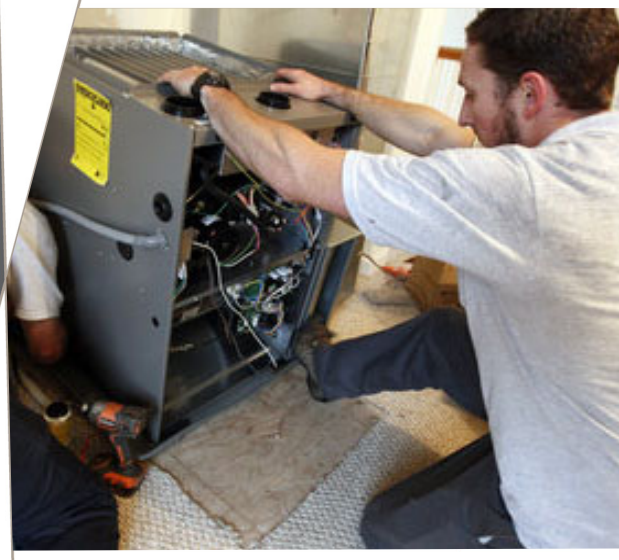
IEP Natural Gas Conversion Analysis

Fairbanks LNG Distribution System Demand Analysis



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Acronyms

ACS	American Community Survey
ADEC	Alaska Department of Environmental Conservation
ADOT	Alaska Department of Transportation
AEA	Alaska Energy Authority
AFB	Air Force Base
AIDEA	Alaska Industrial Development and Export Authority
Bcf	billion cubic feet
BTU	british thermal unit
CCHRC	Cold Climate Housing Research Center
CEO	Chief Executive Officer
CFO	Chief Financial Officer
C-R	concentration-response
DSIRE	Database of State Incentives for Renewables and Efficiency
EPA	Environmental Protection Agency
FNG	Fairbanks Natural Gas

FNSB	Fairbanks North Star Borough
HDD	heating degree days
IEP	Interior Energy Project
IGU	Interior Gas Utility
LNG	Liquefied Natural Gas
Mcf	thousand cubic feet
MO	carbon monoxide
MTP	Metropolitan Transportation Plan
NAAQS	National Ambient Air Quality Standards
NOx	nitrous oxide
OAQPS	Office of Air Quality Planning and Standards
PM	particulate matter
RA	risk assessment
RAMS	Relocatable Air Monitoring System
RCA	Regulatory Commission of Alaska
SIP	State Air Quality Improvement Plan
TIP	Transportation Improvement Plan
UAF	University of Alaska Fairbanks
VOC	volatile organic carbons
WTC	Willingness to Convert

Executive Summary

On April 12, 2013, the Alaska Legislature approved the Interior Energy Project (IEP) (SB 23), which provides a financing package to start the development of a natural gas conditioning and liquefaction plant on the North Slope. Additionally, the IEP provides for the initial financing of Liquefied Natural Gas (LNG) storage, re-gasification, and distribution to bring natural gas to customers within the high and medium density areas of the Fairbanks North Star Borough (FNSB).

The purpose of this analysis is to estimate the demand for natural gas from the IEP and the associated economic benefits of natural gas conversion. Evaluating the total demand for natural gas provides project developers and financers a clearer understanding of expected project revenues.

The scope of the study includes estimating the rate at which both FNSB residents and businesses would convert their existing heating systems to natural gas once the IEP is developed. The scope of the study also includes identifying the total demand for natural gas and the economic benefits of natural gas conversion. These benefits include air quality improvements from reduced $PM_{2.5}$ emissions and lower heating fuel costs.

The study area for this analysis is the proposed natural gas service area surrounding and encompassing Fairbanks and North Pole. The study area is based on a mock six-year build-out for FNG and the IGU developed by Alaska Energy Authority (AEA). Natural gas demand estimates are derived for single-family residential, multi-family residential, commercial businesses and industrial businesses. Chief information sources include data on the use of natural gas in other communities, recent natural gas conversion rates in Homer Alaska, interviews with FNSB businesses, results from the IGU Report titled *Natural Gas in the Fairbanks North Star Borough: Results from a Residential Household Survey*, and a series of focus groups conducted in Fairbanks and North Pole. Information on actual natural gas in other communities, and particularly, the data on recent conversion rates in Homer Alaska, was heavily relied upon to provide a reality check and calibration point for the Fairbanks estimate.

Table ES.1 below provides the estimated annual natural gas demand within the study area. The existing 0.9 Bcf of annual FNG natural gas consumed within the FNG service area is expected to be 1.1 Bcf if the existing interruptible customers were allowed to use natural gas year round. This 1.1 Bcf of existing FNG natural gas demand was combined with the anticipated demand from conversions and included in the final column of **Table ES.1** to account for all anticipated natural gas demand within the study area. We assume that existing FNG demand within the service area remains constant at 1.1 Bcf between Year 0 (year IEP construction starts) and Year 12.

Table ES.1 Total Natural Gas Demand, Buildout Areas and Existing FNG Customers (Bcf)

Year	Demand From Conversions	Demand from Conversions and from Existing FNG Customers (assuming uninterrupted)
Year 0	0.66	1.77
Year 1	3.06	4.17
Year 2	3.97	5.09
Year 3	4.91	6.02
Year 4	5.34	6.45
Year 5	5.70	6.81
Year 6	6.01	7.12

Year	Demand From Conversions	Demand from Conversions and from Existing FNG Customers (assuming uninterrupted)
Year 7	6.16	7.28
Year 8	6.26	7.37
Year 9	6.30	7.41
Year 10	6.33	7.44
Year 11	6.35	7.46
Year 12	6.36	7.47

Notes: Each year includes existing FNG natural gas demand and assumes constant 2012 demand

Table ES.2 provides anticipated annual natural gas demand for each natural gas utility located within the service area. Results are provided over a 12-year period since it is anticipated that all of those willing to convert will do so by the twelfth year. The annual natural gas demand for each utility provided below assumes that expansion of the FNG service area will begin one year prior to the IGU system. IGU could very well begin construction in the same year as FNG and in that case the timing of natural gas demand for IGU would begin in Year 0 rather than Year 1.

Table ES.2 Natural Gas Demand by Service Area and Demand Type (Bcf)

	Year												
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
FNG													
Single-family residential	0.1	0.4	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Multi-family	0.1	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Commercial	0.4	1.7	2.0	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Total FNG from conversions	0.5	2.3	2.8	3.3	3.3	3.3	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Total FNG including existing customers and uninterrupted demand	*1.6*	*3.4*	*3.9*	*4.4*	*4.4*	*4.4*	*4.5*	*4.5*	*4.5*	*4.5*	*4.5*	*4.5*	*4.5*
IGU													
Single-family residential	0.0	0.1	0.3	0.5	0.8	1.1	1.3	1.5	1.6	1.6	1.6	1.6	1.7
Multi-family	0.0	0.0	0.1	0.1	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4
Commercial	0.0	0.0	0.2	0.5	0.7	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0
Total IGU	*0.0*	*0.1*	*0.6*	*1.2*	*1.8*	*2.3*	*2.6*	*2.8*	*2.9*	*2.9*	*2.9*	*3.0*	*3.0*

Demographics and Conversion Rates

FNSB demographic characteristics may affect homeowner ability to pay and/or their ability to recoup investment costs, and thus may affect conversion rates. These demographic characteristics include the proportion of home ownership versus rental properties, income levels, and population mobility. These factors may influence the number of households and businesses that might convert within the study area. For example, single-family rentals may have lower conversion rates, or may convert more slowly because heating fuel savings benefit the renter, while the cost of the conversion is borne by the landlord. Further, low income homeowners within the study area could have lower conversion rates, while high income households could better afford the costs of conversion. Finally, the mobility of study area population could

influence a person's willingness to convert since highly mobile residents may not be in the home long enough to recoup the cost of the heating system conversion. Due to the University and the military presence in Fairbanks, mobility is higher than in other Alaska communities, which would tend to decrease conversion rates.

Economics of Conversion in Fairbanks

The decision to convert household and business heating systems will largely depend on three cost factors: capital cost of installing a natural gas heating system, annual fuel cost savings and the associated repayment time period (the time required to recoup the initial capital cost investment). Capital costs vary by household or business, and depend largely on existing heating system age and type. Cost savings also depend on type of fuel system, as well as total energy use. Regardless of cost savings of conversion, the availability of savings and/or loans to pay for the capital cost of conversion will also influence conversion rates.

The factors influencing businesses to convert to natural gas are the same as residential properties. A recent global survey of CEOs, CFOs, real estate leaders, and facility managers found that nearly 50 percent of executives require a three-year simple payback period to make significant energy efficiency investments in the buildings they own or manage. Only 5 percent require a payback of a year or less, while 90 percent of businesses require a ten-year payback period or less.[1] Other research finds that small/medium businesses, housing communities, and schools prefer a three to five year payback period on energy efficiency improvements.[2]

Table ES.3 summarizes the range of capital costs, savings, and repayment periods estimated for FNSB households located in the proposed build-out area. As shown in the table, the conversion costs are recouped in fuel savings within 1.8 to 10.3 years, with nearly all households recouping conversion costs within five years (not accounting for interest costs or time value of money).

Table ES.3 Study Area Heating System Capital Costs, Savings, and Simple Payoff Period

Existing Primary/ Secondary Systems	Prim./Sec. Systems (% of FNSB Hhlds)	Oil Heating System Types	Annual Savings	House holds	Average Convt. Cost	Payoff Period (Years)
Oil/No Secondary	44.7%	Baseboard Burner Switch	$2,300	4,200	$2,700	1.2
		Baseboard Replacement	$2,300	2,097	$9,100	4.0
		Furnace	$2,200	1,895	$6,400	2.9
		Other oil heater	$1,400	782	$3,100	2.2
Oil/Wood	29.2%	Baseboard Burner Switch	$1,900	2,744	$2,700	1.4
		Baseboard Replacement	$1,900	1,370	$9,100	4.8

[1] Johnson Controls, June 3, 2010, Johnson Controls 2010 Energy Efficiency Indicator Global Survey Results, Website ((http://pacenow.org/wp-content/uploads/2012/07/EEI-2010-Global-Executive-Summary-ENG.pdf) accessed December 13, 2013.

[2] Daswani, Rahul, Hong, Erick, Levitte,, Benjamin and Clara Suh, May 15, 2013, Hope Energy, Designing a Methodology to help Develop Customized, Optimal Energy Technology Solutions, Website (http://mitsloan.mit.edu/actionlearning/media/documents/s-lab-projects/HopeEnergy-Report-2013.pdf) accessed December, 13, 2013.

Existing Primary/ Secondary Systems	Prim./Sec. Systems (% of FNSB Hhlds)	Oil Heating System Types	Annual Savings	House holds	Average Convt. Cost	Payoff Period (Years)
		Furnace	$2,500	1,238	$6,400	2.6
		Other oil heater	$1,400	511	$3,100	2.2
Wood/Oil	9.7%	Baseboard Burner Switch	$1,500	298	$2,700	1.8
		Baseboard Replacement	$1,500	149	$9,100	6.1
		Furnace	$1,900	263	$6,400	3.4
		Other oil heater	$1,500	1,237	$3,100	2.1
Oil/Other	7.0%	Baseboard Burner Switch	$1,900	658	$2,700	1.4
		Baseboard Replacement	$1,900	328	$9,100	4.8
		Furnace	$2,500	297	$6,400	2.6
		Other oil heater	$1,400	122	$3,100	2.2
Other/Oil	1.8%	Baseboard Burner Switch	$900	55	$2,700	3.0
		Baseboard Replacement	$900	28	$9,100	10.1
		Furnace	$3,600	49	$6,400	1.8
		Other oil heater	$300	230	$3,100	10.3

Forecast Conversion Rates

Both the total number of eventual natural gas customers, as well as the timing of conversion has implications for the financing and economic benefits of the IEP. Conversion rates for residential households are estimated as a range based on the IGU willingness to convert predictive model together with our analysis of capital costs and fuel savings to predict the number of households that would convert within each project Phase. We test the predictive ability of the IGU model by applying it to Homer, Alaska and comparing results to actual, observed willingness to convert rates. Applying the IGU model to the Homer area, using fuel cost and heating system data specific to Homer and accounting for other factors that vary between Homer and Fairbanks, indicates that the IGU model (Method A) is a good predictor (likely within 5 percent) of conversion rates. Multi-family residential structures are assumed to have the same conversion rates as single family residential, while 100 percent of commercial and industrial businesses are expected to convert.

Table ES.4 below provides the total expected number of single-family residential, multi-family residential and commercial/industrial businesses within each phase expected to convert each year. It is expected that by Year 12 all of those willing to convert within each phase will have done so. An estimated 77 percent of the combined single-family residential, multi-family residential and commercial/industrial businesses within the proposed service area are expected to convert by Year 12.

Table ES.4 Expected Annual Conversion Rate for Single-Family Residential, Multi-Family Residential, and Commercial/Industrial

Phase	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
Phase 1 (Const. Year 0)	810	3,260	4,070	4,860	5,060	5,170	5,270	5,380	5,390	5,390	5,390	5,390	5,390
Phase 2 (Const. Year 1)	0	450	1,740	2,190	2,630	2,760	2,830	2,900	2,970	2,980	2,980	2,980	2,980
Phase 3 (Const. Year 2)	0	0	310	1,210	1,510	1,820	1,910	1,950	2,000	2,050	2,060	2,060	2,060
Phase 4 (Const. Year 3)	0	0	0	340	1,360	1,700	2,040	2,130	2,180	2,230	2,280	2,280	2,280
Phase 5 (Const. Year 4)	0	0	0	0	350	1,380	1,730	2,080	2,180	2,240	2,300	2,350	2,360
Phase 6 (Const. Year 5)	0	0	0	0	0	300	1,160	1,450	1,750	1,830	1,880	1,930	1,980
Total Single-Family	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
Rate of Conversion	*3%*	*14%*	*25%*	*36%*	*46%*	*56%*	*65%*	*70%*	*72%*	*74%*	*74%*	*75%*	*75%*
Total	810	3,710	6,120	8,590	10,920	13,120	14,930	15,900	16,470	16,720	16,880	17,000	17,050
Rate of Conversion	*4%*	*17%*	*28%*	*39%*	*50%*	*60%*	*68%*	*72%*	*75%*	*76%*	*77%*	*77%*	*77%*

Expected Conversion Demand, Fuel Cost Savings, and Benefits

Table ES.5 summarizes the findings on natural gas demand, fuel cost savings, and the net benefits due to natural gas availability in the study area. The net present value of fuel cost savings is estimated at $835.1 million. Increasing the number of household conversions may reduce the price of natural gas by spreading the fixed investment costs of the LNG plant, storage, regasification and distribution over more units of natural gas sold. This could increase the benefits (and net present value) of natural gas being available within the study area.

Table ES.5 Net Present Value of Conversions

Scenario	Final Fuel Demand (Bcf, Year 12 +)	Fuel Cost Savings (Present Value, $ million)	Net Present Value ($ million)
No Incentives	6.4	$835.1	$835.1

Air Quality Effects and Timing

The EPA sets standards for air quality (National Ambient Air Quality Standards, NAAQS), including standards for particulate matter (PM) concentrations. Ambient concentrations of PM in Fairbanks exceed federal air quality standards for PM smaller than 2.5 micrometers ($PM_{2.5}$) such that in December 2009 FNSB was designated a nonattainment area for $PM_{2.5}$. A primary source of $PM_{2.5}$ in the FNSB borough is residential heating. Of the primary fuel sources in use in Fairbanks (oil, wood, and natural gas), the use of natural gas results in the lowest levels of PM emissions.

In the absence of air quality modeling specific to this analysis, we provide rough estimates based on existing data of how $PM_{2.5}$ emissions in the Fairbanks area may be reduced with conversion of residential heating to natural gas. We estimate how air quality in Fairbanks may be improved, in terms of $PM_{2.5}$ concentrations and tons of emissions, due to the conversion of residential heating to natural gas. We make several simplifying assumptions. For example, we assume that air quality concentrations in the non-attainment area will decrease linearly with the decrease in wood burning. We also assume that the air quality improvement will be uniform across the non-attainment area, and not vary spatially.

As summarized in **Table ES.6**, based on ADEC data and our estimates of the numbers of households converting and their energy use pre and post-conversion, we expect access to natural gas will result in reduced air emissions of approximately 32 percent, which we estimate to equate to approximately 234 tons of reduced annual $PM_{2.5}$ emissions.

Table ES.6 Emission Reduction Achieved by Year

Year	Low Estimate (Method A)	High Estimate (Method B)	Tons of $PM_{2.5}$ Per Year
0	5%	5%	5.2
1	18%	19%	19.6
2	22%	23%	26.0
3	27%	28%	35.8
4	28%	30%	44.5
5	29%	31%	56.9
6	30%	31%	76.4
7	31%	32%	117.1
8	31%	32%	234.2

Air Quality Benefits

The benefits of lower concentrations of $PM_{2.5}$ in the FNSB are primarily related to health benefits and improved visibility. There may also be benefits due to safeguarding federal highway and transit funding, and potential decreased permitting and operating costs for emitting facilities.

Based on previous studies, as well as EPA recognized damage functions to estimate impacts of PM on health, we identify the potential magnitude of health and other benefits from improved air quality in FNSB. These studies indicate that there is a high value of air quality improvement in FNSB, possibly in the range of $64 million to $200 million (based on studies of the effect of air quality on property values, which can include both health and visibility benefits), to $66 to $172 million based on reduced all-cause mortality benefits. The range of possible benefits are quite large due to the significant uncertainty regarding the applicability of previous studies to the Fairbanks context, and the wide range of values found in the literature.

1 Introduction

On April 12, 2013, the Alaska Legislature approved the Interior Energy Project (IEP) (SB 23), which provides a financing package to start the development of a natural gas conditioning and liquefaction plant on the North Slope. Additionally, the IEP provides for the financing of Liquefied Natural Gas (LNG) storage, re-gasification, and distribution to bring natural gas to customers in the Fairbanks North Star Borough (FNSB).

AIDEA's involvement in IEP includes possible participation in the ownership and financing of an LNG plant on the North Slope, along with authorization to issue up to $150 million of bonds to help facilitate the expansion of piped natural gas distribution in the high and medium density areas of the Fairbanks North Star Borough. The distribution components may contain LNG storage, re-gasification, and distribution piping.

To better understand project benefits and financing risks, AIDEA requires a better understanding of the residential and commercial demand for natural gas and the rate of conversion from existing oil and wood heating systems in the Fairbanks area. Furthermore, AIDEA wishes to have a better understanding of the potential project benefits including energy cost savings as well as benefits associated with anticipated improvements to air quality resulting from conversion to natural gas, which is a cleaner fuel source than oil or wood.

The Regulatory Commission of Alaska (RCA) has determined that two natural gas utilities will serve the broader Fairbanks and North Pole Area. Currently, approximately 1,100 natural gas customers within the core area of Fairbanks are served by the Fairbanks Natural Gas (FNG) natural gas utility. FNG purchases gas from the Cook Inlet area of Alaska and once liquefied, transports it by trucks to Fairbanks where it is stored and re-gassed for distributed to customers. The Interior Gas Utility (IGU) is a municipal owned utility formed in 2012 by the FNSB, City of Fairbanks and the City of North Pole with the intention to bring natural gas to an area outside of the existing FNG service area. Although FNG and IGU both expressed interested in providing natural gas service to the area surrounding the existing FNG service area, the exclusive rights to serve this "expansion area" were awarded to IGU by the RCA. The RCA is a state agency which provides a utility the right to serve an area and regulates rates, services, and practices within Alaska.

