Net Savings	Fuel Cost	Tax-Deductible Interest?	Cost-Effectiveness Measures: Energy Savings ($, PV)	Net Cash Flow ($, PV)	Benefit/ Cost Ratio	Simple Payback (years)
Avge Window Costs	FB111241	1.7	3.1	3,069	3,766	697	21.80	3.07	18.73	LOW	YES	3,377	2,874	5.1	3
	FB111251	1.7	3.1	3,069	3,766	697	21.80	3.07	18.73	MID	YES	3,991	3,488	6.0	3
	FB111261	1.7	3.1	3,069	3,766	697	21.80	3.07	18.73	HI	YES	4,582	4,079	6.9	3
Low Window Costs	FB010241	1.7	3.1	2,571	3,085	514	21.80	3.07	18.73	LOW	YES	3,377	3,006	6.8	2
	FB010251	1.7	3.1	2,571	3,085	514	21.80	3.07	18.73	MID	YES	3,991	3,620	8.0	2
	FB010261	1.7	3.1	2,571	3,085	514	21.80	3.07	18.73	HI	YES	4,582	4,211	9.2	2
Highest Window Costs	FB050641	1.7	3.2	3,644	4,681	1,037	22.63	3.40	19.23	LOW	YES	3,467	2,719	3.6	4
	FB050651	1.7	3.2	3,644	4,681	1,037	22.63	3.40	19.23	MID	YES	4,098	3,349	4.2	4
	FB050661	1.7	3.2	3,644	4,681	1,037	22.63	3.40	19.23	HI	YES	4,705	3,956	4.8	4
Interest not Deductible	FB111240	1.7	3.1	3,069	3,766	697	21.80	3.07	18.73	LOW	NO	3,377	2,719	4.9	3
	FB111250	1.7	3.1	3,069	3,766	697	21.80	3.07	18.73	MID	NO	3,991	3,333	5.8	3
	FB111260	1.7	3.1	3,069	3,766	697	21.80	3.07	18.73	HI	NO	4,582	3,924	6.6	3

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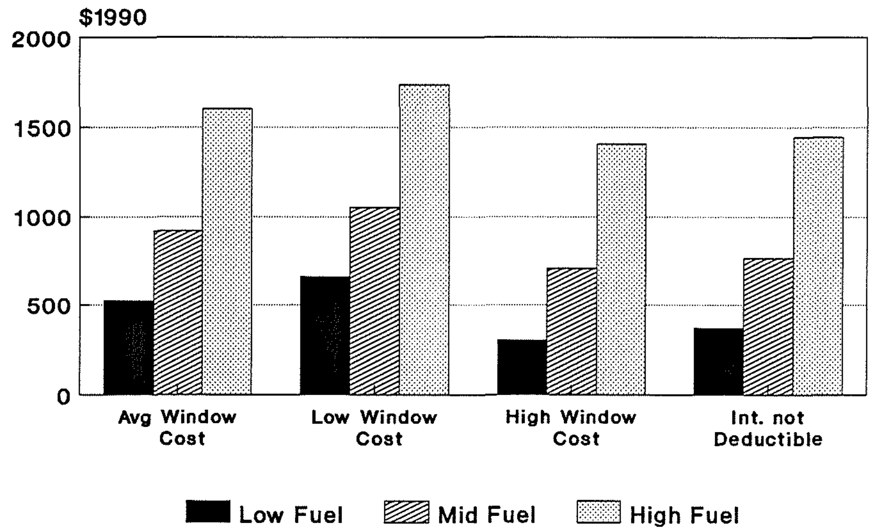
Table 5: Southcentral Results Summary

