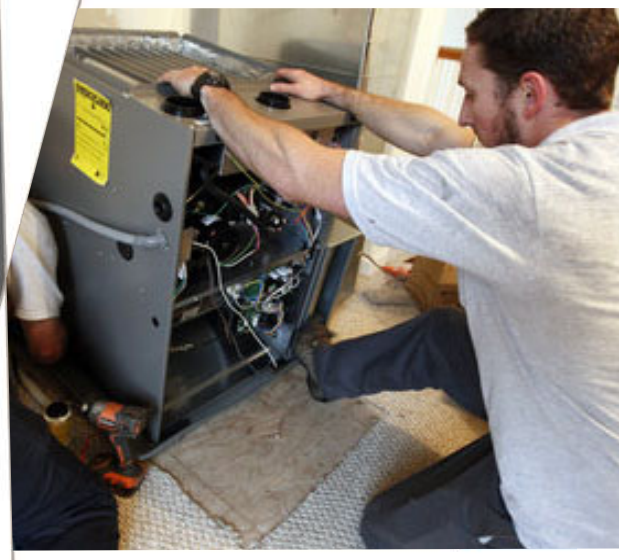
IEP Single-Family Residential Willingness to Convert Price Sensitivity Analysis



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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
WTC	Willingness to Convert

1.1 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 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 natural gas 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 natural gas prices.

1.2 Purpose and Scope

This study estimates single-family residential willingness to convert estimates under a range of natural gas prices. Unlike the *IEP Natural Gas Conversion Analysis*, this sensitivity analysis does not attempt to estimate the speed or rate in which residences will convert to a natural gas system under varying natural gas prices. It merely estimates the percent of households that are willing to convert over an undefined time period. Furthermore, this sensitivity analysis differs from the *IEP Natural Gas Conversion Analysis* in that it does not estimate multi-family, industrial or commercial user's willingness to convert under various natural gas prices. Finally, this sensitivity analysis does not quantify single-family household's natural gas demand for different natural gas 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 area. The study area is based on a mock six-year build-out developed by AEA based upon personal communication with the IGU and FNG. Within the study area there are an estimated 20,077 single-family residential households.[3]

1.3 Data Sources

This analysis relied upon 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 and fuel savings.

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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 ENTRIX, 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.

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 type 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 heating expenditures (and the associated savings) within the study area this analysis relied upon 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 upon primary/secondary heating system energy consumption as determined by the IGU study. It was determined that across all primary/secondary heating systems, the average annual energy consumption for each residential property within the study area is estimated at 161 Mcf.

> **Conversion costs** – Interviews with six regional heating system experts were relied upon 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 install for each of these heating systems.

> **Heating oil price –** As provided by the AIDEA and AEA *Interior Energy Project Feasibility Report*, the price of heating oil within the study area was assumed to be $4 per gallon, which is equivalent to $29.85 per Mcf of natural gas.

> **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 natural gas predictive model. These case studies assessed willingness to convert in other Alaska communities where natural gas distribution system expansion has recently occurred (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.

1.4 Methodology

To conduct the single-family residential willingness to convert price sensitivity analysis, Cardno implemented the following approach:

> All model parameters, with exception of natural gas 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.

> A range of natural gas prices ($14.00 to $29.50 per Mcf) were applied to the underlying single-family residential willingness to convert model previously developed for the *IEP Natural Gas Conversion Analysis*.

Tables 1, 2, and **3** expand upon the analytical approach used to conduct the sensitivity analysis. The first column of **Table 1** identifies the existing primary/secondary heating system by fuel type for study area households. 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 amongst those that exclusively use wood or other non-oil sources would be zero percent).[5]

The second column identifies the most likely natural gas conversion alternative for study area households. This analysis assumed the most likely boiler system conversion (burner switch or a new boiler with a hot water heater) relied upon the age of the existing oil boiler. Boilers ten years old and newer were assumed to be converted through a burner switch, while boilers eleven years or older were assumed to be replaced by a new natural gas boiler with a water heater. Households currently using a furnace are assumed to convert to natural gas by installing a new natural gas furnace with a hot water heater, while households with an existing oil space heater are anticipated to convert by installing a natural gas space heater.