The development of an expanded natural gas distribution system in the Fairbanks/North Pole area is a critical component of the IEP. The IEP would finance a natural gas conditioning and liquefaction plant on the North Slope and also a LNG storage, re-gasification, and distribution system to bring natural gas to FNSB households. The development of the IEP would provide two major benefits to FNSB residents: 1) residential and business heating cost savings, and 2) improved air quality.

Preliminary IEP natural gas cost estimates for providing gas to the "burner tip" in the FNSB is expected to range between $14.59 and $17.09 per Mcf[3], or roughly half the cost of heating with fuel oil.[4] The lower heating fuel price for natural gas would translate into cost savings for FNSB homeowners. The level of savings would vary by household or business depending on fuel demand, which in turn varies based on a

[3] Therriault, Gene and Mark Davis, September 4, 2013, Interior Energy Project: Brining North Slope Natural Gas to Alaskans, Website (http://www.alaskaalliance.com/servlet/content/presentations.html) accessed October 1, 2013.

[4] Calculation assumes heating oil cost of $4 per gallon and that oil generates 134,000 Btu per gallon, while natural gas generates 1,000 Btu per cubic foot.

number of factors, including system efficiency, climate, and the number of days using the heating system.[5]

Replacing wood and oil heating systems with natural gas will also improve FNSB air quality. The US Environmental Protection Agency (EPA) designated portions of the FNSB as a non-attainment area for fine particulate matter ($PM_{2.5}$) on December 14, 2009.[6] The deadline for the FNSB to meet EPA air quality standards and to achieve attainment is currently December 14, 2014.[7]

A major contributor to fine particulate pollution is the use of wood and fuel oil as residential heating fuel.[8] Oil furnaces generate approximately 0.013 pounds (lbs) of $PM_{2.5}$/MMBtu of heat output, while certified wood stoves and uncertified wood stoves generate approximately 1.4 and 4.6 lbs. of $PM_{2.5}$/MMBtu. Conversely, natural gas generates approximately 0.0083 lbs. of $PM_{2.5}$/MMBtu of heat output, which is less than half the $PM_{2.5}$ generated by oil.[9]

A recent survey of Fairbank households determined that approximately three percent of homes in Fairbanks use natural gas natural gas as a primary or secondary heating fuel.[10] Conversely, 92 percent of homes in Fairbanks use heating oil as a primary or secondary heating fuel. Currently, natural gas is available to only approximately 1,100 Fairbanks households.[11]

Increasing household access to natural gas is a necessary step, but access alone may not result in households converting to natural gas as their primary heating fuel. While the cost of heating with natural gas in FNSB is expected to be approximately one-half the price[12] of heating oil, and natural gas can be much less labor intensive than heating with wood, the sizeable capital cost of purchasing and installing gas furnaces is potentially a major hurdle to conversion.

1.1 Purpose and Scope

The purpose of this analysis is to estimate the demand for natural gas from the IEP and the associated economic benefits of natural gas conversion. Evaluating the total demand for natural gas provides project developers and financers a clearer understanding of expected project revenues.

The scope of the study includes estimating the rate at which both FNSB residents and businesses would convert their existing heating systems to natural gas once the IEP is developed. The scope of the study also includes identifying the total economic benefits of natural gas conversion. These benefits include air quality improvements from reduced $PM_{2.5}$ emissions and lower heating fuel costs.

The study area for this analysis is the proposed natural gas service area surrounding and encompassing Fairbanks and North Pole (see **Figure 2.1**). The study area is based on a mock six-year build-out

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5 Therriault, Gene and Mark Davis, September 4, 2013, Interior Energy Project: Bringing North Slope Natural Gas to Alaskans, Website (http://www.alaskaalliance.com/servlet/content/presentations.html) accessed October 1, 2013.

6 State of Alaska, Particulate Matter, Website (http://www.dec.state.ak.us/air/anpms/pm/pm_plan.htm) accessed September 12, 2013.

7 Ibid.

8 Davis, John, Misiuk, David, Colgan, Ryan, and Nathan Wiltse, February 23, 2009, Reducing $PM_{2.5}$ Emissions from Residential Heating Sources in the Fairbanks North Star Borough, Website (http://cchrc.org/docs/reports/$PM_{2.5}$_Final_2-23-09.pdf) accessed September 12, 2013.

9 EPA, Consumers – Energy Efficiency and Wood –Burning Stoves and Fireplaces, Website (http://www.epa.gov/burnwise/energyefficiency.html)

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

11 Fairbanks Natural Gas, LLC., FNG Announces LNG Storage, Website (http://www.fngas.com/) accessed September 12, 2013.

12 Therriault, Gene and Mark Davis, September 4, 2013, Interior Energy Project: Bringing North Slope Natural Gas to Alaskans, Website (http://www.alaskaalliance.com/servlet/content/presentations.html) accessed October 1, 2013.

developed by Alaska Energy Authority (AEA) based upon personal communication with IGU and FNG. The build out area and the associated customer base for each phase of the project will ultimately depend on how each utility develops their service area.

1.2 Data Sources & Methods Overview

This analysis estimates natural gas demand for single-family residential, multi-family residential, commercial businesses and industrial businesses. This analysis relied upon several sources of data to estimate the total number of households and businesses expected to convert, and the timing of conversion by location: use of natural gas in other communities, recent natural gas conversion rates in Homer Alaska, interviews with FNSB businesses, results from the IGU Report titled *Natural Gas in the Fairbanks North Star Borough: Results from a Residential Household Survey*, and a series of focus groups conducted in Fairbanks and North Pole. Information on actual natural gas in other communities, and particularly, the data on recent conversion rates in Homer Alaska, was heavily relied upon to provide a reality check and calibration point for the Fairbanks estimate.

Our methodology to estimate residential rates of conversion included gathering and analyzing the following information for both Fairbanks and Homer (as a point of comparison with recent natural gas conversion).

> Number of potential single-family residential, multi-family residential, commercial, and industrial structures within each project phase.

> Demographic characteristics that may affect interest in conversion and rate of conversion.

> Distribution of existing primary and secondary heating systems for households and associated required capital equipment upgrades for natural gas usage.

> Capital costs of converting existing heating systems to natural gas heating systems.

> Annual homeowner savings from heating system conversions.

> Conversion rates from IGU survey, other communities conversion experience and use of natural gas, and focus groups

We synthesize this data to estimate the rate of conversion for residential and commercial property owners. We then analyze the effect of natural gas conversion on air quality, and estimate the value of air quality improvements in terms of improved health and describe other quality of life benefits. We draw from various information sources, including published data and information on air quality, environmental health, and economics literature; and local interviews with economic development organizations and private sector entities.

1.3 Organization

This report contains seven additional chapters and six Appendices. Chapter 2 provides FNSB demographic characteristics that may affect homeowner ability to pay and/or their ability to recoup investment costs, and thus may affect conversion rates. Chapter 3 provides the sources, data, and findings regarding the conversion costs and fuel savings for residents of each phase of the build out. Chapter 4 describes previous research and empirical data on how quickly natural gas systems are installed in residential homes and businesses once natural gas service is available. Chapter 5 presents estimates of willingness of residents and businesses to convert (at any time in the future), and their expected rate or speed of conversion. Chapter 6 provides the expected benefits of conversion, while Chapter 7 highlights how conversions to natural gas will affect air quality in the study area and Chapter 8 estimates the economic benefits of these air quality improvements.

2 Demographics and Primary Home Heating Fuel

This section presents and analyzes FNSB demographic characteristics that may affect homeowner ability to pay and/or their ability to recoup investment costs, and thus may affect conversion rates. These demographic characteristics include the proportion of home ownership versus rental properties, income levels, and population mobility.

These factors may influence the number of households and businesses that might convert within the study area. For example, single-family rentals may have lower conversion rates, or may convert more slowly because heating fuel savings benefit the renter, while the cost of the conversion is borne by the landlord. Further, low income homeowners within the study area could have lower conversion rates, while high income households could better afford the costs of conversion. Finally, the mobility of study area population could influence a person's willingness to convert since highly mobile residents may not be in the home long enough to recoup the cost of the heating system conversion.

Data are presented for the FNSB, and also for other communities in Alaska with natural gas service, or recent conversion to natural gas. Data are also presented for the State of Alaska and the Nation for comparison. This section primarily relies on data from the 2007-2011 American Community Survey (ACS) [13], but also from other local and federal sources such as the FNSB Community Research Center, the US Air Force, and the Department of Defense.

2.1 Study Area

The study area for this analysis is the natural gas service areas surrounding and encompassing Fairbanks and North Pole. The study area is based on a mock six-year build-out for FNG and the IGU developed by Alaska Energy Authority (AEA). The study area for this analysis is denoted by the area located within the green boundary (proposed IGU buildout area) and the red hashed area (existing FNG service area) in **Figure 2.1** below. The FNG service area is located within the core area of Fairbanks and includes the neighborhoods of Downtown Fairbanks, University, and also portions of the Airport and Wainwright neighborhoods. The proposed IGU buildout area includes North Pole, Eielson, Steese and portions of Downtown Fairbanks, Wainwright, and the Airport neighborhoods.

[13] The ACS was developed to obtain the same information previously collected on the long-form questionnaire of the 2000 Census, but more frequently than every 10 years. In contrast to previous censuses, the 2010 Census did not collect income and poverty information, so the most recent data for these socioeconomic indicators is from the ACS 2007-2011. Reported ACS estimates should be interpreted as average values over the 2007 to 2011 period

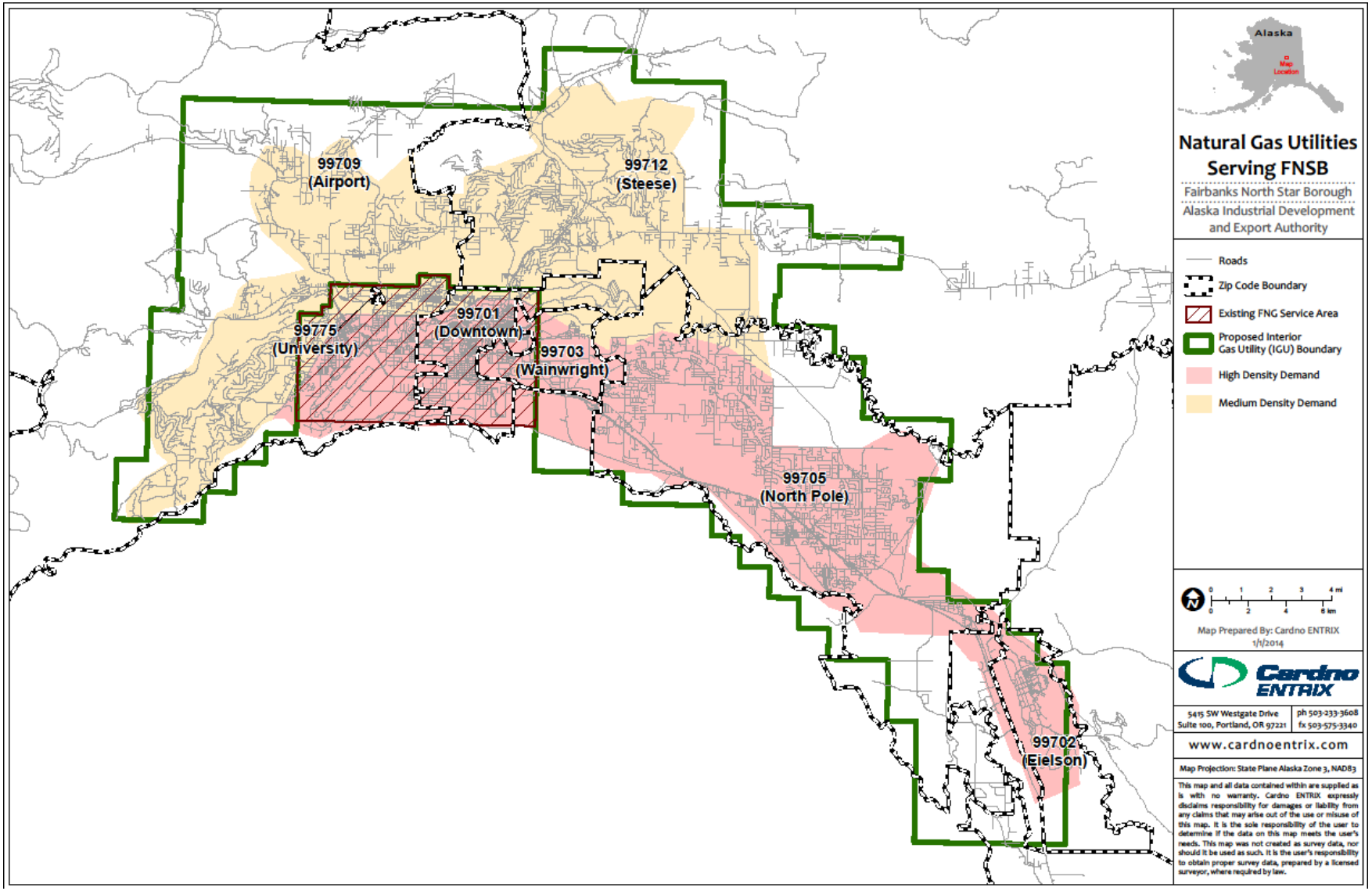

Figure 2.1 IEP Study Area

2.1 Existing FNG Natural Gas Use

Currently, FNG provides service to approximately 1,100 natural gas customers within central Fairbanks. FNG purchases gas from the Cook Inlet area of Alaska and, once liquefied, transports the gas by trucks to Fairbanks where it is stored and re-gassed for distributed to customers. In 2012, a total of 0.9 Bcf of natural gas was consumed by FNG customers. Demand for natural gas in the existing FNG service area is higher, but sales are constrained by supply. As illustrated in **Table 2.1** below, there are a total of eleven small businesses and three large businesses that are currently classified as interruptible customers. These interruptible businesses are restricted to using natural gas during low-demand periods and must use another fuel source during peak demand periods such as the winter months. This analysis used a simple approach to estimate the quantity of natural gas that would be consumed by existing FNG customers if natural gas supply was not constrained.

This analysis assumed that total demand for interruptible customers was being met in June and July for small interruptible businesses, while large interruptible customer demand was being met in April through August. Using the ratio of monthly uninterrupted business demand to interruptible, un-met demand, the analysis extrapolated natural gas demand for interruptible customers during the winter months. It is estimated that if existing interruptible customers were not restricted in their natural gas use, the total natural gas consumption from existing FNG service area customers would be approximately 1.1 Bcf annually.

Table 2.1 Existing FNG Natural Gas Customer Demand (Mcf)

FNG Natural Gas Demand 2012	Average Customer Count	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Residential	455	11,500	6,567	7,160	3,397	2,069	1,262	1,362	1,477	2,200	5,152	8,311	9,833	60,290
Small Commercial	624	73,114	43,591	43,104	25,263	16,090	9,609	10,063	10,997	15,910	34,824	53,540	62,999	399,104
Large Commercial	28	39,760	25,904	25,636	15,604	9,460	6,294	6,628	6,821	10,508	20,070	28,362	33,117	228,164
Interruptible Small Commercial	11	7,123	4,217	5,000	2,568	2,482	2,560	3,289	2,930	3,124	4,023	10,146	9,403	56,865
Interruptible Large Commercial	3	927	14,121	28,930	23,059	12,324	4,492	5,453	8,685	6,434	25,177	13,865	302	143,769
Total 2012														***888,192***
Additional Unmet Demand from Interruptible Customers														
Small interruptible (assuming uninterrupted)	11	12,356	7,396	6,484	4,162	1,805	0	0	664	2,076	7,359	7,353	11,188	60,843
Large interruptible (assuming uninterrupted)	3	57,829	24,159	8,954	0	0	0	0	0	6,946	378	22,248	41,865	162,377
Total Demand Including interruptible Demand														***1,111,412***

Source: Cuyno, Leah and Pat Burden, June 21, 2013, Estimated Natural Gas Demand for the NS LNG Project, Website (http://www.interiorenergyproject.com/Resources%20and%20Documents/LNG%20DEMAND%20STUDY%202.pdf) accessed January 5, 2013.

2.2 Population and Age

In addition to demographic information for the FNSB, Fairbanks, and North Pole this section also provides demographic information for the U.S., Alaska, Homer, and Kachemak City in order to provide context for the study area. There are an estimated 7,130 single-family homes within Fairbanks city limits.[14] Approximately 460 residential customers are currently served by FNG[15]; therefore, the development of IEP could extend natural gas service to an additional 6,670 single-family homeowners within the City of Fairbanks, which comprises 33 percent of the total 20,077 single-family structures located within the study area. Furthermore, the development of the IEP could extend service to a total of 620 single-family homes within the city of North Pole, which constitutes approximately three percent of total single-family homes within the study area. The IEP is anticipated to extend natural gas service to an additional 12,790 single-family residential structures which are located outside of Fairbanks and North Pole city limits.

Study area population age could impact natural gas conversion in two ways. First, older households tend to have greater savings and would generally be more readily able to afford a natural gas conversion. Secondly, select elderly households have indicated they are too old to fully recoup the total cost of conversion.[16] Generally, population age is anticipated to be positively correlated to willingness to convert and the rate of conversion.

As indicated in **Table 2.2**, the average annual population of the FNSB over the 2007 to 2011 period is 96,161, while the cities of Fairbanks and North Pole have populations of 31,467 and 2,236, respectively. The population of the FNSB comprises roughly 14 percent of Alaska's total population. Fairbanks and North Pole residents are younger than the population of Alaska overall and much younger than Homer and Kachemak City. The largest proportion of the population in any age classification over 19 years of age in Fairbanks is in the 20 to 29 age range, with approximately a quarter (25 percent) of the population fitting this age classification. Furthermore, 53 percent of those living in Fairbanks are 29 years old or younger. North Pole is similar with 48 percent of the population in the community being 29 or younger. Statewide, approximately 45 percent of the population is 29 years old or younger, while 37 percent and 28 percent of Homer and Kachemak City fall within this age range.

Table 2.2 Age and Sex of Population

	United States	Alaska	FNSB	Fairbanks	North Pole	Homer	Kachemak City
Population	306,603,772	700,703	96,161	31,467	2,236	4,987	687
Female Population	155,863,556	337,155	45,384	15,008	1,070	2,453	416
Male Population	150,740,216	363,548	50,777	16,459	1,166	2,534	271
19 years and under	27.1%	29.5%	29.0%	28.7%	31.1%	25.1%	19.8%
20 to 29 years	13.8%	15.4%	19.7%	24.5%	16.5%	11.7%	8.1%
30 to 39 years	13.0%	13.0%	13.5%	13.5%	13.0%	10.6%	8.8%
40 to 49 years	14.4%	7.6%	7.3%	7.0%	8.4%	6.9%	7.0%
50 to 59 years	13.5%	7.9%	10.6%	13.9%	9.6%	4.6%	4.5%

[14] US Census Bureau, ACS 2007 - 2011 Data, Table DP04, Selected Housing Characteristics, Website (http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml) accessed January 8, 2014.

[15] FNSB, summer 2013, Community Research Quarterly, Website (ftp://co.fairbanks.ak.us/Community_Research_Center/Quarterly_Archive/2013SUMMERCRQ.pdf) accessed January 8, 2014.

[16] FNSB Focus Groups, October 24-26, 2013.