SUMMARY of WINDOW COMPARISONS for the SOUTHCENTRAL REGION

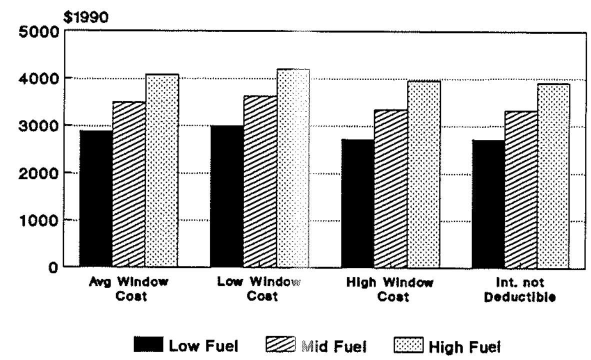
		Window Comparison					Energy Savings (MMBTU/yr)					Cost-Effectiveness Measures			
Comment	Case ID	R-Values Basic	R-Values Effic.	Cost Basic	Cost Efficient	Extra Cost	Gross Savings	Reduced Gain	Net Savings	Fuel Cost	Tax-Deductible Interest?	Energy Savings ($, PV)	Net Cash Flow ($, PV)	Benefit/ Cost Ratio	Simple Payback (years)
Avge Window Costs	SC111271	1.7	3.1	3,069	3,766	697	16.83	3.07	13.76	LOW	YES	2,404	1,893	3.7	4
	SC111281	1.7	3.1	3,069	3,766	697	16.83	3.07	13.76	MID	YES	2,856	2,344	4.4	4
	SC111291	1.7	3.1	3,069	3,766	697	16.83	3.07	13.76	HI	YES	3,290	2,778	5.0	4
Low Window Costs	SC010271	1.7	3.1	2,571	3,085	514	16.83	3.07	13.76	LOW	YES	2,404	2,027	4.9	3
	SC010281	1.7	3.1	2,571	3,085	514	16.83	3.07	13.76	MID	YES	2,856	2,478	5.8	3
	SC010291	1.7	3.1	2,571	3,085	514	16.83	3.07	13.76	HI	YES	3,290	2,912	6.7	3
Highest Window Costs	SC050671	1.7	3.2	3,644	4,681	1,037	17.47	3.40	14.07	LOW	YES	2,460	1,698	2.6	7
	SC050681	1.7	3.2	3,644	4,681	1,037	17.47	3.40	14.07	MID	YES	2,921	2,159	3.1	6
	SC050691	1.7	3.2	3,644	4,681	1,037	17.47	3.40	14.07	HI	YES	3,365	2,603	3.5	6
Interest not Deductible	SC111270	1.7	3.1	3,069	3,766	697	16.83	3.07	13.76	LOW	NO	2,404	1,735	3.5	4
	SC111280	1.7	3.1	3,069	3,766	697	16.83	3.07	13.76	MID	NO	2,856	2,187	4.1	4
	SC111290	1.7	3.1	3,069	3,766	697	16.83	3.07	13.76	HI	NO	3,290	2,620	4.8	4

Net Benefits of Efficient Windows
(Present Value)

Anchorage



Fairbanks



Southcentral

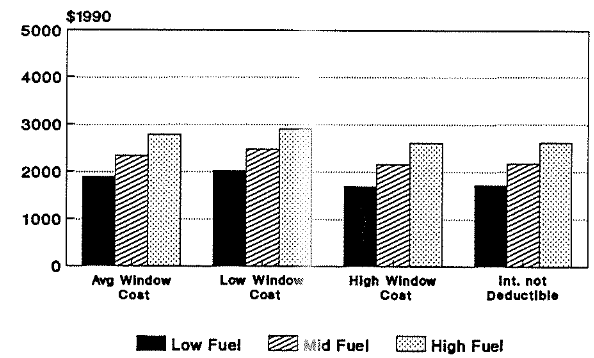


Figure 2: Net Benefits Summary

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APPENDIX A

FUEL PRICE PROJECTIONS

In this technical appendix we present the methodology and data used to produce price projections for natural gas in Anchorage and for home heating oil in Fairbanks and outlying Southcentral Alaska.

World Crude Oil Prices

Both natural gas and heating oil prices are largely determined by the world price of oil. A comprehensive assessment of prevailing "schools of thought" regarding future world oil prices was prepared by ICF, Inc. in 1988 for the Alaska Power Authority (now the Alaska Energy Authority). As part of this project we reviewed several assessments of world oil prices prepared since 1988, paying particular attention to the impact of the invasion of Kuwait on long term OPEC behavior and OPEC capacity. As the rapid return of postwar prices to prewar levels suggests, there is no reason to believe that the Gulf crisis has fundamentally changed the market situation. We have therefore used the ICF 1988 assessment as the basis for the fuel price projections presented here.

