Final IEP Single-Family Residential Willingness to Convert Heating Oil Price Sensitivity Analysis

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Document Information

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Acronyms

AEA	Alaska Energy Authority
AIDEA	Alaska Industrial Development and Export Authority
FNG	Fairbanks Natural Gas
FNSB	Fairbanks North Star Borough
IEP	Interior Energy Project
IGU	Interior Gas Utility
Mcf	thousand cubic feet

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1 Introduction

In January 2014, Cardno completed the *Interior Energy Project (IEP) Natural Gas Conversion Analysis*, which estimated the demand for natural gas from the IEP and the associated economic benefits of natural gas conversion.[1] As part of that analysis, Cardno estimated study area residential willingness to convert, which relied upon the cost of converting to natural gas and the estimated savings obtained from converting to natural gas. The saving estimates relied on a natural gas price of $15 per thousand cubic feet (Mcf) and a heating oil price of $4 per gallon, or the equivalent of $29.85 per Mcf.[2]

The Alaska Industrial Development Export Authority (AIDEA) and Alaska Energy Authority (AEA) wish to better understand heating oil price effects upon residential willingness-to-convert estimates. Therefore, the following sensitivity analysis builds upon the previously completed *IEP Natural Gas Conversion Analysis* to estimate single-family residential willingness to convert under various heating oil prices.

1.1 Purpose and Scope

This study estimates single-family residential willingness to convert under a range of heating oil price scenarios. The analysis assumes the same rate of conversion, or the speed in which residences will convert to a natural gas system, as was assumed for the *IEP Natural Gas Conversion Analysis* (**Table 2**). This sensitivity analysis differs from the *IEP Natural Gas Conversion Analysis* in that it does not estimate multi-family, industrial, or commercial users' willingness to convert under various heating oil prices. Finally, this sensitivity analysis does not quantify single-family households' natural gas demand for different heating oil price points.

The study area for this analysis is the proposed natural gas service area surrounding and encompassing Fairbanks and North Pole and includes both the Interior Gas Utility (IGU) and Fairbanks Natural Gas (FNG) service areas. The study area is based on a mock 6-year build-out developed by AEA based on personal communication with the IGU and FNG. Within the study area there are an estimated 20,077 single-family residential households.[3]

1.2 Data Sources

This analysis relied on several key sources of data to estimate the total number of single-family households expected to convert to natural gas. The following key model components and parameters were used in the *IEP Natural Gas Conversion Analysis*, and subsequently in this sensitivity analysis, to estimate study area single-family residential willingness to convert.

- **Willingness-to-convert predictive model** – A survey of 800 Fairbanks North Star Borough (FNSB) residents was conducted as part of the IGU study titled *Natural Gas in the Fairbanks North Star Borough: Results from a Residential Household Survey* (IGU study).[4] The survey elicited respondents' willingness to convert based on different combinations of conversion costs

[1] AIDEA and AEA, January 2014, IEP Natural Gas Conversion Analysis, Website (http://www.interiorenergyproject.com/Resources%20and%20Documents/IEP_Conversion_Analysis_Final.pdf) accessed October 22, 2014.

[2] AIDEA and AEA, July 2013, Interior Energy Project Feasibility Report, Website (http://www.interiorenergyproject.com/Resources%20and%20Documents/Feasibility_Report_72013.pdf) accessed October 20, 2014.

[3] AIDEA and AEA, Personal communication with Lee Elder, Cardno, September 17, 2013.

[4] Interior Gas Utility, November 2013, Natural Gas in the Fairbanks North Star Borough: Results from a Residential Household Survey, Prepared by Northern Economics.

and fuel savings. Responses were statistically analyzed to generate a predictive model for FNSB residents' willingness to convert to natural gas.