	United States	Alaska	FNSB	Fairbanks	North Pole	Homer	Kachemak City
60 to 69 years	9.2%	7.6%	6.9%	5.2%	7.1%	12.7%	14.1%
70 to 79 years	5.4%	3.1%	2.6%	3.4%	3.0%	4.1%	4.3%
80 and older	3.6%	1.5%	1.1%	2.0%	1.1%	4.0%	6.1%

Source: US Census Bureau, ACS 2007 - 2011 Data, Table S0101, Age and Sex, Website (http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml) accessed November 1, 2013.

2.3 Homeownership vs. Rental Properties

Heating costs for single-family rental properties are generally the responsibility of the tenant.[17] Single-family rentals may therefore have lower conversion rates, or may convert more slowly as the cost savings of conversion (reduced fuel costs) benefit the renter, while the cost of the conversion is borne by the landlord. In other words, when tenants are responsible for paying the home heating bills, which is the case for single-family rentals in the Fairbanks and North Pole area,[18] [19] the landlord may provide the least cost heating equipment option rather than provide the most cost-effective heating system.

However, this may be offset by the fact that landlords need to provide competitive rental options in order to keep their properties rented. Rental properties with natural gas heating systems would be much less expensive to tenants paying utility bills and would be a compelling rental option for prospective renters. Rental property owners also receive tax deductions for equipment upgrades to their property through depreciation write-off.[20]

In contrast to single-family rentals, the costs of heating for rental units located within a multi-unit complex are typically paid by the landlord,[21] (and passed on to the tenant in their rent).[22] As heating bills and the capital cost of the heating system are paid by the landlord, landlords of multi-family rentals may convert more quickly than landlords of single-family rentals.

Within Fairbanks, approximately 54 percent of all occupied housing units (7,633 housing units) are rented. This is a much higher proportion of rentals than elsewhere in the FNSB and in other locations throughout the State.

Table 2.3 Owned, Rented, and Available Housing Units (2007 – 2011)

Location	Total Housing Units	Owner Occupied	Renter Occupied	Percent Renter Occupied	Vacant	Vacancy Rate
Fairbanks	14,179	4,582	7,633	54%	1,964	14%
North Pole	951	498	365	38%	88	9%
Homer	2,684	1,303	869	32%	512	19%
Kachemak City	386	248	55	14%	83	22%
FNSB	41,191	21,079	14,504	35%	5,608	14%

[17] Enoch, Phyllis, Northern Homes Owner, Personal communication with Lee Elder, Cardno ENTRIX, November 1, 2013.

[18] Ibid.

[19] Snell, Riley, JL Properties Property Manager, Personal communication with Lee Elder, Cardno ENTRIX, November 5, 2013.

[20] Enoch, Phyllis, Northern Homes Owner, Personal communication with Lee Elder, Cardno ENTRIX, November 1, 2013.

[21] Personal communication with FNSB property managers.

[22] Snell, Riley, JL Properties Property Manager, Personal communication with Lee Elder, Cardno ENTRIX, November 5, 2013.

Location	Total Housing Units	Owner Occupied	Renter Occupied	Percent Renter Occupied	Vacant	Vacancy Rate
Alaska	304,373	162,646	90,274	30%	51,453	17%
United States	131,034,946	75,896,759	38,864,600	30%	16,273,587	12%

Source: US Census Bureau, ACS 2007 - 2011 Data, Table DP04, Selected Housing Characteristics, Website (http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml) accessed November 1, 2013.

Table 2.3 highlights single-family housing characteristics for the US, Alaska, and select Alaska communities. In Fairbanks, 16 percent of all housing units are single-family renter occupied homes, while 13 percent of all housing units in North Pole are single-family renter occupied homes. It is assumed that the payment of utilities for these properties is the responsibility of the tenants in these homes. The proportion of renter occupied single-family units in Homer is similar to Fairbanks or 15 percent of total households, while 11 percent of all homes in Kachemak City are renter occupied single-family homes.

Table 2.4 Single-Family (Detached and Attached) Housing Occupancy

Location	Total Housing Units	1-Unit	1-Unit Renter Occupied	1-Unit Owner Occupied	Single-Family Renter Occupied (% of All Housing Units)	Single-Family Owner Occupied (% of All Housing Units)
Fairbanks	14,179	6,327	2,313	4,009	16%	28%
North Pole	951	611	123	488	13%	51%
Homer	2,684	1,657	411	1,247	15%	46%
Kachemak City	386	283	41	242	11%	63%
FNSB	41,191	26,936	6,802	20,130	17%	49%
Alaska	304,373	189,184	36,561	152,562	12%	50%
United States	131,034,946	86,300,542	14,574,225	71,722,437	11%	55%

US Census Bureau, ACS 2007 - 2011 Data, Table S2504, Physical Housing Characteristics for Occupied Housing Units, Website (http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml) accessed November 1, 2013.

Table 2.5 highlights multi-family unit housing characteristics for the US, Alaska, and select Alaskan communities. In Fairbanks, 38 percent of all housing units are multi-family renter occupied housing units, while 25 percent of all housing units in North Pole are multi-family renter occupied housing units. It is assumed that the payment of utilities for these properties is the responsibility of the landlord. This proportion of renter occupied multi-family units in Homer is much lower than evident in Fairbanks, with 17 percent of total households being classified as renter occupied multi-units. In Kachemak City 4 percent of all homes are renter occupied multi-family units.

Table 2.5 Multi-Family Unit Housing Occupancy

Location	Total Occupied Housing Units	Multi-family units	Multi-family Units Renter Occupied	Multi-Family Units Owner Occupied	Multi-Family Renter Occupied (% of All Housing Units)	Multi-Family Owner Occupied (% of All Housing Units)
Fairbanks	14,179	5,888	5,320	568	38%	4%
North Pole	951	252	242	10	25%	1%
Homer	2,684	515	458	56	17%	2%
Kachemak City	386	20	14	6	4%	2%
FNSB	41,191	8,647	7,702	949	19%	2%
Alaska	304,373	63,736	53,623	10,084	18%	3%
United States	131,034,946	28,460,817	24,290,375	4,174,322	19%	3%

US Census Bureau, ACS 2007 - 2011 Data, Table S2504, Physical Housing Characteristics for Occupied Housing Units, Website (http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml) accessed November 1, 2013.

2.4 Mobility

If homeowners anticipate that they may move prior to recouping their investment in a natural gas conversion (i.e. their capital costs will be greater than the sum total of their annual energy savings), they are unlikely to convert. It is well documented that technology, such as home energy efficiency improvements, with very quick simple payback periods will have a greater rate of adoption than technology with longer payback periods.[23] [24] **Table 2.6** below, illustrates that a higher proportion of Fairbanks residents 18 years of age or older have moved in the last year than other communities. Of the total population 18 years and older on average over the 2007 – 2011 period 34 percent of the population is not in the same house as they were the previous year. The population of Fairbanks is much more mobile than other communities and locations illustrated in **Table 2.6** below.

[23] Energy Saving Trust, The Energy Saving Trust Housing Model, Website (www.energysavingtrust.org.uk/.../1/.../EST+HEM+assumptions+doc.pdf), Prepared by Nick Asselin-Miller and Craig Douglas Element Energy,

[24] Kodek, Matej, Kim, Hyojoo, Miller, Miller, Douglas, and Antonia Weitzer, March 2013, Boosting Household Investments in Energy Efficiency, Website (http://lgstdept.wharton.upenn.edu/igel/BoostingHouseholdInvestments.pdf) accessed December 5, 2013.

Table 2.6 Average Annual Mobility of Population 18 and Over (2007 – 2011)

Location	Total Population 18 and Older	Population 18 and Older In Same Home as Last year	Percent of Population 18 and Older NOT in Same House as Last Year
Fairbanks	23,479	15,557	34%
North Pole	1,609	1,197	26%
Homer	3,892	3,157	19%
Kachemak City	563	500	11%
FNSB	71,348	52,531	26%
Alaska	514,606	406,953	21%
United States	232,556,019	196,725,797	15%

Source: US Census Bureau, ACS 2007 - 2011 Data, Table B07001, Geographical Mobility in the Past Year by Age for Current Residence in the United States, Website (http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml) accessed November 1, 2013.

The mobility of FNSB residents is attributable to two primary factors; the prevalence of the military and a large student population associated with a university campus. Fort Wainwright is immediately west of downtown Fairbanks and Eielson Air Force Base (AFB) is located approximately ten miles southeast of North Pole. The University of Alaska Fairbanks (UAF) is located northeast of the Fairbanks International Airport approximately five miles from downtown Fairbanks.

Active military and dependents comprise approximately 20 percent of the FNSB total population. The FNSB has a total of 8,451 active duty military personnel and 11,982 military dependents of which 6,568 active duty military personnel and 9,082 dependents are affiliated with Fort Wainwright, while Eielson AFB has 1,822 active duty personnel and 2,900 military dependents.[25] On average military personnel will receive orders to relocate to a new assignment every two to three years.[26] Army policy allows for single (unaccompanied) members in the pay grade of E-6 and above to live off of Fort Wainwright[27], while unaccompanied members in grades E-1 through E-4 are required to live on Eielson AFB.[28]

Fort Wainwright has over 1,500 privatized housing units located on the base.[29] At Fort Wainwright, the occupancy rate for privatized housing is between 96 and 99 percent with over 500 families on the waiting list to move on post. Typically, more than one-third of families assigned to Fort Wainwright reside off post for part of their tour of duty.[30] Personal communication with Ft. Wainwright Family Housing indicates that approximately 50 percent of soldiers live in the barracks, while 20 percent live in on-post housing. The

[25] FNSB, summer 2013, Community Research Quarterly, Website (ftp://co.fairbanks.ak.us/Community_Research_Center/Quarterly_Archive/2013SUMMERCRQ.pdf) accessed November 3, 2013.

[26] Department of Defense, Office of the Deputy Under Secretary of Defense Installations and Environment, Website (http://www.acq.osd.mil/housing/housing101.htm) accessed November 3, 2013.

[27] U.S. Army, Fort Wainwright Welcome Packet, Website (http://www.wainwright.army.mil/sites/installation/Welcome_Packet_Fort_Wainwright_2012.pdf) accessed November 3, 2013.

[28] U.S. Air Force, Eielson Air Force Base 2013-2014 Base Guide, Website (http://ebooks.aqppublishing.com/archive/base_guides/Eielson_AFB.pdf) accessed November 3, 2013.

[29] Military Installations, Fort Wainwright, Alaska, Website (http://www.militaryinstallations.dod.mil/pls/psgprod/f?p=132:CONTENT:0::NO::P4_INST_ID,P4_INST_TYPE:235%2CINSTALLATION) accessed November 3, 2013.

[30] Military Installations, Fort Wainwright, Alaska, Website (http://www.militaryinstallations.dod.mil/MOS/f?p=MI:CONTENT:0:::P4_INST_ID,P4_CONTENT_TITLE,P4_CONTENT_EKMT_ID,P4_CONTENT_DIRECTORY:235,Government%20Housing,30.90.60.30.90.0.0.0.0,8) accessed November 3, 2013.

remaining 30 percent of soldiers live off base and is it is estimated that 6 percent or approximately 400 soldiers stationed at Ft. Wainwright, are homeowners.[31]

It is estimated that by 2014, approximately 1,116 Eielson AFB military families will require housing from the private sector. It is expected that 58 of these families will be homeowners, while 1,058 families will rent homes.[32] Furthermore, it is estimated that 454 unaccompanied Eielson AFB military personnel will require private sector housing in 2014. Of these 454 unaccompanied military personnel, 62 are expected to purchase homes, while 392 are expected to rent homes off base.[33]

UAF has an enrollment of 9,855 students, of which 4,445 students are full-time. It is estimated that approximately 65 percent of full-time students live off campus.[34] Therefore, 2,900 UAF students rent or purchase housing in Fairbanks. However, this does not necessarily translate to a total of 2,900 individual housing units since some students will likely share housing and some students may stay with family members who have homes in the community.

2.5 Primary Heating Fuel for Communities

For those Alaska communities where natural gas is available, it is the primary fuel used for heating needs. For example, natural gas has been available to Anchorage residents since 1961 and currently natural gas is the primary heating fuel for 83 percent of Anchorage households.[35] Furthermore, construction of the Beluga Pipeline System in 1984 brought natural gas service to Palmer and Wasilla[36] and currently 83 percent and 88 percent of households in Palmer and Wasilla, respectively, use natural gas as their primary heating fuel. In Homer, since the natural gas distribution system construction began in spring of 2013, 98 percent of homeowners have paid a connection fee of approximately $1,290.

[31] Ft. Wainwright Family Housing, Personal communication with Lee Elder, Cardno ENTRIX, December 2, 2013.

[32] U.S. Air Force, July 2009, Housing Requirements and Market Analysis, Eielson Air Force Base 2009 – 2014, Website (http://adminpress.jllpress.com/Continental_Group/documents/EielsonAFBHRMA14-Jul-09.pdf) accessed November 3, 2013.

[33] Ibid.

[34] University of Alaska, 2007, The Economic Impact of the University of Alaska, Website (https://www.alaska.edu/files/opa/McDowell-2008-EconomicImpact.pdf) accessed November 3, 2013.

[35] ENSTAR, ENSTAR 50th Anniversary: Company Expects to Keep Gas Flowing, Website (http://www.thefreelibrary.com/ENSTAR+50th+anniversary%3A+company+expects+to+keep+gas+flowing.-a0258240340) accessed November 5, 2013.

[36] Department of Energy Office of Fossil Energy, April 9, 2007, Motion to Intervene and Initial Comments of ENSTAR Natural Gas Company, Website (http://www.fossil.energy.gov/programs/gasregulation/authorizations/enstar.pdf) accessed November 5, 2013.

Table 2.7 Primary Heating Fuel for Select Communities Currently Served by Natural Gas

	Anchorage		Kenai		Palmer		Wasilla	
	Homes	%	Homes	%	Homes	%	Homes	%
Occupied Housing Units	105,123	100%	2,996	100%	1,994	100%	3,101	100%
Utility gas	87,235	83%	2,700	90%	1,662	83%	2,737	88%
Bottled, tank, or LP gas	726	1%	0	0%	13	1%	4	0%
Electricity	13,667	13%	177	6%	241	12%	197	6%
Fuel oil, kerosene, etc.	2,047	2%	69	2%	50	3%	127	4%
Coal or coke	9	0%	0	0%	0	0%	0	0%
Wood	624	1%	40	1%	18	1%	20	1%
Solar energy	15	0%	0	0%	0	0%	0	0%
Other fuel	467	0%	0	0%	10	1%	12	0%
No fuel used	333	0%	10	0%	0	0%	4	0%

US Census Bureau, ACS 2007 - 2011 Data, Table B25040, House Heating Fuel, Website (http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml) accessed November 4, 2013.

Communities throughout Alaska without access to natural gas typically use heating oil as their primary heating source. As illustrated in **Table 2.8** below, between 67 percent and 85 percent of households in the communities of Fairbanks, Homer, Kachemak City, and North Pole use heating oil as their primary heating source.

Table 2.8 Primary Heating Fuel for Select Communities (2007-2011)

	United States		Alaska		FNSB		Fairbanks		North Pole		Homer		Kachemak City	
	Homes	%	Homes	%	Homes	%	Homes	%	Homes	%	Homes	%	Homes	%
Occupied Housing Units	114,761,359	100%	252,920	100%	35,583	100%	12,215	100%	863	100%	2,172	100%	303	100%
Utility gas	57,004,345	50%	123,142	49%	1,584	4%	1,137	9%	20	2%	28	1%	19	6%
Bottled, tank, or LP gas	5,952,308	5%	3,971	2%	508	1%	174	1%	11	1%	321	15%	28	9%
Electricity	40,017,656	35%	25,039	10%	2,044	6%	1,269	10%	25	3%	241	11%	8	3%
Fuel oil, kerosene, etc.	7,767,897	7%	83,916	33%	28,094	79%	8,960	73%	731	85%	1,435	66%	236	78%
Coal or coke	134,090	0%	883	0%	626	2%	235	2%	19	2%	11	1%	0	0%
Wood	2,320,823	2%	13,844	5%	2,163	6%	89	1%	53	6%	92	4%	9	3%
Solar energy	40,063	0%	32	0%	13	0%	0	0%	0	0%	0	0%	0	0%
Other fuel	491,556	0%	1,421	1%	366	1%	242	2%	4	0%	44	2%	3	1%
No fuel used	1,032,621	1%	672	0%	185	1%	109	1%	0	0%	0	0%	0	0%

US Census Bureau, ACS 2007 - 2011 Data, Table B25040, House Heating Fuel, Website (http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml) accessed November 4, 2013.

2.5.1 Income

Household income also indicates the ability of FNSB households to pay for the upfront capital cost of conversion. As conversion in rental units is expected to be paid for by landlords, this analysis focuses on income of owner-occupied housing as the most pertinent data to inform conversion rates in residential homes. The average median household income for owner-occupied housing units in the FNSB between 2007 and 2011 was $88,845 ($80,104 for Fairbanks and $103,958 for North Pole), which is higher than owner-occupied housing units across the US ($66,600) but similar to levels throughout the State.

Low income could be defined in a variety of ways; however, the AHFC low-income weatherization program provides some context on the subject. This program considers households with a median income less than the area median income as eligible for this program.[37] Compared to other areas with recent natural gas conversion (Homer and Kachemak City), Fairbanks and North Pole have higher incomes, and therefore likely greater ability to pay the upfront capital cost of conversion.

Table 2.9 Median Household Income (2007-2011)

	United States	Alaska	FNSB	Fairbanks	North Pole	Homer	Kachemak City
Occupied housing units; Median household income (dollars)	$52,762	$69,014	$68,922	$55,409	$66,339	$55,603	$55,536
Owner-occupied housing units; Median household income (dollars)	$66,600	$85,222	$88,845	$80,104	$103,958	$73,622	$60,625
Renter-occupied housing units; Median household income (dollars)	$32,051	$45,578	$46,898	$46,833	$38,523	$31,595	$28,750

US Census Bureau, ACS 2007 - 2011 Data, Table B24119, Median Household Income the Past 12 Months (In 2011 Inflation Adjusted Dollars) by Tenure, Website (http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml) accessed November 1, 2013.

Table 2.10 Poverty Rates for Families and Population (2007-2011)

	United States	Alaska	FNSB	Fairbanks	North Pole	Homer	Kachemak City
Families	76,507,230	170,948	24,344	7,692	565	1,277	184
Percentage of Families Below Poverty in Last Twelve Months	10.5%	6.5%	5.3%	7.3%	5.8%	4.9%	3.3%
Population	306,603,772	700,703	96,161	31,467	2,236	4,987	687
Percentage of People Below Poverty in Last Twelve Months	14.3%	9.5%	7.8%	10.5%	6.1%	8.5%	9.4%

US Census Bureau, ACS 2007 - 2011 Data, Table DP03, Select Economic Characteristics, Website (http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml) accessed November 1, 2013.

[37] AHFC, FY 2013 Income Limits for Alaska, Website (http://www.ahfc.us/files/7613/6218/5306/FY2013_HUD_Income_Limits.2.14.13.pdf) accessed September 21, 2013.

3 Economics of Conversion in Fairbanks

The decision to convert household heating systems will largely depend on three cost factors: capital cost of installing a natural gas heating system, annual fuel cost savings and the associated repayment time period (the time required to recoup the initial capital cost investment). Capital costs vary by household or business, and depend largely on existing heating system age and type. Cost savings also depend on type of fuel system, as well as total energy use. Regardless of cost savings of conversion, the availability of personal savings and/or loans to pay for the capital cost of conversion will also influence conversion rates.