The ICF/APA crude oil price projections are for Saudi Light crude oil delivered to the U.S. Gulf coast and can be summarized as follows:

Table A-1

Projected World Crude Oil Prices (1990 Dollars)

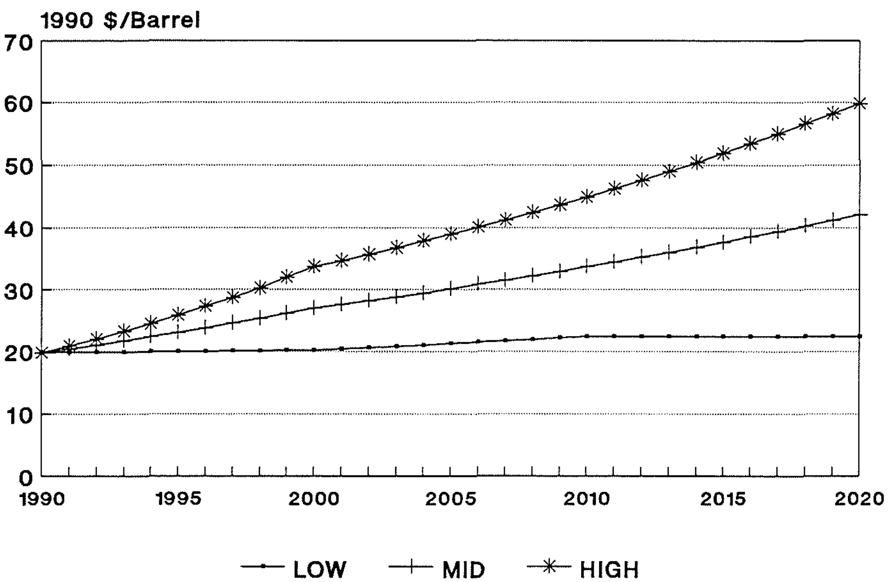
Year	LOW	MID	HIGH
1990	15.71	20.20	22.45
2000	20.20	26.94	33.67
2010	22.45	33.67	44.89

As figure A-1 shows, the LOW case represents essentially zero real growth in oil prices, while the MID and HIGH cases represent growth rates of 2.7 and 4.2 percent between 1990 and 2010.

To extend our analysis over a thirty year period, we have extrapolated these price projections through the year 2020 using the average growth rates computed during the period 2000-2010. In the LOW case, we have left the price constant at the 2010 level, reflecting the "low price" school of thought which holds that real oil prices have remained constant during the past century and will continue to do so.

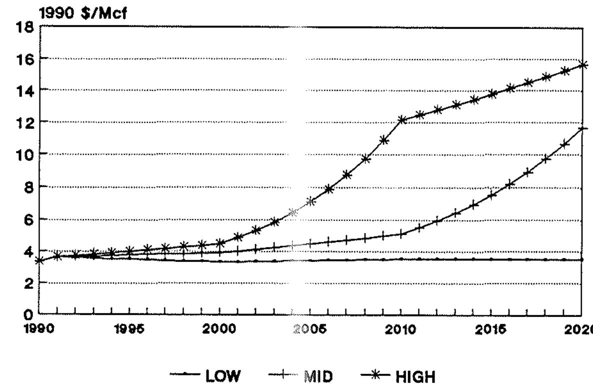
Energy Price Projections

World Crude Oil Price Projections



source: ICF 1988

Anchorage Natural Gas Price Projections



Fairbanks Heating Oil Price Projections

(Southcentral Price is 3 cents lower)

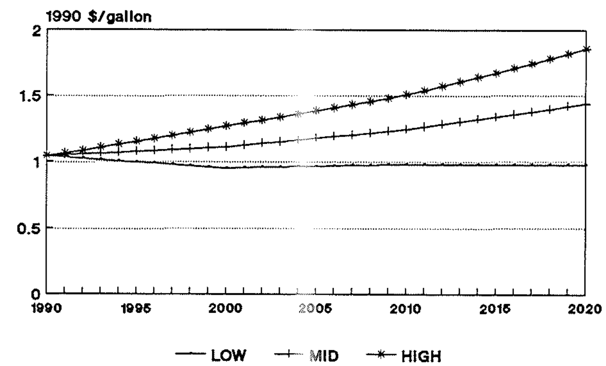


Figure A-1: Energy Price Projections

Anchorage Natural Gas Price Projections[1]

Retail natural gas prices are comprised of two components: the wellhead cost of gas, which is what Enstar pays to the gas producers, and the distribution charge. The current distribution charge is $1.61 per thousand cubic feet (Mcf). We assume that this charge will remain constant in real dollars.