- **Primary/secondary heating systems** – The IGU study also solicited survey respondents regarding the number of household heating systems, the types of fuel used for each heating system, and the age of heating systems.
- **Home energy consumption estimates** – To estimate the existing and post-conversion single-family residential unit heating expenditures (and the associated savings) within the study area, this analysis relied on primary and secondary heating system energy consumption estimates provided by the IGU study. These estimates were modified for those households with furnaces to account for hot water energy consumption since it is assumed the conversion to a natural gas boiler or furnace would also include the installation of a natural gas water heater. Energy consumption estimates used in the sensitivity analysis relied on primary/secondary heating system energy consumption as determined by the IGU study. Across all primary/secondary heating systems, the average annual energy consumption for each residential property within the study area was estimated at 161 Mcf.
- **Conversion costs** – Interviews with six regional heating system experts were relied on to develop a range of equipment and installation costs for natural gas conversion. Conversion costs for the study area are defined as the purchase price for a boiler, furnace, space heater, or burner. Conversion costs estimates also include the cost of piping, valves, and labor for full installation of each of these heating systems.
- **Natural gas price** – As provided by the AIDEA and AEA *IEP Natural Gas Conversion Analysis*, the price of natural gas within the study area was assumed to be $15 per Mcf.
- **Case-study analysis and focus groups** – Case studies and focus group input were used to ground-truth willingness-to-convert estimates generated by the IGU study and natural gas predictive model. These case studies assessed willingness to convert in other Alaska communities where natural gas distribution system expansion has recently occurred (e.g., Homer and Kachemak City). Additionally, ENSTAR representatives provided further input on community willingness to convert to natural gas. Finally, a series of four focus groups were conducted in Fairbanks and North Pole to better understand focus group participants' willingness to convert.

2 Methodology

All model parameters, with the exception of heating oil prices, previously used in the *IEP Natural Gas Conversion Analysis* (i.e., primary/secondary heating systems, conversion costs, home energy consumption estimates, heating oil prices, etc.) were held constant for the sensitivity analysis.

The model assumes that heating oil prices for the first year of analysis will equal current heating oil prices for each scenario ($2.75 per gallon).[5] Each of the following scenarios assumed prices in the second and third years would be 10 percent greater or less than current prices (either $2.48 or $3.03 per gallon), while the fourth year would either be current heating oil prices ($2.75 per gallon) or $4.00 per gallon. **Table 1** below illustrates the eight heating oil price scenarios considered within the sensitivity analysis as well as the baseline heating oil price scenario ($4.00 per gallon) evaluated previously in the IEP analysis.

Table 1 FNSB Heating Oil Price Scenarios, dollars per gallon

Scenario	Year 1	Year 2	Year 3	Year 4 and Beyond
#1	$2.75	$2.48	$2.48	$2.75
#2	$2.75	$2.48	$2.48	$4.00
#3	$2.75	$2.48	$3.03	$2.75
#4	$2.75	$2.48	$3.03	$4.00
#5	$2.75	$3.03	$2.48	$2.75
#6	$2.75	$3.03	$2.48	$4.00
#7	$2.75	$3.03	$3.03	$2.75
#8	$2.75	$3.03	$3.03	$4.00
Baseline	$4.00	$4.00	$4.00	$4.00

Research on conversions in Homer indicates that the rate of conversion will be influenced by the construction season, which will affect when natural gas will be available to households and businesses alike. The timing of residential conversions within the study area relies on conversion rate estimates provided by ENSTAR. As illustrated in **Table 2**, ENSTAR expects 60 percent of the total customer base to convert within the first year of a system build-out and approximately 75 percent of the customer base to have converted by the end of the second year. Within 3 years of providing natural gas service to an area, ENSTAR expects approximately 90 percent of the residential housing units to convert, and 95 percent to convert by the seventh year, with no additional conversions thereafter.[6] Stated differently, of those single-family residential properties that are going to convert, all will have done so 7 years following build-out or by year 8.

This analysis assumes that owners of single-family rental properties will be as willing to convert to a natural gas system as owner-occupied single-family properties, but at a slower rate. Therefore, we assume single-family rental owners will take an additional year compared with property owners to fully convert.

[5] Sourdough Fuel, Personal communication with Lee Elder, Cardno, September 9, 2015.

[6] Pierce, Charlie, ENSTAR, Southern Division Manager, Personal communication with Lee Elder, Cardno, September 23, 2013.

Table 2 Estimated Cumulative Residential Rate of Conversion by Year

	Construction (Year 1)[1]	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Single-family residential[2]	15%	60%	75%	90%[3]	93%	95%	98%	100%	100%
Single-family renter-occupied	15%	45%	60%	75%	90%	93%	95%	98%	100%

1 Assumed existing Homer construction year rate of conversion for study area

2 Source (unless noted): Pierce, Charlie, ENSTAR, Southern Division Manager, Personal communication with Lee Elder, Cardno, September 23, 2013.

3 Source: Starring, Coleen, Personal communication with Lee Elder, Cardno, Shanna Zuspan, Agnew::Beck, and Tanya Iden, Agnew::Beck, September 18, 2013.