The factors influencing businesses to convert to natural gas are the same as residential properties. A recent global survey of CEOs, CFOs, real estate leaders, and facility managers found that nearly 50 percent of executives require a three-year simple payback period to make significant energy efficiency investments in the buildings they own or manage. Only 5 percent require a payback of a year or less, while 90 percent of businesses require a ten-year payback period or less.[38] Other research finds that small/medium businesses, housing communities, and schools prefer a three to five year payback period on energy efficiency improvements.[39]

This chapter provides the sources, data, and findings regarding the conversion costs and fuel savings for residents of each phase of the build out. Heating system expenditures are based on existing fuel usage (as reported in *Natural Gas in the Fairbanks North Star Borough: Results from a Residential Household Survey*[40] and *The Alaska Consumer Guide to Home Heating*[41]) and the relative price of fuel oil ($30 per MMBtu, as reported by *The Interior Energy Project Feasibility Report*[42]) versus the expected price of IEP natural gas ($15 per MMBtu, as forecast by *The Interior Energy Project Feasibility Report*).

Assuming that fuel usage will remain constant likely represents an underestimation for homes installing a new natural gas system, since a new system will likely improve heating efficiency and result in greater savings than would be attained with just a lower cost heating fuel. This efficiency gain of a new heating system depends on a number of factors including the age of the existing system. Newer high-efficiency boilers are rated as 97 percent efficient, medium-efficiency boilers are rated at 87 percent efficient and newer furnaces are approximately 90 percent efficient. Conversely, depending on the oil systems age, a burner switch will likely create a slight decrease in efficiency, and may result in lower cost savings than estimated in this analysis.[43] Efficiency loss estimates associated with a burner switch are on the magnitude of 4 percent; however, knowledgeable heating and plumbing experts can sometime reduce this efficiency loss to only one percent. **Table 3.1** summarizes the range of capital costs, savings, and repayment periods estimated for FNSB households located in the proposed build-out area.

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38 Johnson Controls, June 3, 2010, Johnson Controls 2010 Energy Efficiency Indicator Global Survey Results, Website ((http://pacenow.org/wp-content/uploads/2012/07/EEI-2010-Global-Executive-Summary-ENG.pdf) accessed December 13, 2013.

39 Daswani, Rahul, Hong, Erick, Levitte,, Benjamin and Clara Suh, May 15, 2013, Hope Energy, Designing a Methodology to help Develop Customized, Optimal Energy Technology Solutions, Website (http://mitsloan.mit.edu/actionlearning/media/documents/s-lab-projects/HopeEnergy-Report-2013.pdf) accessed December, 13, 2013.

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

41 AHFC and CCHRC, The Alaska Consumer Guide to Home Heating, Website (http://cchrc.org/docs/reports/Consumer_Guide_Home_Heating.pdf) accessed December 13, 2013.

42 AIDEA and AEA, July 2013, Interior Energy Project Feasibility Report, Website (http://www.interiorenergyproject.com/Resources%20and%20Documents/Feasibility_Report_72013.pdf) accessed December 13, 2013.

43 Smith, Bill, Personal communication with Lee Elder, Cardno ENTRIX, November 7, 2013.

Table 3.1 Study Area Heating System Capital Costs, Savings, and Simple Payoff Period

Existing Primary/ Secondary Systems	Prim./Sec. Systems (% of FNSB Hhlds)	Oil Heating System Types	Annual Savings	House holds	Average Convt. Cost	Payoff Period (Years)
Oil/No Secondary	44.7%	Baseboard Burner Switch	$2,300	4,200	$2,700	1.2
		Baseboard Replacement	$2,300	2,097	$9,100	4.0
		Furnace	$2,200	1,895	$6,400	2.9
		Other oil heater	$1,400	782	$3,100	2.2
Oil/Wood	29.2%	Baseboard Burner Switch	$1,900	2,744	$2,700	1.4
		Baseboard Replacement	$1,900	1,370	$9,100	4.8
		Furnace	$2,500	1,238	$6,400	2.6
		Other oil heater	$1,400	511	$3,100	2.2
Wood/Oil	9.7%	Baseboard Burner Switch	$1,500	298	$2,700	1.8
		Baseboard Replacement	$1,500	149	$9,100	6.1
		Furnace	$1,900	263	$6,400	3.4
		Other oil heater	$1,500	1,237	$3,100	2.1
Oil/Other	7.0%	Baseboard Burner Switch	$1,900	658	$2,700	1.4
		Baseboard Replacement	$1,900	328	$9,100	4.8
		Furnace	$2,500	297	$6,400	2.6
		Other oil heater	$1,400	122	$3,100	2.2
Other/Oil	1.8%	Baseboard Burner Switch	$900	55	$2,700	3.0
		Baseboard Replacement	$900	28	$9,100	10.1
		Furnace	$3,600	49	$6,400	1.8
		Other oil heater	$300	230	$3,100	10.3

3.1 Existing Fuel Source

According to a 2012 survey of FNSB residents, 81 percent of FNSB primary residential heating systems use heating oil, which is closely aligned with primary heating fuel estimates as determined by the Census Bureau (79 percent).[44] Primary heating systems are only part of the picture as nearly 50 percent of FNSB households use secondary heating systems to supplement their home heating needs. In addition to the 81 percent of FNSB households that use heating oil as their primary fuel source, 11.4 percent of households use heating oil as a secondary fuel. In total, approximately 92 percent of FNSB households

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

use heating oil as a primary or secondary heating fuel. **This analysis conservatively assumes that only those 92 percent of households currently using heating oil as a fuel source (either primary or secondary) 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). This assumption is supported by recent survey data 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).**[45]

Table 3.2 Percent of FNSB Households Primary and Secondary Heating System Fuel Use

Secondary Fuel Sources	Primary Fuel Sources						
	Heating Oil	**Wood**	**Gas**	**Other Fuels**	**Electricity**	**Coal**	**Total**
No secondary fuel	44.7%	3.1%	1.8%	0.6%	0.3%	0.2%	50.8%
Wood	29.2%	1.4%	0.0%	0.1%	0.2%	0.1%	31.0%
Heating Oil	1.4%	9.7%	0.0%	0.1%	0.2%	0.1%	11.4%
Other Fuel	2.9%	0.4%	0.0%	0.1%	0.0%	0.0%	3.4%
Electricity	1.7%	0.1%	0.0%	0.4%	0.0%	0.0%	2.3%
Gas	0.8%	0.0%	0.0%	0.1%	0.0%	0.0%	0.9%
Coal	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%
Total	81.0%	14.7%	1.8%	1.4%	0.7%	0.4%	100.0%

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

According to **Table 3.2**, the most common oil primary/secondary fuel pairs for FNSB households are oil/no secondary (44.7 percent), oil/wood (29.2 percent), wood/oil (9.7 percent), oil/other (7.0 percent), and other/oil (1.8 percent). Based on this and additional information on the types of primary and secondary heating systems, we estimate that 59.4 percent of FNSB homes have an oil boiler/baseboard system, 18.6 percent have an oil furnace, and 14.4 percent of FNSB homes use fixed or portable oil stoves.

To estimate conversion cost, it is necessary to estimate the total number of households using an oil boiler/baseboard system, oil furnace, and oil portable/fixed heaters (see **Table 3.3**). To do this by phase, results by zip code from the IGU study were used to derive the number of primary and secondary systems specific to each zip code (i.e., data as shown in **Table 3.3**, but specific to each zip code, see Appendix B). A similar approach as outlined for primary and secondary fuel types described above was implemented to estimate heating system types by project phase. For example, those project phases located in numerous zip codes were analyzed separately in order to capture the appropriate primary and secondary heating systems for that zip code within each project phase and aggregated to illustrate each build-out phase primary and secondary heating systems that use oil.

IGU study results did not explicitly designate the number of households using primary and secondary heating system types by fuel use. Therefore, it was necessary to use the proportion of households using baseboards, furnaces, and portable/fixed heaters to estimate the number of households that used oil heating systems (see Column four of **Table 3.3**). It was assumed that those households using a

[45] Sierra Research, 2013, Wood Tag Survey.

baseboard system or a furnace also used heating oil as a heating fuel. Furthermore, it was assumed that if a portable or fixed stove was used, heating oil was used as a heating fuel. Primary and secondary heating systems within each zip code are provided in Appendix B.

Table 3.3 Study Area Primary and Secondary Heating System Pairs that use Oil

Primary/Secondary Systems	Primary/Secondary Systems (% of FNSB Households)	Oil Heating System Types	Relative use of oil heating systems (% of oil systems)	Percent of total households	FNSB Households
Oil/No Secondary	44.7%	Baseboard	70%	31%	12,920
		Furnace	21%	9%	3,888
		Other oil heater	9%	4%	1,605
Oil/Wood	29.2%	Baseboard	70%	20%	8,440
		Furnace	21%	6%	2,540
		Other oil heater	9%	3%	1,048
Wood/Oil	9.7%	Baseboard	23%	2%	918
		Furnace	14%	1%	540
		Other oil heater	64%	6%	2,538
Oil/Other	7.0%	Baseboard	70%	5%	2,023
		Furnace	21%	1%	609
		Other oil heater	9%	1%	251
Other/Oil	1.8%	Baseboard	23%	0.4%	170
		Furnace	14%	0.2%	100
		Other oil heater	64%	1.1%	471
Baseboard/boiler				59.4%	24,471
Furnace				18.6%	7,677
Other oil heater				14.4%	5,913
Total				92.4%	38,060

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

US Census Bureau, ACS 2007 - 2011 Data, Table DP04, Selected Housing Characteristics, Website (http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml) accessed November 1, 2013.

1 Other category includes fixed heaters and portable stoves.

3.2 Conversion Costs

Conversion costs for the study area are defined as the purchase price for the boiler, furnace, space heater and burner. Additionally, conversion costs estimates include the cost of piping, valves and labor for full install. The $120 permit fee for a boiler installation within the city limits of Fairbanks and the $50 permitting fee for North Pole have been excluded from the conversion cost estimates.[46] [47]

[46] City of Fairbanks, Building Department, Personal communication with Lee Elder, Cardno ENTRIX, December 2, 2013.

[47] Butler, Bill, City of North Pole, Personal communication with Lee Elder, Cardno ENTRIX, December 2, 2013.

The existing heating system within each home affects the likely conversion options available to these homes and will have significant implications upon their willingness to convert. The conversion options for heating systems in the study area were based upon numerous interviews with heating and plumbing businesses and also on focus group input. This section identifies the conversion options available to households with boilers, furnaces, and portable/fixed heating systems and provides the assumptions used for this analysis.

Depending on equipment requirements, capital cost of converting to natural gas heating is expected to range from approximately $2,300 to $10,700. **Table 3.4** below provides the range of conversion costs provided by heating and plumbing businesses. The range of total installation costs for high-efficiency boilers with a water heater is $7,300 to $13,500, with the average installation costs being $10,700. The range of medium-efficiency boilers with a water heater is $7,500 to $10,000, with the average installation cost being $9,000. The weighted average conversion cost for a boiler system is estimated to be $9,100. Total installation costs for a furnace with a water heater ranges from $4,000 to $9,000, with the average cost being $6,400. The total installation costs for burners range between $1,000 and $4,000, with the average being $2,700. The total space heater installation costs range between $2,000 and $3,500 with the average being $2,750 (see **Table 3.4**).

All cost provided in **Table 3.4** include the cost for the heating systems, piping and valves, and labor for full install. The $120 permit fee for a boiler installation within the city limits of Fairbanks and the approximate $50 permitting fee for North Pole are excluded from these conversion cost estimates.[48] [49]

[48] City of Fairbanks, Building Department, Personal communication with Lee Elder, Cardno ENTRIX, December 2, 2013.

[49] Butler, Bill, City of North Pole, Personal communication with Lee Elder, Cardno ENTRIX, December 2, 2013.

Table 3.4 Natural Gas Heating System Conversion Cost Estimates

System	Business #1	Business #2	Business #3	Business #4	Business #5	Business #6	Average
Boiler high-efficiency unit w/hot water	$7,300 - $9,000	$13,500		$10,000 - $12,000		$10,000	$10,700
Boiler medium-efficiency unit w/hot water		$9,350	$10,000	$8,000 - $10,000		$7,500	$9,000
Furnace w/hot water	$4,800 - $7,000	$7,700	$4,000 - $5,000			$6,000 - $9,000	$6,400
Water heater (only)	$1,800 - $2,000	$2,000 - $3,500					$2,300
Burners	$2,000	$2,500	$1,000 - $1,500	$3,000 - $4,000		$4,000	$2,700
Space heaters					$2,000 - $3,500		$2,800

Sources: Sloanwhite, Andy, Residential Divisional Manager, Altrol, Personal communication with Elizabeth Harrison, Cardno ENTRIX, November 22, 2013.

Simpson, Lanny, Energy Resource Analyst, Eayr's Plumbing and Heating, Personal communication with Lee Elder, November 20, 2013

Pavey, Rocky, Rocky's Heating Service, Personal communication with Shanna Zuspan, Agnew::Beck, October 15, 2013.

Smith, Preston, Frontier Plumbing Supply, Personal communication with Shanna Zuspan, Agnew::Beck, October 3, 2013.

Portwine, Dan, Portwine Plumbing and Heating, Personal communication with Elizabeth Harrison, Cardno ENTRIX, November 22, 2013.

Dennis, Kraft Heating, Personal communication with Elizabeth Harrison, Cardno ENTRIX, November 22, 2013.

Actual conversion costs will depend on a host of factors including; home heating system size, equipment prices, and contractor fees. For a more precise conversion cost estimate, please consult a home heating expert to provide a conversion estimate specifically for your home.

Permits are required for homes located within the boundaries of North Pole and Fairbanks. Permit charges would apply for the switching of a heating unit and not for burner replacement.

The estimates provided above included heating system cost, piping, and labor for installation.

The major factors affecting conversion costs are the age of the existing heating system, the type of natural gas heating system, the cost of piping the home for natural gas, and the labor required for installation.[50] [51] In addition, the installation of a heating system that requires welding within the city limits of Fairbanks and North Pole will also require a permitting fee.

Depending on the type and age of the existing heating system, conversions to natural gas heating systems are anticipated to occur in one of the following four ways:

> Switching the oil burner in an existing boiler to operate with natural gas (least expensive conversion option, but only possible in boilers less than 10 years old)

> Replacing an oil boiler and hot water heater with a new natural gas boiler and hot water heater

> Replacing an oil furnace and hot water heater with a new natural gas furnace and hot water heater

> Replacing an oil space heater with a new natural gas space heater

The age of existing systems will dictate if the homeowner can convert to natural gas using a relative low cost conversion option (switching the burner).[52] Only heating systems less than ten years of age or newer can be converted by switching the oil burner with a natural gas burner.[53] [54] To convert a boiler/baseboard system eleven years old or older require purchase and installation of a new natural gas boiler. As illustrated in **Table 3.5** below, approximately 67 percent of boilers in the FNSB are ten years old or newer, while 64 percent of furnaces are older than ten years old or newer.

The switching of a burner is a much lower natural gas conversion cost option than switching the boiler and would be an appealing option for residents. Homeowners with boilers that are ten years old or newer (67 percent of households with boilers) are assumed to base their conversion decision on the lower capital cost of switching the burner rather than purchasing a new heating system. This analysis assumes that the existing distribution of boiler age as determined by the IGU study is representative of boiler age during each project phase.

[50] Pavey, Rocky, Rocky's Heating Service, Personal communication with Shanna Zuspan, Agnew::Beck, October 15, 2013.

[51] Smith, Preston, Frontier Plumbing Supply, Personal communication with Shanna Zuspan, Agnew::Beck, October 3, 2013.

[52] Fannie Mae, 2013, Estimated Useful Life Table, Website (https://www.fanniemae.com/content/guide_form/4099f.pdf) accessed January 8, 2014.

[53] Pavey, Rocky, Rocky's Heating Service, Personal communication with Shanna Zuspan, Agnew::Beck, October 15, 2013.

[54] Eayrs, Steve, Eayrs Heating and Plumbing, Personal communication with Lee Elder, Cardno ENTRIX, September 16, 2013.

Table 3.5 Age of FNSB Oil Boilers and Furnaces

Age of System (years)	Baseboard	Furnace forced air
0	1.5%	2.6%
1	5.9%	4.7%
2	7.6%	9.7%
3	5.5%	11.0%
4	5.9%	5.7%
5	7.0%	10.5%
6	7.5%	3.4%
7	5.4%	3.0%
8	7.0%	0.6%
9	3.1%	3.3%
10	10.3%	9.1%
Total 10 years or newer	66.7%	63.6%

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

The remaining 33 percent of households with an existing oil boiler system are expected to weigh their conversion decision on whether or not to purchase a new natural gas boiler. In general, the useful life of boilers is estimated to be between 22 and 30 years of age.[55] Based upon interviewee input, the boiler replacement options are generally defined as a either a high-efficiency boiler or medium efficiency boiler. Typically, boiler systems in the Fairbanks area serve a dual purpose by not only providing space heating needs, but also providing hot water for the home. Therefore, it is assumed that if conversion to natural gas is to occur the new natural gas boiler systems will also require a hot water heater.

This analysis weights the average conversion cost estimates for boilers so as to take into consideration the proportion of households expected to purchase a high-efficiency boiler. It is expected that approximately ten percent of FNSB households with boilers have radiant heat floors and interviews suggest to fully capitalize on the efficiency ratings of high-efficiency boilers, they should be used in conjunction with radiant heat floors. Consequently, it is assumed that ten percent of homeowners with boilers are more likely to purchase a high-efficiency boiler. The average boiler conversion cost for this analysis uses the weighted average of the medium-efficiency boiler conversion cost estimate of $9,000 (90 percent weight) and the average high-efficiency boiler cost estimate of $10,700 (10 percent weight) to arrive at a weighted average boiler conversion cost of $9,100.

For those households currently using an oil furnace it is anticipated these homeowners will more than likely weigh their decision to convert based upon the conversion costs and savings obtained from installing a natural gas furnace. While it is technically possible to replace the burner in an oil furnace, it is unlikely this would be a realistic conversion option. Therefore, this analysis assumes that those households with an oil furnace will most likely look to convert their existing system by purchasing a natural gas furnace. Further, it is assumed that these homes will also install a natural gas water heater since installation of the furnace will require the home to be piped for natural gas and installation of the water heat at the same time should reduce labor costs.

[55] Fannie Mae, 2013, Estimated Useful Life Table, Website (https://www.fanniemae.com/content/guide_form/4099f.pdf) accessed January 8, 2014.

Based upon the conversions occurring in Homer, this analysis assumes that households with existing portable oil or fixed oil systems will most likely base their conversion decision upon the conversion cost and savings of installing a natural gas space heater in their homes. Further, FNSB homeowners that have these types of systems are not expected to base their conversion decision on the additional cost of installing a natural gas hot water heater. This is because portable oil and fixed oil heating systems are generally used as a secondary heating source and not the primary heat system. Meaning, they are generally used to supplement their existing primary system. For example, approximately 7.8 percent of households in FNSB use a portable oil or fixed oil heating system as a primary heating system, while nearly 18.8 percent of households with secondary systems use these systems as a secondary heating source.