The wellhead cost of gas is currently determined by two contracts, each of which ties the price paid by Enstar to the world price of crude oil. The APL-4 contract indexes the base gas rate of $1.55/Mcf to the base world crude oil price of $18.00/bbl.[2] The Shell-Beluga contract indexes the base gas price of $2.32/Mcf to a base home heating oil price of $.96/gallon measured at the gate of the Nikiski refinery on November 1.

For the APL-4 contract, the oil price used to determine the 1991 cost of gas is $19.82/bbl. This corresponds to a cost of gas of $1.75/Mcf. For the Shell-Beluga contract, the price used for 1991 is $1.26/gallon. This translates to a wellhead gas cost of $3.09/Mcf. The blended wellhead cost of gas which is passed on to the customer is calculated as (approximately) 60% of the APL-4 price plus 40% of the Shell-Beluga price. The Shell-Beluga fraction of Enstar's gas supply is expected to decline to near zero by the year 2000.

The gas available under the terms of the APL-4 contract will be largely exhausted after the year 2000. It is an open question whether inexpensive gas will continue to be available after the turn of the century. The ICF fuel price report (ICF 1988) analyzed the prospects for continuing supplies of cheap Cook Inlet gas by focusing on the geological properties of the area and the expected costs of and yields from future drilling activity. A very important result of this work was a statistical equation relating the cost of producing additional reserves to the total amount already taken from the Cook Inlet region. This marginal cost of reserves puts a floor under future gas prices. The ICF analysis projects a rapid increase in the cost of producing new gas sometime after the year 2000. The timing of this increase depends on the amount of gas exported, since more exports reduce the remaining stock of inexpensive reserves.

While the cost of producing new gas places a floor under the price, the value of the gas to the consumer places a ceiling on the price. ICF estimated these ceiling prices, or "marginal values," based on the price of heating oil. We used these prices as a cap on rapidly increasing gas prices.

Table A-2 summarizes the elements of the Low, Middle, and High case price projections based on the corresponding crude oil price scenarios. In the Low case, we assume that inexpensive gas

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[1]This section is based on personal communication with Enstar Natural Gas Co., Dan Dieckgraaf, 12/17/90 and 2/20/91.

[2]The oil price is determined annually as the average of the quoted settle prices for New York light sweet crude futures contracts expiring during the months of July, August, and September, and recorded only during the time when such contracts are the next ones to expire. In practice, the last settle date for June delivery is May 21, so the period during which the relevant contracts are the next to expire is from May 22 through August 21. These prices can be thought of as spot market prices with some of the day-to-day volatility removed.

reserves will continue to be available throughout the analysis period and that current contract terms are renewed when current contracts expire. Under these assumptions gas prices continue to be tied directly to world crude oil prices, which remain low throughout the period.

For the Middle case, we assume that current contract terms are renewed through the year 2010. At this time current gas reserves have been exhausted, and the ICF cost-of-reserves equation is used to project gas prices from 2010 through 2020.

For the High case, ICF projects the cost of gas rising rapidly between 2000 and 2010, as export activity drains current reserves. At this time, the gas price reaches rough equivalence of the heating oil price, in terms of dollars per Btu. Between 2010 and 2020 the gas price rises only as fast as the price of heating oil.