The third column of **Table 1** provides the number of study area households with the identified primary/secondary heating system combination. Column four provides the estimated conversion cost for converting to the likely natural gas conversion alternative. Column five identifies the annual single-family residential household savings obtained from converting to natural gas. Saving estimates, as illustrated in in column five of **Table 1**, are calculated based upon the average household energy consumption estimates, heating oil price of $4 per gallon (or $29.85 per Mcf) and natural gas price of $15 per Mcf. The price of natural gas is modified within this sensitivity analysis to calculate different annual saving estimates for each of the heating systems provided in **Table 1.**

Column six illustrates the willingness to convert estimates generated when applying the conversion cost estimates in column four and annual savings in column five within the predictive model developed by the IGU study;

$$Pc = 2.43 + (-0.41)\ \ln Conversion\ Cost + (0.24)\ \ln Annual\ Savings$$[6]

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.

Column seven identifies the number of single-family households willing to convert within the study area. It is determined by multiplying column three by column six. **Table 2** provides the estimated number of single-family households willing to convert when assuming a natural gas price of $20 per Mcf, while **Table 3** provides the estimated number of single-family households willing to convert assuming a natural gas price of $25 per Mcf.

[5] 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)

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

Table 1 Single-Family Residential Willingness to Convert (Natural Gas priced at $15 Mcf)

Existing Heating System	Assumed Natural Gas Conversion	Households Using Oil	Conversion Cost	Annual Savings (at $15 Mcf)	Percent WTC[1]	Households WTC
Oil/No Secondary						
Baseboard	Burner Switch	4,200	$2,700	$2,260	100%	4,200
Baseboard	New Boiler and Hot Water heater	2,097	$9,100	$2,260	55%	1,145
Furnace	New Furnace and Hot Water heater	1,895	$6,400	$2,200	68%	1,296
Other Oil Heater	New Space Heater	782	$3,100	$1,400	87%	682
Oil/Wood						
Baseboard	Burner Switch	2,744	$2,700	$1,900	100%	2,744
Baseboard	New Boiler and Hot Water heater	1,370	$9,100	$1,900	50%	691
Furnace	New Furnace and Hot Water heater	1,238	$6,400	$2,500	71%	885
Other Oil Heater	New Space Heater	511	$3,100	$1,400	87%	446
Wood/Oil						
Baseboard	Burner Switch	298	$2,700	$1,500	95%	282
Baseboard	New Boiler and Hot Water heater	149	$9,100	$1,500	45%	67
Furnace	New Furnace and Hot Water heater	263	$6,400	$1,900	65%	171
Other Oil Heater	New Space Heater	1,237	$3,100	$1,500	89%	1,100
Oil/Other						
Baseboard	Burner Switch	658	$2,700	$1,900	100%	658
Baseboard	New Boiler and Hot Water heater	328	$9,100	$1,900	50%	166
Furnace	New Furnace and Hot Water heater	297	$6,400	$2,500	71%	212
Other Oil Heater	New Space Heater	122	$3,100	$1,400	87%	107
Other/Oil						
Baseboard	Burner Switch	55	$2,700	$900	82%	46
Baseboard	New Boiler and Hot Water heater	28	$9,100	$900	33%	9
Furnace	New Furnace and Hot Water heater	49	$6,400	$3,600	80%	39
Other Oil Heater	New Space Heater	230	$3,100	$300	50%	115
Total		18,551				15,059
% of Single-Family Households (20,077)		92%				75%

Table 2 Single-Family Residential Willingness to Convert (Natural Gas priced at $20 Mcf)