3.3 Heating Fuel Costs

Natural gas from the IEP is anticipated to cost $15 per Mcf, while heating oil in the Fairbanks area is currently $30 per Mcf.[56] The price of green wood is similar to natural gas, at approximately $14 per Mcf.[57] However; many households in FNSB collect their own firewood, which costs time but reduces the out-of-pocket financial cost of wood energy.

Table 3.6 Study Area Heating Fuel Prices

Heating Fuel	Price per unit	Btu per Unit	Price per MMBtu & Mcf
Heating oil	$4.00 gallon	134,000	$29.85
Natural gas (IEP)	$15.00 Mcf	1,000,000	$15.00
Wood (Green)	$250.00 cord	17,750,000	$14.10

As previously discussed, heating oil is used as a primary or secondary fuel in 92 percent of FNSB households. **Table 3.7** below illustrates the average annual expenditures for the predominate primary fuel combinations evident in the FNSB and the anticipated savings for these systems provided households convert their existing oil systems to natural gas systems. This calculation assumes that natural gas is roughly half the cost of heating oil on a Btu basis and that the updated system retains the same efficiency rate. Furthermore, this calculation assumes that the ratio of existing fuel system use (fuel oil to wood) remains the same once the fuel oil system is replaced with a natural gas system. As, illustrated below, conversion to natural gas is expected to result in a significant reduction in annual home heating expenditures.

[56] Each gallon of heating oil contains approximately 134,000 Btu of energy, while each Mcf of natural gas contains one million Btu. At a price of $4 per gallon, it cost $28.99 to provide one million Btus from heating oil,

[57] A cord of green wood in FNSB cost approximately $250 and contains approximately 17.75 million Btus of energy.

Table 3.7 Primary and Secondary Heating System Pairs Using Oil

Primary/Secondary Systems (% of Households)	Current Expenditures			Expenditures Post Conversion			Annual Savings
	Oil	Wood	Total	Natural Gas	Wood	Total	
Oil/No Secondary (44.7%)	$4,299	$0	$4,299	$2,160	$0	$2,160	$2,139
Oil/Wood (29.2%)	$3,463	$746	$4,209	$1,740	$746	$2,486	$1,723
Wood/Oil (9.7%)	$2,955	$690	$3,645	$1,485	$690	$2,175	$1,470

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

Calculation assumes heating oil cost of $4 per gallon and that oil generates 134,000 Btu per gallon, while natural gas generates 1,000 Btu per cubic foot and cost $15 per Mcf. Expenditures for wood are based upon $250 per green cord and each cord is assumed to have 20 million Btu of energy. Also assumes efficiency remains the same for the natural gas system and that the proportion of wood to oil system use remains the same. Calculations also assume Oil/No Secondary systems use on average 144 Mcf of energy, Oil/Wood Systems use 116 Mcf/53 Mcf of energy respectively, and Wood/Oil systems use 49 Mcf/99 Mcf of energy, respectively.

There are a number of factors that could alter the annual savings from the estimates above, including primary/secondary heating system utilization, system efficiency, and the intensity/duration of winter. Also, the savings calculations conservatively assume that only the price change of the heating oil fuel affects home heating savings, when the quantity of fuel used may also change with conversion. Fuel savings would likely be greater for those households that install new furnaces or boilers as newer heating systems are typically more efficient at converting fuel to energy and therefore use less fuel to achieve a required energy output. Conversely, it is expected that those homeowners who elect to switch their oil burners with natural gas burners would possibly experience slightly lower system efficiency.[58]

There is a broad range of energy use by homes throughout Alaska and even within the Fairbanks/ North Pole Area. The IGU survey estimated the average energy consumption for study area households by conducting a random sample of 800 owner-occupied homes, which generated 699 useable responses. The IGU survey estimated that in the Fairbanks/North Pole area the average energy use per owner-occupied home was 151 Mcf.

The IGU survey results include energy consumption estimates for space heating for some households and both space heating and hot water heating for other homes. For example, 85 percent of respondents with a boiler/baseboard heating system reported using the system for both space heating and water heating needs. Similarly, 18 percent and 14 percent of respondents with a furnace and another heating system, respectively, reported using their systems for space heating and water heating. Therefore, the average 151 Mcf per household includes space heating energy use and to a lesser degree household energy requirements to heat water. To ensure that the natural gas demand forecast accurate reflects demand for both space heating and water heating as appropriate, this analysis made several adjustments to the IGU survey energy use estimates.

First, this current analysis conservatively assumes that the average energy use for households that reported using a boiler in the IGU survey captures both home heating and water heating energy consumption for all homes with these systems. Second, energy consumption for study area households using a space heater was also considered to be accurately represented by the IGU survey since this

[58] Smith, Bill, Personal communication with Lee Elder, Cardno ENTRIX, November 7, 2013.

analysis assumes that these households will likely convert to natural gas by installing a new natural gas space heater and will likely not purchase a natural gas hot water heater.

In contrast, energy consumption for households that use a furnace in the IGU survey was assumed to include only space heating energy use, and energy use estimates were adjusted to also account for water heating energy consumption. This adjustment was made based on previous research indicating that roughly half of a home's energy consumption is for space heating and between 15 and 25 percent of a home's energy consumption is for water heating.[59] This analysis conservatively adjusts energy consumption for study area households with furnaces to be 15 percent greater than estimated by the IGU survey in order to account for hot water energy consumption. After adjusting the IGU survey annual energy consumption to account for water heating needs for those households with a furnace, the overall average space heating and water heating energy consumption for households willing to convert in the study area was estimated to be 161 Mcf.

Table 3.8 Average Annual Household Energy Consumption for Study Area Households Post Conversion (Mcf)

Primary or Secondary Heating System	Natural Gas	Wood	Other fuel	Total
Baseboard[1]	154	5	5	165
Furnace[1]	169	5	7	181
Other oil heaters[2]	115	7	3	126
Average across all systems	151	5	5	161

Note: The above average Mcf estimates for each heating system were calculated by using data from Table 2 and Table 7 of the IGU report. Data from Table 2 of the IGU report was used primarily, while wood/heating oil system energy use estimates from Table 7 was used to supplement Table 2 data for these types of systems.

[1] Space heating and water heating energy consumption

[2] Space heating energy consumption only

The average annual natural gas use of 161 Mcf per household is supported by research provided by the Energy Information Administration (EIA). The EIA determined the average annual residential energy consumption for each residential customer in Alaska for 2010, 2011, and 2012 was 154 Mcf, 166 Mcf, and 174 Mcf, respectively.[60] Additionally, other research supports the use of average household energy consumption obtained from the IGU survey. The *2009 Alaska Housing Assessment* found that the average home in Fairbanks requires 150,700 Btus per year for space heating needs, which is equivalent to 151 Mcf of energy.[61]

The *AEA End Use Study* also provides estimates for the total energy consumption of homes in the Fairbanks/North Pole area. These estimates rely upon the Alaska Retrofit Information System (ARIS). The *AEA End Use Study* determined that the average total energy use in the Fairbanks/Interior region (Climate Zone 8) is 264 Mcf per year of which 215 Mcf per year is required for space heating, 27 Mcf is required for water heating, and 22 Mcf is required for powering appliances.[62] While this data is useful, it is not a true random sample of households in the region given that individual homeowners have self-selected to have an audit completed upon their home in order to participate in AHFC energy efficiency

[59] AHFC and CCHRC, The Alaska Consumer Guide to Home Heating, Website (http://cchrc.org/docs/reports/Consumer_Guide_Home_Heating.pdf) accessed January 3, 2014

[60] EIA, Natural Gas Annual, Website (http://www.eia.gov/naturalgas/annual/archive/2011/) accessed January 2, 2014.

[61] CCHRC, 2009 Alaska Housing Assessment Part I and Part II, Prepared by Information Insights, Website (http://www.cchrc.org/docs/reports/TR_2009_02_2009_AK_Housing_Assessment_Final.pdf) accessed January 2, 2014.

[62] AEA, End Use Study 2012, Website (http://www.akenergyauthority.org/PDF%20files/EndUseStudy2012/AlaskaEndUseStudy2012.pdf) accessed January 2, 2014.

programs. Notably, homeowners that wish to participate in these energy efficiency programs demonstrate a need to lower their energy consumption which suggests the home currently has high energy consumption. Furthermore, a strong linear relationship exists between income and participation in the AHFC Home Energy Rebate Program (HERP)[63], meaning that households with higher income are more likely to participate in HERP. It is well documented that households with high income exhibit high energy use; therefore, home energy consumption estimates provided by ARIS are likely higher than the average study area home.[64] [65] [66]

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 survey. As noted above, these estimates were modified for those households with furnaces to account for hot water energy consumption since it is assumed conversion to a natural gas boiler or furnace will also entail the installation of a natural gas water heater.

Table 3.9 Heating System Energy Use Pre- and Post-Conversion (Mcf)

Existing Primary/ Secondary Systems	Primary/Secondary Systems (% of FNSB Households)	Oil Heating System Types	Current System Energy Use (Mcf)		Post Conversion System Energy Use (Mcf)	
			Primary	Secondary	Primary	Secondary
Oil/No Secondary	44.7%	Baseboard	152	0	152	0
		Furnace	146	0	146	0
		Other oil heater	95	0	95	0
Oil/Wood	29.2%	Baseboard	125	57	169	13
		Furnace	165	61	212	14
		Other oil heater	96	42	128	10
Wood/Oil	9.7%	Baseboard	49	99	11	137
		Furnace	49	128.7	11	166
		Other oil heater	49	99	11	137
Oil/Other	7.0%	Baseboard	125	57	125	57
		Furnace	165	61	165	61
		Other oil heater	96	42	96	42
Other/Oil	1.8%	Baseboard	146	59	146	59
		Furnace	103	244	103	244
		Other oil heater	32	21	32	21

[63] CCHRC and AHFC, March 29, 2012, Home Energy Rebate Program Outcomes, (http://www.ahfc.us/files/6313/5769/3840/wx_assistance_prog_outcomes.pdf) accessed January 3, 2014.

[64] Marcus, William B., Ruszovan, Gregory, and Jeffrey A. Nahigian, September 2002, Economic and Demographic Factors Affecting California Residential Energy Use, Website (http://www.jbsenergy.com/downloads/California%20Residential%20Energy%20Use%20Economic%20and%20Demographic%20Report.pdf) accessed January 3, 2014.

[65] Public Utilities Commission of California, June 21, 2012, Electricity Use and Income, Website (http://www.cpuc.ca.gov/NR/rdonlyres/609BC107-EF3C-4864-AD56-E964884D51AC/0/PPDElectricityUseIncome.pdf) accessed January 3, 2014.

[66] Estiri, Hossen, Gabriel, Ryan, Howard, Eric and Li Wang, June 14, 2013, Different Regions, Differences in Energy Consumption: Do Regions Account for the Variability in Household Energy Consumption?, Website (http://www.csss.washington.edu/Papers/wp134.pdf) accessed January 3, 2014.

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

AHFC and CCHRC, The Alaska Consumer Guide to Home Heating, Website (http://cchrc.org/docs/reports/Consumer_Guide_Home_Heating.pdf) accessed December 13, 2013.

Furnace energy consumption estimates from IGU survey were increased by 15 percent to account for water heater energy consumption.

3.3.1 Cost Savings from Reduced Wood Heating

As provided in **Table 3.9** above, the initial cost saving attained from converting from oil to natural gas combined with the cost of conversion is expected to drive the decision for households to participate in converting. The utilization of the existing oil heating systems was held constant post natural gas conversion in **Table 3.9** because it is expected that homeowners will base their conversion decision upon the initial savings of converting their oil heating system to a natural gas heating system. However, once conversion to a lower cost fuel occurs, the utilization of their other heating system is anticipated to change.

To illustrate this concept, the elasticity of wood energy consumption within the US with respect to the price of non-wood energy[67] was used to derive how wood energy utilization in the FNSB would adjust following household conversion to natural gas. The elasticity of wood energy consumption relative to the price of non-wood energy throughout the US was found to be 1.55 percent.[68] In other words, for every one percent change in the price of non-wood energy within the US the consumption of wood changes by 1.55 percent. More importantly, as it relates to this analysis, a one percent decrease in the price of non-wood energy reduces the consumption of wood by 1.55 percent.

A 50 percent reduction in the price of non-wood energy as expected in the FNSB when switching from heating oil to natural gas results in a 77.5 percent reduction in wood energy consumption for these households. Therefore, those FNSB households that currently utilized wood and heating oil in some capacity (38.9 percent of all FNSB households) will utilize wood to a lesser degree provided these homes convert to natural gas. FNSB households with a wood secondary heating system (29.2 percent of FNSB households) use on average 3 cords of wood annually[69], at an estimated 17.75 million Btu per cord. In other words, these households consume on average 53 million Btu per year from cordwood. A non-wood energy price reduction of 50 percent for households with a wood secondary system would support a 12 million Btu reduction in energy generated from wood, which reduces wood consumption for these households to 0.7 cords of wood per year.

The implications of a cheaper non-wood energy source are expected to be even greater for those households that use wood as a primary fuel and oil as a secondary fuel. Approximately 9.7 percent of FNSB households fit this description and use an average of 6.2 cords of cordwood annually.[70] A 50 percent reduction in the price of non-wood energy is expected to drop the household consumption of these households to 1.4 cords annually.

Despite the eventual modification of primary/secondary heating system utilization, the initial cost saving attained from converting from oil to natural gas combined with the cost of conversion is expected to drive

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67 Non-wood energy prices were defined as the price of natural gas, electricity, fuel oil, liquefied propane, and kerosene.

68 Song, Nianfu, Aguilar, Francisco X., Shifley, Stephen R., and Michael E. Goerndt, 2012, Factors Affecting Wood Energy Consumption by U.S. Households, Energy Economics (34), 389-397, Website (http://www.nrs.fs.fed.us/pubs/jrnl/2012/nrs_2012_song_001.pdf) accessed November 10, 2013.

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

70 Ibid.

the decision for households to participate in converting. As provided in **Table 3.10**, once households convert, it is expected the availability of a lower priced heating fuel will begin to alter the utilization of their natural gas systems and their wood heating system so that their eventual annual savings is approximately $1,816 when compared to their initial oil heating system. However, the decision to convert will more than likely be based upon the initial savings obtained ($1,856) from switching their existing heating oil system to a natural gas system.

Table 3.10 Effect of Heating Fuel Price Reduction on Existing Heating Oil/Wood System Utilization

	Primary	Secondary	Total
Heating oil boiler/wood energy use (Mcf)[1]	125	57	182
Current average heating expenditures (oil/wood)	$3,731	$803	$4,534
Initial savings obtained by converting oil heating system to natural gas	$1,856	$0	$1,856
Natural gas price effects on system energy use over time (Mcf equivalent)	169	13	182
Annual heating expenditures with natural gas	$2,538	$181	$2,718
Annual Savings over time	$1,194	$622	$1,816

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

This analysis does not estimate the rate of conversion for those study area households which use wood as a primary or secondary fuel and do not use heating oil as a heating fuel. However, this is a small proportion of total FNSB households. For instance, as illustrated in **Table 3.2** above, wood is the primary or secondary fuel used by 45.7 percent (31.0 percent plus 14.7 percent) of FNSB households, while wood is used in conjunction with oil by 38.9 percent (29.2 percent and 9.7 percent) of FNSB households. It is unknown how the remaining 6.8 percent of FNSB households that use wood in some capacity will respond to the availability of natural gas and have been excluded from this analysis.

4 Conversion Rate Research

This section describes previous research and empirical data on how quickly natural gas systems are installed in residential homes and businesses once natural gas service is available. This section focuses on the rate of conversion in various locales, with particular focus on communities in Alaska. Information specific to the expected conversion rate in the mock build-out service area in the FNSB borough, including new data developed specifically for this analysis, is then presented and discussed.

4.1 Conversion Rates in Other Communities

This section presents information on natural gas conversion in Homer and Kachemak City, as well as general conversion information obtained from the ENSTAR natural gas utility. As highlighted in **Table 2.6**, approximately 66 percent of households in Homer use oil as their primary heating fuel, while 78 percent of Kachemak City households use oil as their primary fuel. This is similar to Fairbanks and North Pole, where 73 percent and 85 percent of households, respectively, use oil as their primary heating fuel. However, homes in Homer and Kachemak City differ from Fairbanks and North Pole in that a higher proportion of homes in Homer (15 percent) and Kachemak City (9 percent) use propane as their primary fuel, while propane is used as a primary fuel by one percent of households in both Fairbanks and North Pole.

Other discrepancies between Homer, Kachemak City, Fairbanks, and North Pole is that, with exception of a few properties, all of Homer and Kachemak City property owners are paying an assessment to cover the cost of building the natural gas distribution system. Furthermore, interviews with area heating experts and realtors familiar with housing stock indicate that a high proportion of homes have space heaters such as Monitor stoves.[71] Based upon these interviews, it was determined that it is common for homes in Homer built prior to 2000 to have space heaters, while homes build after 2000 to typically have boiler systems.[72] Furthermore, the number of Homer households with furnaces is considered negligible, while furnaces account for nearly 19 percent of FNSB primary heating systems.[73] [74]

Despite the differences between the Fairbanks area and the Homer area the process of developing a natural gas distribution system and the rate of business and residential conversion within the Homer area provides valuable context for how the process may occur in the Fairbanks area.

4.1.1 Homer, Alaska

The construction of the 23 mile natural gas line that brings natural gas from Anchor Point to Homer and Kachemak City began in March of 2013.[75] The entire Homer distribution system is a network of 73 miles of pipeline that will carry gas from the trunk line to homes and businesses throughout the city. Once constructed, approximately 90 percent of lots within the city's boundaries will have access to natural gas, while the remaining ten percent of lots will not have access to natural gas due to legal access issues, the

[71] Pitzman, Denise, Alderfer Group Reality, Personal communication with Lee Elder, Cardno ENTRIX, November 18, 2013.