Table A-2: Components of Projected Natural Gas Prices

Case		World Oil Price $/bbl	Alternative Wellhead Costs: Marginal Cost of Reserves $/Mcf	Alternative Wellhead Costs: Marginal Value of Gas $/Mcf	Alternative Wellhead Costs: APL-4 Contract Formula $/Mcf	Adopted Wellhead Cost $/Mcf	Distribution Cost $/Mcf	Retail Gas Price $/Mcf
Low	1990	19.82	NA	5.62	2.01	2.01	1.61	3.63
	2000	20.20	0.97	6.35	1.73	1.73	1.61	3.34
	2010	22.45	3.50	6.76	1.93	1.93	1.61	3.55
	2020	22.45	13.47	6.76	1.93	1.93	1.61	3.55
Middle	1990	19.82	NA	6.35	2.01	2.01	1.61	3.63
	2000	26.94	0.97	7.49	2.29	2.29	1.61	3.90
	2010	33.67	3.50	8.62	2.90	3.50	1.61	5.12
	2020	42.09	13.47	10.08	3.62	10.08	1.61	11.69
High	1990	19.82	NA	6.76	2.01	2.01	1.61	3.63
	2000	33.67	1.85	8.62	2.85	2.85	1.61	4.46
	2010	44.89	5.98	10.56	3.87	10.56	1.61	12.17
	2020	59.86	13.47	14.08	5.15	14.08	1.61	15.69

Fairbanks Heating Oil Price Projections

The price of home heating oil in Fairbanks is based directly on the world crude oil price. As ICF (1988) reports, the "swing" producer serving the Fairbanks market is Tesoro at its Nikiski refinery. The crude oil for this refinery is North Slope Crude purchased from the Valdez terminal. Table A-3 summarizes the calculations used to derive retail oil prices from the cost of North Slope Crude Oil. These calculations follow the detailed analysis of this market prepared by ICF.

Table A-3: Derivation of Fairbanks Heating Oil Prices

		Low $1990	Mid $1990	High $1990
Tesoro Cost of North Slope Crude (consistent with ICF Crude price)	1990	12.09	16.52	18.73
	2000	17.72	24.36	31.00
	2010	18.92	29.99	41.06
	2020	18.92	38.30	55.81
plus Refiner Margin ($/bbl)	all yrs	9.53	9.53	9.53
equals Nikiski gate Price ($/gal)	1990	0.51	0.62	0.67
	2000	0.65	0.81	0.96
	2010	0.68	0.94	1.20
	2020	0.68	1.14	1.56
plus transport to FBX	all yrs	0.11	0.11	0.11
plus Distribution Margin	all yrs	0.19	0.19	0.19
equals Fairbanks Delivered Price $/gal	1990	0.82	0.92	0.98
	2000	0.95	1.11	1.27
	2010	0.98	1.24	1.51
	2020	0.98	1.44	1.86
1990 "actual" cost of Fuel Oil (Sourdough Fuel Co., Jan '91)		1.04	1.04	1.04
Ten Year Growth Rates using 1990 "actual"				
	1990-2000	-0.9%	0.7%	2.0%
	2000-2010	0.3%	1.1%	1.7%
	2010-2020	0.0%	1.5%	2.1%
	1990-2020	-0.2%	1.1%	2.0%

Southcentral Heating Oil Price Projections

Analysis similar to that for the Fairbanks market produces price projections for Southcentral Alaska which are a constant 3 cents below the Fairbanks price. This difference arises from a combination of lower transport costs from the Nikiski refinery, in combination with higher estimated distribution margins. These may result from the higher costs of delivering to the more dispersed residential areas of the outlying Southcentral region.

Energy Price Projections Summary

Tables A-4 through A-6 show the detailed price projections used in the analysis.