Existing Heating System	Assumed Natural Gas Conversion	Households Using Oil	Conversion Cost	Savings (at $20 Mcf)	Percent WTC	Estimated WTC
Oil/No Secondary						
Baseboard	Burner Switch	4,200	$2,700	$1,500	95%	3,972
Baseboard	New Boiler and Hot Water heater	2,097	$9,100	$1,500	45%	939
Furnace	New Furnace and Hot Water heater	1,895	$6,400	$1,400	58%	1,090
Other Oil Heater	New Space Heater	782	$3,100	$900	77%	600
Oil/Wood						
Baseboard	Burner Switch	2,744	$2,700	$1,200	89%	2,448
Baseboard	New Boiler and Hot Water heater	1,370	$9,100	$1,200	39%	540
Furnace	New Furnace and Hot Water heater	1,238	$6,400	$1,600	61%	752
Other Oil Heater	New Space Heater	511	$3,100	$900	77%	392
Wood/Oil						
Baseboard	Burner Switch	298	$2,700	$1,000	85%	253
Baseboard	New Boiler and Hot Water heater	149	$9,100	$1,000	35%	52
Furnace	New Furnace and Hot Water heater	263	$6,400	$1,300	56%	147
Other Oil Heater	New Space Heater	1,237	$3,100	$1,000	79%	979
Oil/Other						
Baseboard	Burner Switch	658	$2,700	$1,200	89%	587
Baseboard	New Boiler and Hot Water heater	328	$9,100	$1,200	39%	129
Furnace	New Furnace and Hot Water heater	297	$6,400	$1,600	61%	180
Other Oil Heater	New Space Heater	122	$3,100	$900	77%	94
Other/Oil						
Baseboard	Burner Switch	55	$2,700	$600	73%	40
Baseboard	New Boiler and Hot Water heater	28	$9,100	$600	23%	6
Furnace	New Furnace and Hot Water heater	49	$6,400	$2,400	70%	34
Other Oil Heater	New Space Heater	230	$3,100	$200	41%	93
Total		18,551				13,328
% of Single-Family Households (20,077)		92%				66%

Table 3 Single-Family Residential Willingness to Convert (Natural Gas priced at $25 Mcf)

Existing Heating System	Assumed Natural Gas Conversion	Households Using Oil	Conversion Cost	Savings (at $25 Mcf)	Percent WTC	Estimated WTC
Oil/No Secondary						
Baseboard	Burner Switch	4,200	$2,700	$740	78%	3,260
Baseboard	New Boiler and Hot Water heater	2,097	$9,100	$740	28%	583
Furnace	New Furnace and Hot Water heater	1,895	$6,400	$700	41%	775
Other Oil Heater	New Space Heater	782	$3,100	$500	63%	489
Oil/Wood						
Baseboard	Burner Switch	2,744	$2,700	$600	73%	1,992
Baseboard	New Boiler and Hot Water heater	1,370	$9,100	$600	23%	312
Furnace	New Furnace and Hot Water heater	1,238	$6,400	$800	44%	546
Other Oil Heater	New Space Heater	511	$3,100	$500	63%	320
Wood/Oil						
Baseboard	Burner Switch	298	$2,700	$500	68%	204
Baseboard	New Boiler and Hot Water heater	149	$9,100	$500	18%	27
Furnace	New Furnace and Hot Water heater	263	$6,400	$600	37%	98
Other Oil Heater	New Space Heater	1,237	$3,100	$500	63%	774
Oil/Other						
Baseboard	Burner Switch	658	$2,700	$600	73%	477
Baseboard	New Boiler and Hot Water heater	328	$9,100	$600	23%	75
Furnace	New Furnace and Hot Water heater	297	$6,400	$800	44%	131
Other Oil Heater	New Space Heater	122	$3,100	$500	63%	77
Other/Oil						
Baseboard	Burner Switch	55	$2,700	$300	56%	31
Baseboard	New Boiler and Hot Water heater	28	$9,100	$300	6%	2
Furnace	New Furnace and Hot Water heater	49	$6,400	$1,200	54%	26
Other Oil Heater	New Space Heater	230	$3,100	$100	24%	55
Total		18,551				10,252
% of Single-Family Households (20,077)		92%				51%

1.5 Results

The approach described in Section 1.3 above was replicated for various natural gas prices, ranging from $14.00 to $29.50, which generated a range of willingness to convert estimates for single-family households within the study area. As illustrated in **Table 4** below, as the price of natural gas increases, fewer single-family households within the study area are willing to convert to natural gas. **Figure 1** provides a graphical representation of natural gas prices and the corresponding single-family residential willingness to convert to natural gas.