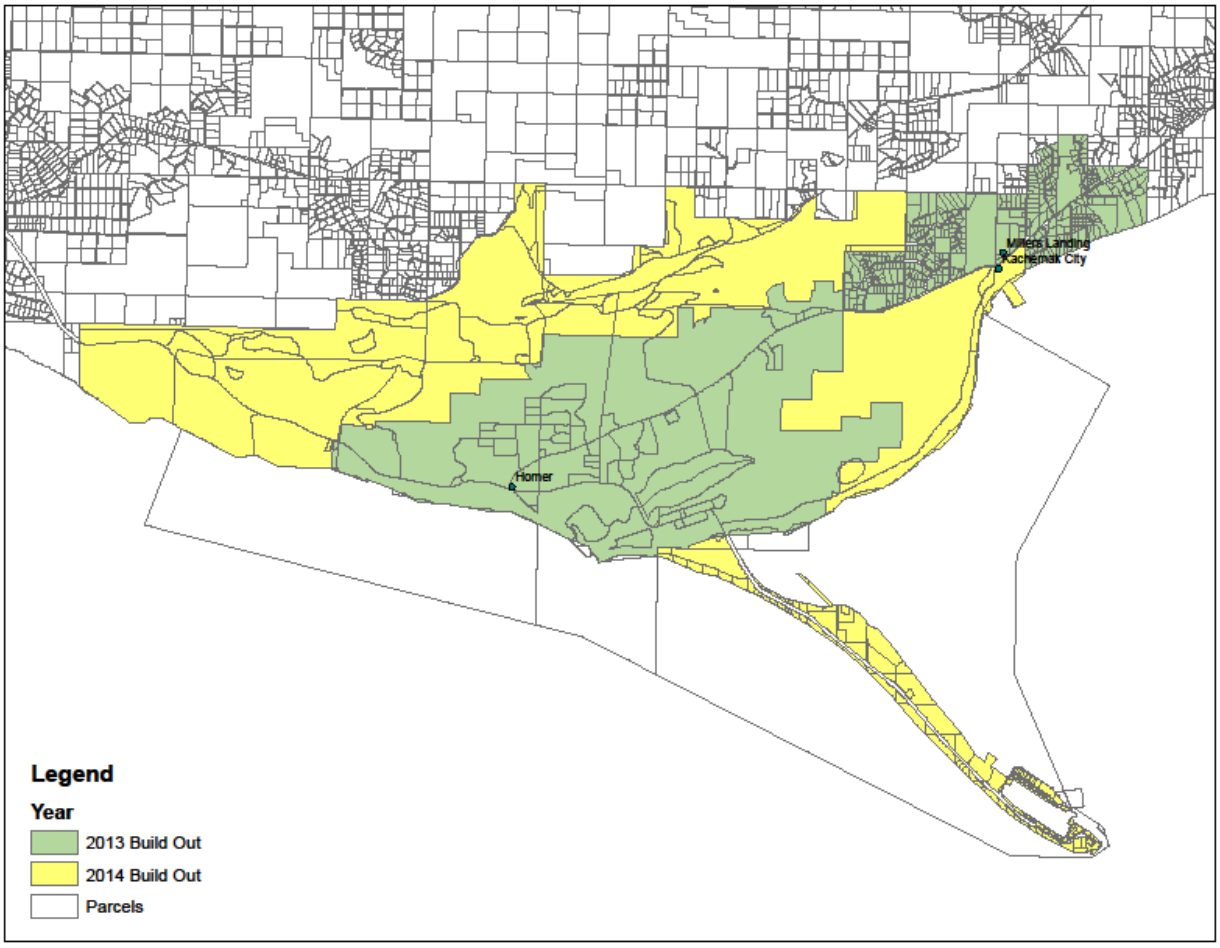
[72] Cavasos, Connie, VBS Heating, Personal communication with Lee Elder, Cardno ENTRIX, November 16, 2013.

[73] Pitzman, Denise, Alderfer Group Reality, Personal communication with Lee Elder, Cardno ENTRIX, November 18, 2013.

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

[75] City of Homer, Construction of the Gasline, Website (http://www.cityofhomer-ak.gov/naturalgas/construction-gas-line) accessed October 18, 2013.

lot is undevelopable, or if extensive piping is required to serve only a few customers.[76] Construction of Phase 1 of the Homer distribution system is nearly complete with one mile of pipe to be installed.[77]



Source: ENSTAR, Homer Expansion, Website (http://www.enstargas.com/HomerExpansion.aspx) accessed November 2, 2013.

Figure 4.1 Homer and Kachemak City Distribution System Build-out Phases

ENSTAR expects a total of 3,000 residential and commercial customers in the Homer area once the distribution system is completely built out.[78] Furthermore, ENSTAR anticipates that 95 percent of residential dwellings in Homer will convert within seven years and that 100 percent of commercial customers will convert within three years.[79] Phase 1 of the distribution system will provide service to approximately 1,200 customers by the end of 2013, while Phase 2 of the project is anticipated to extend service to an additional 1,800 customers by the end of 2014. As of October 30, 2013, ENSTAR has 871

[76] City of Homer, Forming a Homer Special Assessment District, Website (http://www.cityofhomer-ak.gov/naturalgas/how-does-special-assessment-district-work) accessed November 24, 2013.

[77] City of Homer, Fall Update: Progress on Natural Gas, October 30, 2013, Website (http://www.cityofhomer-ak.gov/naturalgas/fall-update-progress-natural-gas) accessed November 13, 2013.

[78] Spence, Hal, February 25, 2007, Enstar Plan would Deliver South central's Gas to Homer, Website (http://www.alaskajournal.com/Alaska-Journal-of-Commerce/February-2007/Enstar-plan-would-deliver-Southcentrals-gas-to-Homer/) accessed November 24, 2013.

[79] Pierce, Charlie, Southern Division Manager, ENSTAR, January 13, 2012, City of Homer Natural Gas Distribution System, Core Area Construction Cost Estimate, Memorandum to Walt Wrede, Homer City Manager.

service lines installed for Phase 1 and anticipated installing the remaining 81 service lines during November 2013.[80] Despite there being 871 service lines, a total of 1,170 meters have been sold within the community because some service lines have multiple meters. As of October 31, 2013, approximately 200 meters are turning and providing gas to Phase 1 customers. However, it is estimated that an additional 400 to 500 residents are currently attempting or have scheduled an appointment for heating and plumbing contractors to convert their homes.[81]

Approximately 98 percent of Homer households in Phase 1 (1,170/1,200) have exhibited their willingness to convert to natural gas given they have currently elected to pay for their natural gas service line and the meter. However, to date, 16 percent of households in Phase 1 have actually converted during the first year and an estimated 33 to 42 percent[82] are attempting to convert. This high level of willingness to convert may be partially influenced by the fact that each property owner in the community was required to pay a $3,283 assessment for the natural gas distribution system. Some Homer residents may have the perception that since they have paid an assessment for the distribution system they should take advantage of the system and switch to natural gas.

4.1.1.1 Comparison to Fairbanks: Demographics and Conversion Costs

The demographics for Homer are comparable to Fairbanks and North Pole in some respects, but differ in others. Homer has a total population of nearly 5,000, while Fairbanks and North Pole have populations of 31,500 and 2,240, respectively. The population of Homer is less mobile than the residents of Fairbanks and North Pole. For instance, 19 percent of the population 18 years or older in Homer were not in the same household as last year, while 34 percent and 26 percent of the population in Fairbanks and North Pole, respectively, were not in the same house as last year. This is attributable to the large number of military personnel and their dependents residing in the Fairbanks area. Military personnel and their dependents comprise approximately 20 percent of FNSB population. By comparison, nearly 60 people (1 percent of the population) in Homer are employed in the armed forces.[83] A large military presence has implications on the mobility of the population since on average military personnel will receive orders to relocate to a new assignment every two to three years.[84]

The high mobility of a population also has implications on the composition of the housing market. For example, 63 percent of occupied homes in Fairbanks are renter occupied, whereas nearly 40 percent of occupied homes in Homer are renter occupied. The number of renter occupied homes in North Pole is similar to Homer, with approximately 42 percent of occupied homes being renter occupied.

Income characteristics for Homer are similar to Fairbanks. The median household income for occupied homes in Homer is $55,600, while median income for occupied homes in Fairbanks is $55,400. The proportion of families living in poverty is lower in Homer (4.9 percent) than Fairbanks (7.3 percent) and North Pole (5.8 percent).

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[80] City of Homer, Fall Update: Progress on Natural Gas, October 30, 2013, Website (http://www.cityofhomer-ak.gov/naturalgas/fall-update-progress-natural-gas) accessed November 13, 2013.

[81] Simpson, Lanny, Energy Resource Analyst, Eayr's Plumbing and Heating, Personal communication with Lee Elder, November 20, 2013

[82] Ibid.

[83] Census Bureau, Table DP03, Selected Economic Characteristics, 2007-2011 ACS 5-Year Estimates, Website (http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml) accessed November 24, 2013.

[84] Department of Defense, Office of the Deputy Under Secretary of Defense Installations and Environment, Website (http://www.acq.osd.mil/housing/housing101.htm) accessed November 3, 2013.

The City of Homer is paying for the distribution system through a $12.7 million loan from the Kenai Borough[85] which will be repaid by Homer residents through a special property assessment regardless of whether or not the property owner elects for natural gas service. With approximately 3,855 lots in Homer, each property owner will be responsible for paying $3,283 for each lot/parcel that they own.[86] Residents can either pay this $3,283 assessment upfront or finance this amount at 4 percent interest over a ten year period, which is a $33 per month payment. As this cost is incurred by all property owners, regardless of whether they connect to the natural gas line, this is a 'sunk cost' that may not affect the economics of choosing to pay for the service line and appliances necessary to convert to natural gas. However, in reality, by requiring all households to contribute to the cost of the natural gas distribution system, conversion rates in Homer may be higher and faster as people may be more inclined to convert to natural gas since they have already paid for access to natural gas.

It is the choice of each homeowner whether to pay for the service line connecting the home to the main line of the Homer distribution system. Provided the homeowner signs up for service prior to end of 2013, the cost of this service line will be $1,290 for the first 100 feet and $2 for every additional foot of service line required to provide natural gas to the home.[87] The homeowner will also be required to pay for the meter for their home, which will cost approximately $200.

In addition to these connection costs, each household converting to natural gas will incur expenses related to purchasing natural gas appliances and/or converting their existing system to natural gas. In order to have the natural gas meter turned on at a Homer residence, ENSTAR requires that the homeowner must have at least one natural gas appliance installed and ready to use in their home. Equipment costs can differ dramatically depending on the equipment purchased and/or the modifications necessary to the homes existing system. A recent analysis for the City of Homer evaluated the cost of converting home heating systems for seven Homer households, and illustrates the broad range of conversion costs for area residents.[88] As illustrated in **Table 4.1** below, the cost of converting each homes heating system to natural gas varies widely, ranging from approximately $2,350 to $14,150.

4.1.1.2 Homer Heating Systems

The costs of converting to natural gas will differ between Homer households, but these conversion costs for the specific system types are generally aligned with Fairbanks conversion costs. Homer is distinct from Fairbanks in that all property owners in Homer pay a property assessment to pay for the distribution system and a higher proportion of homes have space heaters such as Monitor stoves. Personal communication with area heating system retailers and realtors familiar with housing stock indicate that a high proportion of homes have space heaters.[89] Interviews also indicate that it is common for homes built prior to 2000 to have space heaters, while newer homes typically have boiler systems.[90] Furthermore, the number of Homer households with furnaces is considered to be negligible.[91]

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85 Van Cleave, Ariel, March 22, 2013, Assembly Approves Gasline Loan for Homer, Website (http://kbbi.org/content/assembly-approves-gasline-loan-homer) accessed October 19, 2013.

86 City of Homer, Forming a Homer Special Assessment District, Website (http://www.cityofhomer-ak.gov/naturalgas/how-does-special-assessment-district-work) accessed October 19, 2013.

87 Armstrong, Michael, February 18, 2013, After Debate, Homer Maker Move Toward Natural Gas, Website (http://homernews.com/homer-news/2013-06-19/enstar-gas-line-build-out-%E2%80%94-questions-answered) accessed October 20, 2013.

88 Smith, Bill, Homer Case Studies, Website (http://www.cityofhomer-ak.gov/sites/default/files/fileattachments/case_studies_conversion_comparisons_updated_10-15.pdf) accessed September 12, 2013.

89 Pitzman, Denise, Alderfer Group Reality, Personal communication with Lee Elder, Cardno ENTRIX, November 18, 2013.

90 Cavasos, Connie, Personal communication with Lee Elder, Cardno ENTRIX, November 16, 2013.

91 Pitzman, Denise, Alderfer Group Reality, Personal communication with Lee Elder, Cardno ENTRIX, November 18, 2013.

As described above, the proportion of Homer households with a specific type of heating systems was based upon interviews with Homer residents familiar with the housing stock. The proportion of households by primary fuel type was obtained from the Census Bureau and then applied to the proportion of households using a boiler/baseboard system or a space heater. It was assumed that households that use electricity, wood and other fuels for their primary heating fuel also used a heating oil space heater as a secondary system.[92] Heating system type and the fuel used for Homer household are provided in **Table 4.1** below. The primary systems provided in **Table 4.1** represent 100 percent (2,684 households) of the households in Homer.

Approximately one percent of Homer households report using utility gas as a primary fuel. Utility gas is defined by the Census Bureau as gas that is piped through underground pipes from a central system.[93] It is anticipated that these one percent of households actual use propane since there were no centralized gas distribution systems located in Homer over the 2007 – 2011 timeframe when the ACS conducted surveys for the area. Furthermore, area propane distribution companies were unable to identify any centralized gas distribution system that would have existed over the 2007-2011 timeframe.[94]

Table 4.1 Homer Primary and Secondary Heating System Pairs

Primary Heating Fuel	Primary Systems (% of Households)[1]	Heating System Types	Relative use of heating systems[2]	Percent of total households	Total Homer Households
Oil	66.1%	Baseboard	33%	22%	591
		Other heater	67%	44%	1,182
Propane	14.8%	Baseboard	33%	5%	132
		Other heater	67%	10%	264
Electricity (Oil secondary assumed)	11.1%	Baseboard	0%	0%	0
		Other heater	100%	11%	298
Wood (Oil secondary assumed)	4.2%	Baseboard	0%	0%	0
		Other heater	100%	4%	114
Utility Gas	1.3%	Baseboard	33%	0%	12
		Other heater	67%	1%	23
Other[3] (Oil secondary assumed)	2.5%	Baseboard	0%	0%	0
		Other heater	100%	3%	68
Baseboard				27%	735
Other heater				73%	1,949
Total				100%	2,684

1 US Census Bureau, ACS 2007 - 2011 Data, Table B25040, House Heating Fuel, Website (http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml) accessed November 4, 2013.

2 Pitzman, Denise, Alderfer Group Reality, Personal communication with Lee Elder, Cardno ENTRIX, November 18, 2013.

3 Other primary heating fuels include coal, solar, and other

92 Pitzman, Denise, Alderfer Group Reality, Personal communication with Lee Elder, Cardno ENTRIX, November 18, 2013.

93 Social Explorer, Data Dictionary, Website (http://www.socialexplorer.com/data/ACS2010/metadata/?ds=ACS10&var=B25040001) accessed December 6, 2013.

94 Amerigas, Personal communication with Lee Elder, Cardno, December 2, 2013.

The total capital costs for conversion in Homer is similar to total capital cost estimates expected for the Fairbanks area. For example, it is estimated that total homeowner costs for switching out an oil burner with a natural gas burner will be $3,500 in Homer, while this same conversion will be approximately $3,000 in Fairbanks. The total capital costs for installing a high-efficiency boiler and water heater in Homer (approximately $14,000) is comparable to estimates provided by Fairbanks area heating and plumbing experts ($7,750 - $13,950).[95] [96] Based upon personal communication with area heating and plumber specialists, of those homeowners converting to natural gas in Homer approximately one-third are switching their burners, one-third are getting new boilers, and one-third are getting new natural gas space heaters.[97]

The price of natural gas in Homer is approximately $10.75 when accounting for ENSTARs base rate, gas cost adjustment, trunk line tariff, and customer account charge.[98] [99] It is expected that natural gas from the IEP will cost approximately $15 per Mcf.[100] This price for natural gas in Homer excludes the cost of the distribution system since the distribution system cost will be paid by all Homer residents regardless of their conversion decisions.

[95] Smith, Preston, Frontier Plumbing Supply, Personal communication with Shanna Zuspan, Agnew::Beck, October 3, 2013.

[96] Pavey, Rocky, Rocky's Heating Service, Personal communication with Shanna Zuspan, Agnew::Beck, October 15, 2013.

[97] Simpson, Lanny, Energy Resource Analyst, Eayr's Plumbing and Heating, Personal communication with Lee Elder, November 20, 2013

[98] ENSTAR, Rates & Regulatory, Website (http://www.enstargas.com/RatesRegulatory.aspx) accessed January 3, 2014.

[99] Customer account charge calculation assumes the annual $162 customer account charge ($13.50 monthly) is allocated over 150 Mcf of annual natural gas usage.

[100] AIDEA and AEA, July 2013, Interior Energy Project Feasibility Report, Website (http://www.interiorenergyproject.com/Resources%20and%20Documents/Feasibility_Report_72013.pdf) accessed December 13, 2013.

Table 4.2 Conversion Cost Repayment Schedule for Homes in Homer

	Home 1	Home 2	Home 3	Home 4	Home 5	Home 6	Home 7	House 8	Retail Shop	Office building
Existing System	**Oil Boiler**	**Oil Boiler**	**Oil Space Heater**	**Oil Furnace**	**Propane Boiler**	**Oil Space Heater**	**Propane Boiler and Space Heater**	**Oil Furnace**	**Propane Space Heater**	**Oil Boiler**
Type of Conversion	**Replace burner**	**Replace boiler w/high-efficiency unit**	**Replace space heater**	**Furnace replaced w/high-efficiency unit**	**Convert existing propane system**	**Replace space heater**	**Convert boiler & space heater**	**Replace with high-efficiency furnace**	**Convert Existing Space Heater**	**Replace burner**
Total Capital Costs (A)	$3,464	$14,147	$2,615	$6,326	$2,351	$4,158	$4,531	$6,099	$2,435	$3,726
Current annual heating cost (oil) (B)	$3,437	$4,388	$1,491	$2,544	$3,481	$2,010	$4,900	$2,983	$2,036	$6,039
Anticipated annual heating costs (natural gas) (C)	$1,173	$1,497	$509	$781	$746	$687	$1,674	$917	$388	$2,522
Annual fuel cost savings (D = B - C)	$2,264	$2,891	$982	$1,763	$2,735	$1,323	$3,226	$2,066	$1,648	$3,517
Avg. mthly fuel cost savings (E = D / 12)	$189	$241	$82	$147	$228	$110	$269	$172	$137	$293
Mthly conversion cost payments (assuming 10 year terms and 6% interest) F	$38	$157	$29	$70	$26	$46	$50	$68	$27	$41
Avg. mthly bill savings (G = E - F)	$150	$84	$53	$77	$202	$64	$219	$104	$110	$252
Years until savings repay total conversion costs (A / D)	1.5	4.9	2.7	3.6	0.9	3.1	1.4	3.0	1.5	1.1

Source: Smith, Bill, October 15, 2012, Homer Case Studies, Website (http://www.cityofhomer-ak.gov/sites/default/files/fileattachments/case_studies_conversion_comparisons_updated_10-15.pdf) accessed September 12, 2013.

4.1.2 Kachemak City, Alaska

The Kachemak City distribution system is anticipated to cost nearly $1.2 million.[101] The city is funding $400,000 of this with their own funds, while a private group of investors are funding $600,000 of the project. The remaining portion is to be financed through the Kenai Borough. The interest rate on these funding sources is to be 4 percent.[102]

These loans are to be repaid by Kachemak City residents through an assessment against each lot in the community. With approximately 380 lots in Kachemak City, each property owner within the service area will pay approximately $3,200 for each lot/parcel that they own.[103] Residents could pay this $3,200 assessment upfront; however the city is allowing for residents to repay this amount over a 10-year period at an interest rate of 4 percent.[104]

As is the case for Homer residents, it is the responsibility of Kachemak City homeowners to purchase the service line connecting the home to the main line of the Kachemak City distribution system. Provided the homeowner signed up for service prior to July 1, 2013, the cost of this service line will be $1,290 for the first 100 feet and $2 for every additional foot of service line required to provide natural gas to the home.[105] The homeowner will also be required to pay for the meter for their home, which will cost approximately $200.

A rebate program was implemented by Kachemak City to encourage residents to sign up for natural gas service. Kachemak City residents are eligible for a $500 rebate if they pay ENSTAR for the connection ($1,290) prior to July 1st. Once residents pay this connection fee they must submit proof to the City for the rebate. Primary program funding for this rebate program is provided through the mainline allowance pay back provided to the city by ENSTAR. A mainline allowance from ENSTAR provides the distribution system developer a credit based upon the estimated annual load of the home. Rather than using this credit from ENSTAR to pay down debt; Kachemak City elected to use the freemain allowance to encourage residents to convert to natural gas.