Table A-4: LOW Case Fuel Price Projections
Real 1990 Dollars

	World Oil Price $/bbl	Wellhead Gas Price $/Mcf	Gas Dist'n Cost $/Mcf	Retail Gas Price $/Mcf	Fairbanks Oil Price $/gal	SCntrl Oil Price $/gal
1990	19.82	1.75	1.61	3.36	1.04	1.01
1991	19.86	2.01	1.61	3.63	1.03	1.00
1992	19.90	1.98	1.61	3.59	1.02	0.99
1993	19.93	1.94	1.61	3.56	1.01	0.98
1994	19.97	1.91	1.61	3.53	1.00	0.97
1995	20.01	1.88	1.61	3.49	0.99	0.96
1996	20.05	1.85	1.61	3.46	0.99	0.96
1997	20.09	1.82	1.61	3.43	0.98	0.95
1998	20.13	1.79	1.61	3.40	0.97	0.94
1999	20.16	1.76	1.61	3.37	0.96	0.93
2000	20.20	1.73	1.61	3.34	0.95	0.92
2001	20.42	1.75	1.61	3.36	0.95	0.92
2002	20.63	1.77	1.61	3.38	0.96	0.93
2003	20.85	1.79	1.61	3.40	0.96	0.93
2004	21.07	1.81	1.61	3.42	0.96	0.93
2005	21.30	1.83	1.61	3.44	0.97	0.94
2006	21.52	1.85	1.61	3.46	0.97	0.94
2007	21.75	1.87	1.61	3.48	0.97	0.94
2008	21.98	1.89	1.61	3.50	0.97	0.94
2009	22.21	1.91	1.61	3.53	0.98	0.95
2010	22.45	1.93	1.61	3.55	0.98	0.95
2011	22.45	1.93	1.61	3.55	0.98	0.95
2012	22.45	1.93	1.61	3.55	0.98	0.95
2013	22.45	1.93	1.61	3.55	0.98	0.95
2014	22.45	1.93	1.61	3.55	0.98	0.95
2015	22.45	1.93	1.61	3.55	0.98	0.95
2016	22.45	1.93	1.61	3.55	0.98	0.95
2017	22.45	1.93	1.61	3.55	0.98	0.95
2018	22.45	1.93	1.61	3.55	0.98	0.95
2019	22.45	1.93	1.61	3.55	0.98	0.95
2020	22.45	1.93	1.61	3.55	0.98	0.95

		World Oil Price	Wellhead Gas Price	Gas Dist'n Cost	Retail Gas Price	Fairbanks Oil Price	SCntrl Oil Price
Growth Rates	1990-2000	0.2%	-0.1%		-0.1%	-0.9%	-0.9%
	1991-2000		-1.7%		-0.9%		
	2000-2010	1.1%	1.1%		0.6%	0.3%	0.3%
	2010-2020	0.0%	0.0%		0.0%	0.0%	0.0%
	1990-2020		0.3%		0.2%	-0.2%	-0.2%

Basis: LOW case assumes current gas contracts can be extended through 2020. Cost of new reserves is assumed LOW.

Table A-5: MIDDLE Case Fuel Price Projections
Real 1990 Dollars

	World Oil Price $/bbl	Wellhead Gas Price $/Mcf	Gas Dist'n Cost $/Mcf	Retail Gas Price $/Mcf	Fairbanks Oil Price $/gal	SCntrl Oil Price $/gal
1990	19.82	1.75	1.61	3.36	1.04	1.01
1991	20.44	2.01	1.61	3.63	1.05	1.02
1992	21.07	2.04	1.61	3.65	1.05	1.02
1993	21.73	2.07	1.61	3.68	1.06	1.03
1994	22.41	2.10	1.61	3.71	1.07	1.04
1995	23.11	2.13	1.61	3.74	1.07	1.04
1996	23.83	2.16	1.61	3.77	1.08	1.05
1997	24.57	2.19	1.61	3.81	1.09	1.06
1998	25.33	2.22	1.61	3.84	1.10	1.07
1999	26.12	2.26	1.61	3.87	1.10	1.07
2000	26.94	2.29	1.61	3.90	1.11	1.08
2001	27.54	2.39	1.61	4.00	1.12	1.09
2002	28.17	2.49	1.61	4.11	1.14	1.11
2003	28.80	2.60	1.61	4.21	1.15	1.12
2004	29.45	2.71	1.61	4.33	1.16	1.13
2005	30.12	2.83	1.61	4.44	1.17	1.14
2006	30.80	2.95	1.61	4.57	1.19	1.16
2007	31.49	3.08	1.61	4.70	1.20	1.17
2008	32.20	3.22	1.61	4.83	1.22	1.19
2009	32.93	3.36	1.61	4.97	1.23	1.20
2010	33.67	3.50	1.61	5.12	1.24	1.21
2011	34.43	3.89	1.61	5.51	1.26	1.23
2012	35.21	4.33	1.61	5.94	1.28	1.25
2013	36.00	4.81	1.61	6.42	1.30	1.27
2014	36.81	5.34	1.61	6.96	1.32	1.29
2015	37.65	5.94	1.61	7.55	1.34	1.31
2016	38.49	6.60	1.61	8.22	1.36	1.33
2017	39.36	7.34	1.61	8.95	1.38	1.35
2018	40.25	8.16	1.61	9.77	1.40	1.37
2019	41.16	9.07	1.61	10.68	1.42	1.39
2020	42.09	10.08	1.61	11.69	1.44	1.41