This analysis assumes that only those households currently using heating oil (92 percent of all study area households) would consider converting to natural gas (i.e., that conversion among those who exclusively use wood or other non-oil sources would be zero percent).[7]

Willingness to convert is a function of conversion costs and estimated annual savings. Willingness-to-convert estimates are generated when applying the heating system conversion cost along with the associated annual savings within the predictive model developed by the IGU study:

$$Pc = 2.43 + (-0.41) \ln Conversion\ Cost + (0.24) \ln Annual\ Savings$$[8]

Pc represents the portion of respondents that would be willing to convert to a natural gas system from their current heating system and "ln" represents the natural logarithm. The price of heating oil is modified within this sensitivity analysis to calculate different annual saving estimates for each of the heating systems, which then feeds into the predictive model function to generate willingness-to-convert estimates.

7 This assumption is supported by recent survey data (Sierra Research, 2013, Wood Tag Survey) indicating that approximately 11 percent of households would continue burning wood, even if natural gas were available at prices less than $1 per gallon equivalent of heating oil, and 26 percent would continue burning wood if natural gas were available at prices below $2 per gallon equivalent of heating oil (projected natural gas prices are approximately $2.15 per gallon equivalent of heating oil).

8 Interior Gas Utility, November 2013, Natural Gas in the Fairbanks North Star Borough: Results from a Residential Household Survey, Prepared by Northern Economics.

3 Results

As illustrated in **Table 3** below, heating oil prices in the FNSB affect residential conversion rates. Scenarios in which heating oil price increases to $4.00 per gallon by the fourth year and remains at that level from that time on (Scenarios 2, 4, 6, and 8) achieve the same residential conversion rates as the baseline scenario. However, up until year 3, heating oil prices of $2.48 and $3.03 per gallon support residential conversion rates of 14 percent and 21 percent, respectively, whereas, a price of $4.00 per gallon supports a residential conversion rate of 25 percent. For those scenarios in which heating oil price remains $2.75 per gallon from year 4 and on (Scenarios 1, 3, 5, and 7) residential conversion rates are expected to be 54 percent by year 13. **Table 4** provides the total cumulative number of residences expected to convert each year for each heating oil price scenario.

Table 3 Cumulative Rates of Residential Conversation (Across All Phases)

Scenario	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
#1	2%	8%	14%	25%	33%	40%	46%	49%	52%	52%	53%	53%	54%
#2	2%	8%	14%	36%	46%	56%	65%	70%	72%	74%	75%	75%	75%
#3	2%	8%	21%	25%	33%	40%	46%	49%	52%	52%	53%	53%	54%
#4	2%	8%	21%	36%	46%	56%	65%	70%	72%	74%	75%	75%	75%
#5	2%	12%	14%	25%	33%	40%	46%	49%	52%	52%	53%	53%	54%
#6	2%	12%	14%	36%	46%	56%	65%	70%	72%	74%	75%	75%	75%
#7	2%	12%	21%	25%	33%	40%	46%	49%	52%	52%	53%	53%	54%
#8	2%	12%	21%	36%	46%	56%	65%	70%	72%	74%	75%	75%	75%
Baseline	3%	14%	25%	36%	46%	56%	65%	70%	72%	74%	75%	75%	75%

Table 4 Cumulative Number of Residential Conversation (Across All Phases)

Scenario	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
#1	460	1,640	2,840	5,110	6,580	8,050	9,270	9,930	10,340	10,510	10,630	10,710	10,750
#2	460	1,640	2,840	7,180	9,250	11,320	13,040	13,980	14,550	14,790	14,960	15,070	15,120
#3	460	1,640	4,130	5,110	6,580	8,050	9,270	9,930	10,340	10,510	10,630	10,710	10,750
#4	460	1,640	4,130	7,180	9,250	11,320	13,040	13,980	14,550	14,790	14,960	15,070	15,120
#5	460	2,380	2,840	5,110	6,580	8,050	9,270	9,930	10,340	10,510	10,630	10,710	10,750
#6	460	2,380	2,840	7,180	9,250	11,320	13,040	13,980	14,550	14,790	14,960	15,070	15,120
#7	460	2,380	4,130	5,110	6,580	8,050	9,270	9,930	10,340	10,510	10,630	10,710	10,750
#8	460	2,380	4,130	7,180	9,250	11,320	13,040	13,980	14,550	14,790	14,960	15,070	15,120
Baseline	640	2,880	5,010	7,180	9,250	11,320	13,040	13,980	14,550	14,790	14,960	15,070	15,120