A total of 243 homes are to be located in the Kachemak City service area and as of September 2013, of these homes 190 have signed up for a natural gas service line.[106] Therefore, as of September 2013, approximately 78 percent of homes in the service area are exhibiting a willingness to convert to natural gas. The purchase of a service line does not necessarily mean homeowners have installed gas appliances or have started using natural gas. As of September 2013, 175 meters had been installed in the community and approximately 100 meters are running and providing gas to homes.[107]

4.1.2.1 Comparison to Fairbanks: Demographics and Conversion Costs

Kachemak City has a much smaller population (nearly 700 people) than both Fairbanks and North Pole. Furthermore, the population of Kachemak City is much less mobile than the residents of Fairbanks and North Pole. For instance, 11 percent of the population 18 years or older in Kachemak City were not in the same household as last year, while 34 percent and 26 percent of the population in Fairbanks and North

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[101] Morse, Phil, Mayor of Kachemak City, Personal communication with Lee Elder, October 21, 2013.

[102] Ibid.

[103] Ibid.

[104] Morse, Phil, Mayor of Kachemak City, Personal communication with Lee Elder, September 16, 2013.

[105] Armstrong, Michael, February 18, 2013, After Debate, Homer Maker Move Toward Natural Gas, Website (http://homernews.com/homer-news/2013-06-19/enstar-gas-line-build-out-%E2%80%94-questions-answered) accessed October 20, 2013.

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

[107] Morse, Phil, Mayor of Kachemak City, Personal communication with Lee Elder, October 21, 2013.

Pole, respectively, were not in the same house as last year. Furthermore, unlike Fairbanks and North Pole, Kachemak City does not have any armed services employees in the community[108]

The high mobility of a population also has implications on the composition of the housing market. For example, 62 percent of occupied homes in Fairbanks are renter occupied, while 18 percent of occupied homes in Kachemak City are renter occupied. The number of renter occupied homes in North Pole is also much higher than in Kachemak City, with approximately 42 percent of occupied homes being renter occupied.

Income characteristics for Kachemak City are similar to Fairbanks. The median household income for occupied homes in Kachemak City is $55,500, while median income for occupied homes in Fairbanks is $55,400. The proportion of families living in poverty is lower in Kachemak City (3.3 percent) than Fairbanks (7.3 percent) and North Pole (5.8 percent).

Given Kachemak City's proximity to Homer, the conversion cost provided for Homer in **Table 4.2** above, are representative of Kachemak City. As previously described, each property owner is required to pay $3,200 for each lot that they own. For most property owners this will be only one lot; however some residents own multiple lots. As is the case for Homer, the property assessment for the natural gas distribution system in Kachemak City may partially influence residents to convert to natural gas more than would normally occur. Property owners will also be required to pay at a minimum $1,290 for a service line; however, for those property owners that require more than 100 feet of service line will be required to pay $2 for each additional foot of the line. Kachemak City residents are eligible for a $500 rebate if they pay ENSTAR for the connection ($1,290 prior to July 1st). Additionally, each property owner will be required to purchase a meter, which cost approximately $200.

4.1.2.2 Kachemak City Heating Systems

The majority of homes in Kachemak City (78 percent) use heating oil as the primary fuel to heat their homes.[109] The second most common heating fuel used in Kachemak City is propane, with 9 percent of homes using propane as their primary heating fuel. Since Kachemak City and Homer adjoin one another, the proportion of Kachemak City households with a specific type of heating systems was based upon the same interviews obtained for the Homer estimates. It was assumed that households that use electricity, wood, and other fuels for their primary heating fuel also used a heating oil space heater as a secondary system.[110] The primary systems provided in **Table 4.3** below represent 100 percent (386 households) of the households in Kachemak City.

Approximately six percent of Kachemak City households report using utility gas as a primary fuel. Utility gas is defined by the Census Bureau as gas that is piped through underground pipes from a central system.[111] As is the case with Homer, it is anticipated that these six percent of households use propane since there were no centralized gas distribution systems located in the community over the 2007 to 2011 timeframe when the ACS conducted surveys for the area.

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[108] Census Bureau, Table DP03, Selected Economic Characteristics, 2007-2011 ACS 5-Year Estimates, Website (http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml) accessed November 24, 2013.

[109] U.S. Census Bureau, American Community Survey 5-Year Estimates, Website (https://www.census.gov/acs/www/), accessed October 15, 2013.

[110] Ibid.

[111] Social Explorer, Data Dictionary, Website (http://www.socialexplorer.com/data/ACS2010/metadata/?ds=ACS10&var=B25040001) accessed December 6, 2013.

Table 4.3 Kachemak City Primary and Secondary Heating System Pairs

Primary Heating Fuel	Primary Systems (% of Households)[1]	Heating System Types	Relative use of heating systems[2]	Percent of total households	Total Kachemak City Households
Oil	77.9%	Baseboard	33%	26%	100
		Other heater	67%	52%	200
Propane	9.2%	Baseboard	33%	3%	12
		Other heater	67%	6%	24
Electricity (Oil secondary assumed)	2.6%	Baseboard	0%	0%	0
		Other heater	100%	3%	10
Wood (Oil secondary assumed)	3.0%	Baseboard	0%	0%	0
		Other heater	100%	3%	11
Utility Gas	6.3%	Baseboard	33%	2%	8
		Other heater	67%	4%	16
Other[3] (Oil secondary assumed)	1.0%	Baseboard	0%	0%	0
		Other heater	100%	1%	4
Baseboard				31%	120
Other heater				69%	266
Total				100%	386

1 US Census Bureau, ACS 2007 - 2011 Data, Table B25040, House Heating Fuel, Website (http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml) accessed November 4, 2013.

2 Pitzman, Denise, Alderfer Group Reality, Personal communication with Lee Elder, Cardno ENTRIX, November 18, 2013.

3 Other primary heating fuels include coal, solar, and other

4.1.3 ENSTAR

ENSTAR is a regulated gas utility that serves approximately 350,000 Alaska residents through 134,000 meters.[112] ENSTAR is the natural gas service provider for Homer and Kachemak City and has been conducting business in Alaska since 1961. This analysis conducted interviews with ENSTAR representatives to understand their experiences and expectations regarding the conversion process in Alaska communities where service has been extended.

Within the first year of a system build-out ENSTAR expects that 60 percent of the total customer base will convert to natural gas, with approximately 75 percent converting by the second year. [113] Within three years of providing natural gas service to an area ENSTAR expects approximately 90 percent of the customer base with access to natural gas to convert.[114] Additional conversion rate estimates, specific to Homer from ENSTAR, indicate they expect 95 percent of residences to convert within seven years and that 100 percent of commercial customers will convert within three years.[115] It was also conveyed that

112 ENSTAR., About ENSTAR, Website (http://www.enstargas.com/AboutENSTAR.aspx) accessed November 25, 2013.

113 Pierce, Charlie, ENSTAR, Southern Division Manager, Personal communication with Lee Elder, September 23, 2013.

114 Starring, Coleen, Personal communication with Lee Elder, Cardno ENTRIX, Shanna Zuspan, Agnew::Beck and Shelly Wade, Agnew::Beck, September 18, 2013.

115 Pierce, Charlie, Southern Division Manager, ENSTAR, January 13, 2012, City of Homer Natural Gas Distribution System, Core Area Construction Cost Estimate, Memorandum to Walt Wrede, Homer City Manager.

approximately 5 percent of the population will not convert to natural gas.[116] Therefore, by the seventh year, ENSTAR estimates that all of those that are willing to convert will have converted.

4.1.4 FNBS Borough Conversion

4.1.4.1 Previous Fairbanks Estimate

Based on the same general service area considered in this study, a previous study conducted in June 2013 estimated the demand for natural gas in Fairbanks over the 2025 to 2030 period by projecting the rate of conversion. As shown in **Table 4.4**, this previous research projects that 10 percent of the residential homes will convert in the first year of each build-out phase, while another 40 percent will convert in the second year (for 50 percent cumulative conversion by end of year 2). By the end of the fourth year, 85 percent of the residential customer base for each Phase is anticipated to have converted to natural gas.

Table 4.4 Estimated Cumulative Conversion Rates by Year and Customer Type for Each Project Phase

	Year									
	1	2	3	4	5	6	7	8	9	10
Residential	10%	50%	70%	85%	90%	91%	92%	93%	94%	95%
Commercial	10%	60%	80%	90%	100%					
Multi-Residential	10%	60%	80%	90%	100%					

Source: Cuyno, Leah and Pat Burden, June 21, 2013, Estimated Natural Gas Demand for the NS LNG Project, Website (http://www.interiorenergyproject.com/Resources%20and%20Documents/Estimated%20Natural%20Gas%20Demand.pdf) accessed October 17, 2013.

4.1.4.2 FNSB Focus Groups

As part of this present study a series of four focus groups were held in Fairbanks and North Pole over a three-day period in late October of 2013 (See Appendix D). While focus groups are not designed to provide statistically representative data, they provide considerable qualitative information to help understand the key issues. Three of the four focus groups were held at the Noel Wien Public Library in Fairbanks and one was held at North Pole High School in North Pole. There were 46 participants representing 41 households at these meetings. The objectives of the focus groups were to obtain information on the following:

> Rate of household conversion to natural gas

> Percent of households willing to make the switch

> Factors impacting the rate of household conversion

> Incentive programs that will increase the rate of conversion

Compared to the general population, the focus group participants were older, had higher household income, and were all homeowners. Focus group participants had a higher proportion of boiler/baseboard primary heating systems (84 percent) than exhibited throughout the borough (63 percent of households).[117] Despite this, a similar proportion of focus group participants (83 percent) use heating oil

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

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

as their primary fuels as evident throughout the borough (81 percent of households).[118] The age of primary heating systems used by focus group participants is similar to the age distribution for all homeowners in the borough.[119]

The focus groups provided participants an overview of the IEP, highlighted the comparative savings of using natural gas versus wood and fuel oil, and discussed various types of incentive programs that might be available to assist FNSB residents with natural gas conversion costs. The focus group sessions solicited participant input on a number of home heating topics, including but not limited to: participant cost of heating, existing heating fuel sources, and likelihood and timing of converting once natural gas is available. Focus group participants were first asked about the likelihood and timing of their converting without any incentives, and then asked how their likelihood and timing of converting would change with incentives.

As provided in **Figures 4.2** and **4.3** below, 95 percent of focus group respondents indicated that they would be somewhat likely, very likely, or certain to convert to natural gas without being offered any incentives. Of those interested in converting, 62 percent of respondents indicated that they would convert within a year, while 21 percent indicated that they would convert within 1 – 2 years. Following the discussion of possible incentive programs 100 percent of respondents were somewhat likely, very likely, or certain to convert to natural gas, exhibiting a 5 percent increase in likelihood of converting. In addition, when respondents were specifically asked how quickly they would convert to natural gas provided an incentive program was available, 73 percent indicated they would convert within a year or less, while 20 percent of respondents would convert in 1 – 2 years. These responses indicate that at least for the type of people participating in the focus groups, the availability of incentive programs may increase the number of people converting by approximately 10 percent within a year, and may increase the final number of residential homes converting by approximately 5 percent.

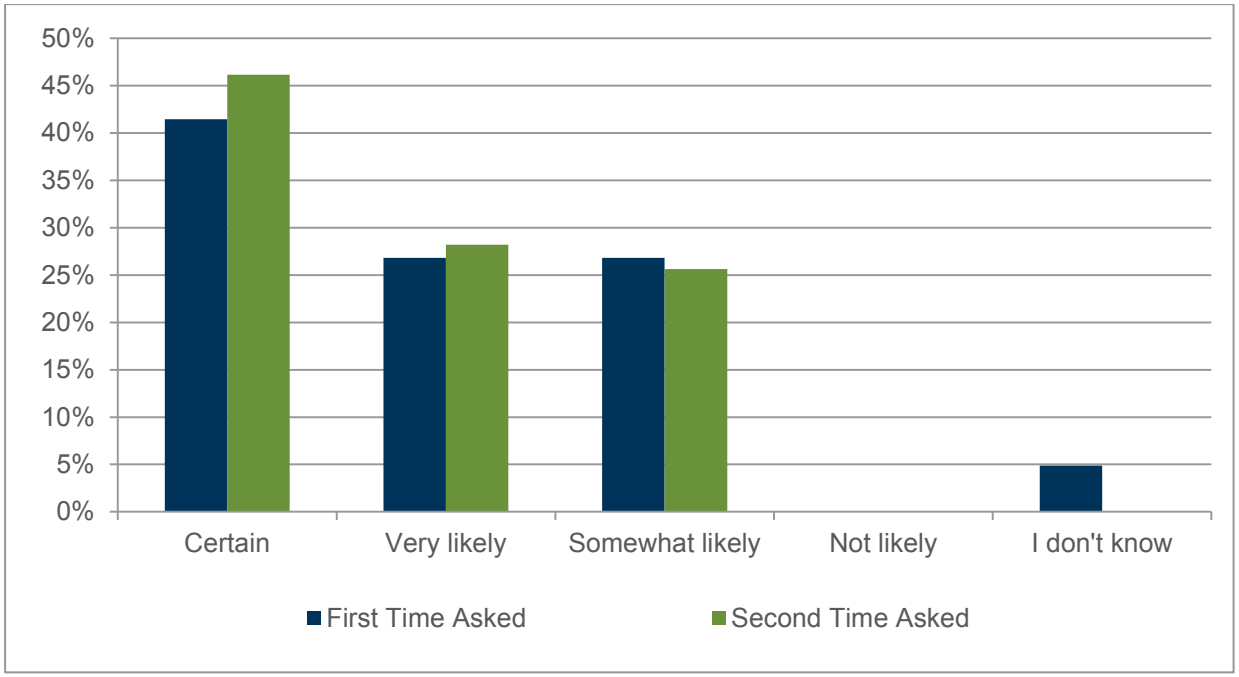

Figure 4.2 Focus Group Participants Willingness to Convert (WTC) to Natural Gas

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

[119] Ibid.

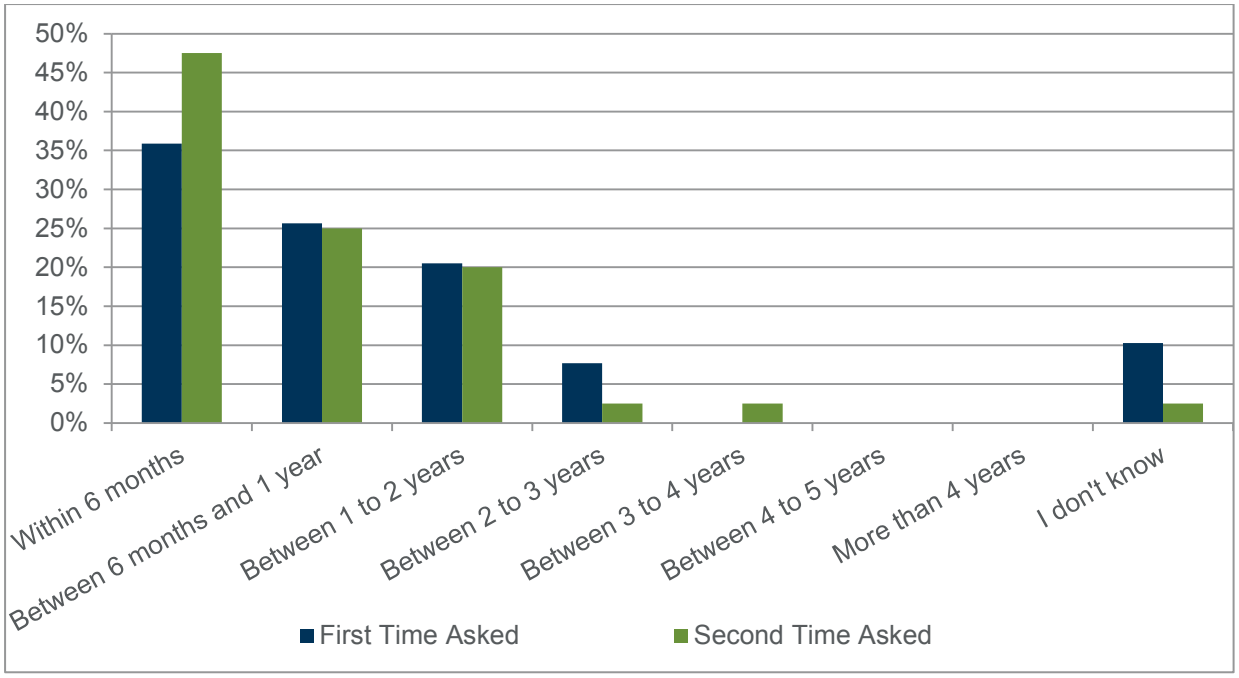

Figure 4.3 Focus Group Participants Rate of Natural Gas Conversion

Information from focus group participants was obtained on how their likelihood to convert varied based on different annual savings and upfront costs of converting (similar to the IGU study). A series of slides were presented to participants, which asked them to select one of two potential conversion scenarios for their household, identify if they were indifferent to either scenario, or if they did not know which scenario they prefer. The scenarios differed in the up-front costs and annual savings. The results were analyzed to estimate how focus group participants weigh the up-front costs and annual savings.

Focus group responses indicate that participants are willing to pay roughly $4.38 more in upfront-costs for every additional dollar in annual savings. This can also be interpreted to indicate that focus group participants, on average, will convert if they will recoup capital costs within 4.38 years. **Figure 4.4** illustrates how the likelihood of conversion increases with increased annual fuel savings. The graph displays the likelihood to convert at different savings rates with upfront conversion cost fixed at $6,000. **Figure 4.5** highlights how the likelihood of converting decreases with rising capital costs. The Figure shows the proportion of focus groups opting to convert at different capital cost levels, given an annual savings of $1,800. These results are generally consistent with the IGU survey, although focus groups did indicate that they would convert at a higher rate for a given cost/savings combination compared to the IGU survey respondents. This is likely due to the fact that focus group attendees were higher income and older than the general FNSB population.