Table 4 Single-Family Residential Willingness to Convert at Select Natural Gas Prices

Natural Gas Price (Mcf)	Single-Family Residential Willingness to Convert	Number of Single-Family Households Willing to Convert	Annual Single-Family Savings (Weighted Average of those Willing to Convert)
$14.00	75.7%	15,200	$2,123
$15.00	75.0%	15,060	$2,006
$16.00	73.5%	14,760	$1,846
$17.00	72.4%	14,530	$1,718
$18.00	70.7%	14,200	$1,593
$19.00	69.0%	13,850	$1,468
$20.00	66.4%	13,330	$1,306
$21.00	64.3%	12,910	$1,187
$22.00	61.7%	12,390	$1,053
$23.00	58.9%	11,830	$933
$24.00	55.1%	11,070	$788
$25.00	51.1%	10,250	$653
$26.00	46.4%	9,320	$527
$27.00	40.3%	8,090	$397
$28.00	29.5%	5,930	$244
$29.00	16.2%	3,260	$114
$29.50	2.7%	540	$50

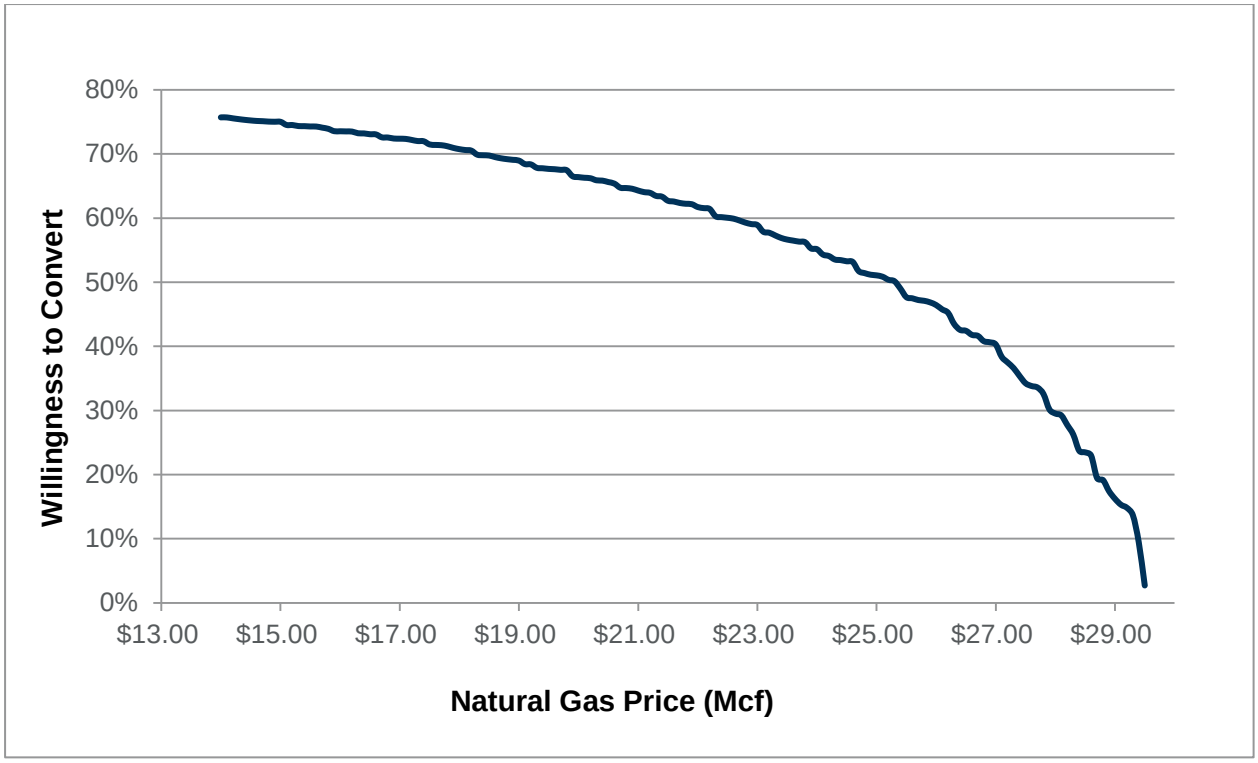

Figure 1 Single-Family Residential Willingness to Convert at Select Natural Gas Prices