		World Oil	Wellhead Gas	Gas Dist'n	Retail Gas	Fairbanks Oil	SCntrl Oil
Growth Rates	1990-2000	3.1%	2.7%		1.5%	0.7%	0.7%
	1991-2000		1.4%		0.8%		
	2000-2010	2.3%	4.3%		2.7%	1.1%	1.2%
	2010-2020	2.3%	11.1%		8.6%	1.5%	1.5%
	1990-2020		6.0%		4.2%	1.1%	1.1%

Basis: MID case assumes that costs of new reserves rise after 2000, driving up gas prices but not above the cost of fuel oil.

Table A-6: HIGH Case Fuel Price Projections
Real 1990 Dollars

	World Oil Price $/bbl	Wellhead Gas Price $/Mcf	Gas Dist'n Cost $/Mcf	Retail Gas Price $/Mcf	Fairbanks Oil Price $/gal	SCntrl Oil Price $/gal
1990	19.82	1.75	1.61	3.36	1.04	1.01
1991	20.90	2.01	1.61	3.63	1.06	1.03
1992	22.04	2.09	1.61	3.70	1.08	1.05
1993	23.24	2.17	1.61	3.79	1.10	1.07
1994	24.50	2.26	1.61	3.87	1.13	1.10
1995	25.83	2.35	1.61	3.96	1.15	1.12
1996	27.24	2.44	1.61	4.05	1.17	1.14
1997	28.72	2.54	1.61	4.15	1.19	1.16
1998	30.28	2.64	1.61	4.25	1.22	1.19
1999	31.93	2.74	1.61	4.35	1.24	1.21
2000	33.67	2.85	1.61	4.46	1.27	1.24
2001	34.65	3.25	1.61	4.86	1.29	1.26
2002	35.66	3.70	1.61	5.32	1.31	1.28
2003	36.71	4.22	1.61	5.83	1.34	1.31
2004	37.78	4.81	1.61	6.42	1.36	1.33
2005	38.88	5.48	1.61	7.10	1.38	1.35
2006	40.01	6.25	1.61	7.87	1.41	1.38
2007	41.18	7.13	1.61	8.74	1.43	1.40
2008	42.38	8.13	1.61	9.74	1.46	1.43
2009	43.62	9.26	1.61	10.88	1.48	1.45
2010	44.89	10.56	1.61	12.18	1.51	1.48
2011	46.20	10.87	1.61	12.48	1.54	1.51
2012	47.55	11.19	1.61	12.80	1.57	1.54
2013	48.94	11.51	1.61	13.13	1.61	1.58
2014	50.37	11.85	1.61	13.46	1.64	1.61
2015	51.84	12.20	1.61	13.81	1.67	1.64
2016	53.35	12.55	1.61	14.17	1.71	1.68
2017	54.91	12.92	1.61	14.53	1.75	1.72
2018	56.51	13.29	1.61	14.91	1.78	1.75
2019	58.16	13.68	1.61	15.30	1.82	1.79
2020	59.86	14.08	1.61	15.70	1.86	1.83

		World Oil	Wellhead Gas	Gas Dist'n	Retail Gas	Fairbanks Oil	SCntrl Oil
Growth Rates	1990-2000	5.4%	5.0%		2.9%	2.0%	2.1%
	1991-2000		3.9%		2.3%		
	2000-2010	2.9%	14.0%		10.6%	1.7%	1.8%
	2010-2020	2.9%	2.9%		2.6%	2.1%	2.2%
	1990-2020		7.2%		5.3%	2.0%	2.0%

Basis: HIGH case assumes that costs of new reserves rise after 2000, driving up gas prices but not above the cost of fuel oil. Additional export activity causes cost of new reserves to rise faster than in MID case.