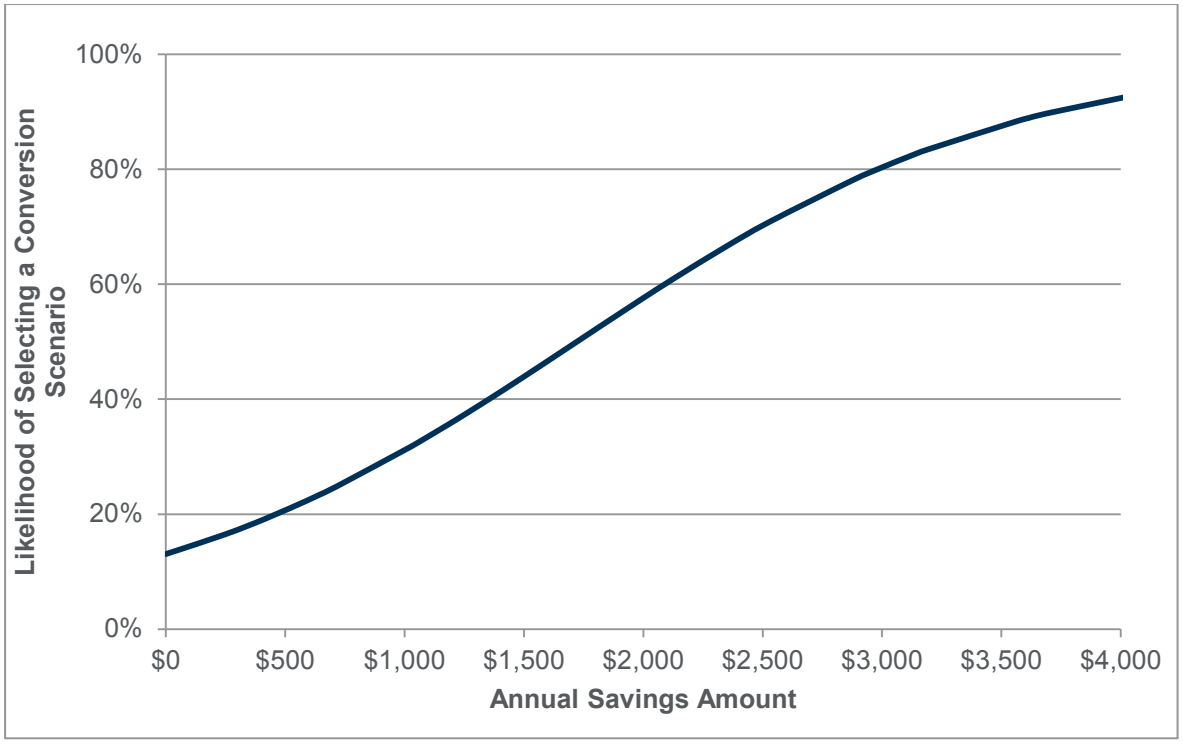

Figure 4.4 Likelihood of Converting at Different Annual Savings Levels (At $6,000 Conversion Cost)

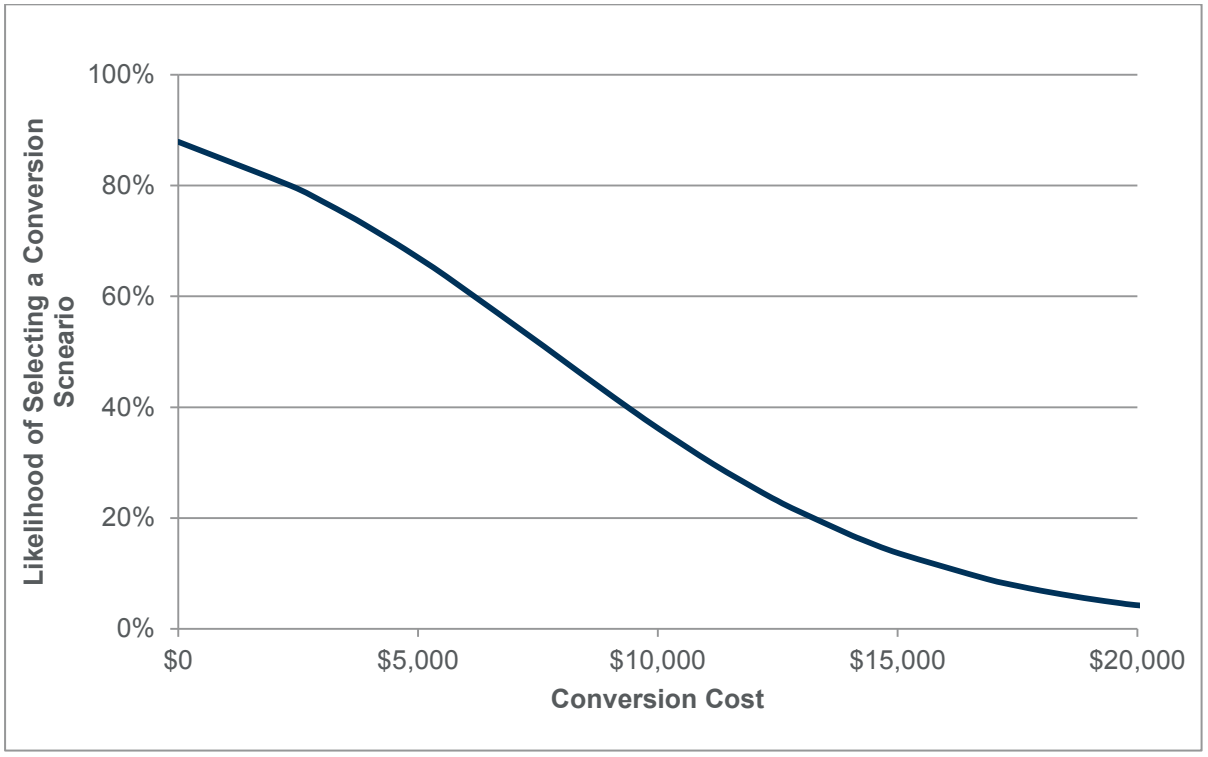

Figure 4.5 Effects of Conversion Cost on Likelihood of Converting (At $1,800 Annual Savings)

4.1.5 Rental and Multi-Family Conversion

As described in Chapter 2, a large proportion of homes in Fairbanks and North Pole are rental properties. A series of interviews were conducted with Fairbanks area rental property owners and managers to have a better understanding of whether natural gas conversion rates may differ for rental properties than for owner-occupied housing. These interviews indicate that most multi-unit property owners in the Fairbanks area pay the heating oil cost for their units, while heating bills in single-family units are typically paid by the tenant. Similar to homeowners, the rate at which rental property owners would convert to a natural gas system will depend on the cash flow and the economics of converting rental units. The upgrading of a rental property heating system is currently incentivized because rental property owners receive tax deductions for equipment upgrades to a property through depreciation write-off.[120] In general, the interviews indicate that multi-family rental property owners would convert at similar rates as homeowners.

The interest by landlords in converting to natural gas, even for single-family rentals, is evident by the examples of Birchwood Homes and JL Properties. Birchwood Homes is unique to other single-family rental properties in the Fairbanks area in that the property owner purchases the heating fuel for each home within the community. Birchwood Homes is a community of single-family 3, 4, and 5 bedroom homes located adjacent to Fort Wainwright in Fairbanks. Many of the tenants in the community are military families given the proximity to the base and the community has an average turnover rate of two years. Birchwood Home's representatives express a high demand for natural gas and have been actively petitioning for natural gas service to be extended to the property. Property management anticipates connecting to natural gas within a 90 day period, once natural gas is available to the community.

JL Properties is the largest real estate development and rental firm in Alaska. Within Fairbanks the company has six apartment complexes, which include Jillian Square (356 units), Sophie Plaza (355 units), Willow Woods (228 units), Yak Estates (97 units), Northward Building (177 units), and Parkwest (84 units).[121] Each of these apartment complexes use heating oil for heating purposes, with the exception of the Northward Build which is on steam. In total, JL Properties own and manage approximately 1,300 apartment units in Fairbanks, of these 1,120 units use fuel oil for heating purposes. Provided that natural gas supply was available to their properties, JL Properties indicate they would more than likely convert their complexes to natural gas within a three year timeframe.[122]

4.1.6 FNSB Business Conversion Interviews

Nineteen FNSB businesses were contacted and interviewed regarding their interest in converting to natural gas, and the speed at which they would likely convert. These business owners were provided a description of the IEP and what the potential cost saving would be if they were to convert to natural gas. **Table 4.5** below provides a summary of each business's response. Approximately 89 percent (17 out of the nineteen) of interviewed businesses responded "Maybe" or "Yes" to conversion. Eight businesses indicated that they would convert within 2 years, while six businesses specified they would need to evaluate the cost of conversion and their financials to determine how quickly they would convert.

[120] Enoch, Phyllis, Northern Homes Owner, Personal communication with Lee Elder, Cardno ENTRIX, November 1, 2013.

[121] JL Properties, Inc., Fairbanks Residential Properties, Website (http://www.jlproperties.com/projects/fairbanks.php) accessed November 4, 2013.

[122] Snell, Riley, JL Properties Property Manager, Personal communication with Lee Elder, Cardno ENTRIX, November 1, 2013.

Table 4.5 FNSB Business Interview Results

Type of Business	Current fuel or system	Would you be willing to switch to natural gas?	How quickly would you expect to convert to natural gas?
Freight transportation company	Boiler	Yes if much cheaper than heating oil	No response
Drilling company	Diesel	Maybe, if it's trucked in it won't be much cheaper than diesel. If it's in the price range as natural gas in Anchorage then yes.	No response
Insurance adjustor	Electric forced air	Yes	Subject to conversation costs and pricing
Auto dealership	Fuel oil	Yes	Less than a year
Fraternal organization	Fuel oil	No, if it cost $15,000 like I was reading in the paper.	No response
Machine shop	Fuel oil	Yes, if the annual saving estimates are accurate.	Within a year
Restaurant and gas station	Heating Fuel	Don't know	No response
Auto part retailer	Heating fuel	Yes	Immediately
Beauty salon	Heating Fuel	Yes	Up to the building owner
Architectural firm	Heating Oil	Yes	Depends on financials
Car wash	Heating oil	Yes	Immediately
Mechanic	Multiple systems; boiler and others	Yes, if annual cost is half	Would depend on what is involved in conversion
Charter school	Oil	Yes	Within one to two years
Bank	Oil	yes	Within one to two years
Martial arts academy	Oil	Yes, if half the cost of heating oil	Depends on available funds and cost of conversion
Gas station	Oil	Depends on the conversion cost, but if reasonable then yes	Within a few months
Hostel	Oil	Maybe	Depends on what is involved with the conversion
Fitness facility	Oil furnace	Yes if cost effective.	Depends on cost effectiveness. We need a five year return on investment for us to do anything.
Drilling company	No response	Yes	Immediately

Multiple FNSB businesses, Personal communication with Rush Childs, Cardno ENTRIX, November 22, 2013.

4.1.7 Interior Gas Utility Report

IGU is the Fairbanks/North Pole area natural gas utility with exclusive rights to serve the “expansion area” within the FNSB. IGU recently funded a telephone survey of 800 FNSB homeowners to understand home

heating attributes and to estimate homeowner willingness to convert to natural gas. Specifically, the primary objectives for the IGU report were to determine the following:

> The average annual energy use per residential unit for all sources (heating oil, wood, and other)

> The age of existing fuel oil heating systems and type (boiler, furnace and other)

> The likely conversion rate from the existing heating system to natural gas system, based upon a range of natural gas prices ($14 Mcf to $24 per Mcf)

> The number of heat conversion participants and amount of assistance required for home conversion

> Level of interest and expected participation in heating system change out programs through direct state loans or through an on-bill loan repayment mechanism

The survey also elicited respondents' willingness to convert based on different combinations of conversion costs and fuel savings. Survey respondents were told to assume that the cost of conversion would be financed with a low interest loan or through their utility bill. Responses were statistically analyzed to generate a predictive model for FNSB resident's willingness to convert to natural gas (assuming that low interest loan is available for conversion). The resulting willingness to convert estimates at varying conversion costs and savings levels are provided in **Table 4.6** below.

Table 4.6 IGU Report Projected Conversion Rates Using Conversion Cost and Annual Savings

Annual Savings	Conversion Costs									
	$2,000	**$4,000**	**$6,000**	**$8,000**	**$10,000**	**$12,000**	**$14,000**	**$16,000**	**$18,000**	**$20,000**
$5,000	95%	95%	88%	76%	67%	59%	53%	48%	43%	38%
$4,500	95%	95%	85%	74%	64%	57%	51%	45%	40%	36%
$4,000	95%	95%	83%	71%	62%	54%	48%	42%	37%	33%
$3,500	95%	95%	79%	68%	58%	51%	45%	39%	34%	30%
$3,000	95%	92%	76%	64%	55%	47%	41%	35%	31%	26%
$2,500	95%	88%	71%	60%	50%	43%	37%	31%	26%	22%
$2,000	95%	83%	66%	54%	45%	38%	31%	26%	21%	17%
$1,500	95%	76%	59%	47%	38%	31%	24%	19%	14%	10%
$1,000	95%	66%	50%	38%	29%	21%	15%	9%	5%	5%
$500	78%	50%	33%	21%	12%	5%	5%	5%	5%	5%

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

5 Forecast Conversion Rates

This section presents estimates of willingness of residents and businesses to convert (at any time in the future), and the expected rate or speed of conversion. Both the total number of eventual natural gas customers, as well as the timing of conversion has implications for the financing and economic benefits of the IEP.

The study area for this analysis is the proposed natural gas service area surrounding and encompassing Fairbanks and North Pole. The study area is based on a mock six-year (six phase) build-out for FNG and the IGU developed by AEA based upon personal communication with these utilities. The build out area and the associated customer base, for each phase of the project will ultimately depend on each utility's construction decisions. This analysis expects FNG to expand service within its existing service area while IGU will expand service the FNSB expansion area (see **Figure 2.1**).

This analysis provides baseline willingness to convert estimates based the IGU willingness to convert predictive model together with our analysis of capital costs and fuel savings to predict the number of households that would convert within each project Phase. We test the predictive ability of the IGU model by applying it to Homer, Alaska and comparing results to actual, observed willingness to convert rates. Applying the IGU model to the Homer area, using fuel cost and heating system data specific to Homer, indicates that the IGU model is likely accurate within approximately five percent of conversion rates (after adjusting for other factors that vary between Homer and Fairbanks, such as population mobility).

Table 5.1 below provides the total expected number of single-family residential, multi-family residential and commercial/industrial businesses within each phase expected to convert each year using the Method A and Method B approach. The only source of discrepancy between each method is due to the anticipated number of single-family residential households expected to convert under each method. The expected number of multi-family residential and commercial/industrial businesses is expected to remain the same under both analytical approaches. It is expected that by Year 12 all of those willing to convert within each phase will have done so. Therefore, 77 percent of the total 22,006 single-family residential, multi-family residential and commercial/industrial businesses within the proposed service area are expected to convert using the Method A approach, while 82 percent of the total customer base is expected to convert under the Method B approach.

Table 5.1 Expected Annual Conversion Rate for Single-Family Residential, Multi-Family Residential, and Commercial/Industrial

Method A	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
Phase 1 (Const. Year 0)	810	3,260	4,070	4,860	5,060	5,170	5,270	5,380	5,390	5,390	5,390	5,390	5,390
Phase 2 (Const. Year 1)	0	450	1,740	2,190	2,630	2,760	2,830	2,900	2,970	2,980	2,980	2,980	2,980
Phase 3 (Const. Year 2)	0	0	310	1,210	1,510	1,820	1,910	1,950	2,000	2,050	2,060	2,060	2,060
Phase 4 (Const. Year 3)	0	0	0	340	1,360	1,700	2,040	2,130	2,180	2,230	2,280	2,280	2,280
Phase 5 (Const. Year 4)	0	0	0	0	350	1,380	1,730	2,080	2,180	2,240	2,300	2,350	2,360
Phase 6 (Const. Year 5)	0	0	0	0	0	300	1,160	1,450	1,750	1,830	1,880	1,930	1,980
Total Single-Family	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
Rate of Conversion	*3%*	*14%*	*25%*	*36%*	*46%*	*56%*	*65%*	*70%*	*72%*	*74%*	*74%*	*75%*	*75%*
Total	810	3,710	6,120	8,590	10,920	13,120	14,930	15,900	16,470	16,720	16,880	17,000	17,050
Rate of Conversion	*4%*	*17%*	*28%*	*39%*	*50%*	*60%*	*68%*	*72%*	*75%*	*76%*	*77%*	*77%*	*77%*

5.1 Study Area Customer Base

The number of residential, multi-family, and commercial structures, as estimated by the AEA, represents the potential customer base for natural gas service for the IEP. AEA used 2013 FNSB land/parcel tax database and input from area utilities to derive estimates of the number of structures within each phase of the project.

The geographic boundary of the IEP natural gas service area is based on a mock six-year build-out for FNG and IGU developed by AEA based upon personal communication with utility representatives. The build out area and the associated customer base, for each phase of the project will ultimately depend on each utility's construction decisions. This analysis expects FNG to expand service within its existing service area while IGU will expand service to the FNSB expansion area (see Figure 2.1).

The study area customer base is estimated by determining any parcel that falls within 100 feet of the mock distribution system build-out. The structures located on these parcels were considered to be the potential customer base for the mock distribution system.

As provided in **Table 5.2** below, once the natural gas distribution system is completely built, the total potential residential customer base is expected to include 20,077 homes, 721 manufacturing facilities, 1,184 commercial facilities, and 24 industrial users for a total customer base of 22,006 structures.

Table 5.2 Study Area Natural Gas Distribution System Customer Base

Build-Out Phase	Miles of Pipeline	Residential	Multi-Family Residential Structures	Small Commercial	Midsize Commercial	Large Commercial	Industrial	Total Structures
1	143.4	6,026	370	292	384	84	21	7,177
2	140.8	3,758	59	52	42	2	2	3,915
3	127.3	2,667	39	51	50	3	0	2,810
4	122.5	2,396	193	132	14	0	0	2,735
5	143.4	2,850	22	36	19	1	1	2,929
6	105.4	2,380	38	13	8	1	0	2,440
Total	782.8	20,077	721	576	517	91	24	22,006

Source: AEA and AIDEA, Personal communication with Lee Elder, Cardno ENTRIX, September 17, 2013.

5.2 Construction Schedule

As noted in **Table 5.2** above the IEP is anticipated to be built in six project phases. The construction of each project phase is expected to last one construction season. Therefore, complete buildout of the IEP is anticipated to take a total of six years. Based upon the buildout of the Homer natural gas system it is known that as the natural gas distribution system is constructed and pressurized natural gas is available for some areas within each phase as construction occurs. **Table 5.3** below provides the anticipated buildout schedule for the IEP.

Table 5.3 IEP Construction Schedule

Phase	Construction Period (Year)
Phase 1	Year 0 (2015)
Phase 2	Year 1 (2016)
Phase 3	Year 2 (2017)
Phase 4	Year 3 (2018)
Phase 5	Year 4 (2019)
Phase 6	Year 5 (2020)

5.3 Baseline Willingness to Convert

This section provides willingness to convert results along with additional detail on the approach used to derive willingness to convert estimates. Willingness to convert estimates for single-family residential, multi-family residential and commercial/industrial properties are provided below.

5.3.1 Baseline Single-Family Residential Willingness to Convert

The baseline single-family residential willingness to convert estimates relies upon the IGU Survey predictive model to estimate the number of study area households that will eventually convert to natural gas. As described in Chapter 2, heating expenditures for single-family rental properties are generally the responsibility of the tenant. [123] It is anticipated that owners of single-family rental properties will be as willing to convert to a natural gas system as owners of single-family residential properties that are not rentals, but at a slower rate (see Section 5.3.1 below).

The baseline single-family willingness to convert was modified to account for differences in conversion rates by phase due to the differences in the number of military homeowners likely to reside in each phase of the project. Due to their high mobility (reside on average two to three years in FNSB), without incentives military homeowners are assumed to not convert since most households would not recoup the conversion cost within a three year time period. As provided in **Table 5.4**, it is anticipated that, on average, 75 percent of households in the study area are willing to convert to natural gas. Phase 1, 2, and 3 are proximate to Fort Wainwright and Eielson Air Force Base, and are assumed to be the home of 520 military homeowners as follows; Phase 1 (200 military homeowners), Phase 2 (120 military homeowners), and Phase 3 (200 military homeowners). [124] [125] We assume that military homeowners would not convert under baseline conditions, and that these phases would therefore have a lower conversion rate based on

[123] Enoch, Phyllis, Northern Homes Owner, Personal communication with Lee Elder, Cardno ENTRIX, November 1, 2013.

[124] Ft. Wainwright Family Housing, Personal communication with Lee Elder, Cardno ENTRIX, December 2, 2013.

[125] U.S. Air Force, July 2009, Housing Requirements and Market Analysis, Eielson Air Force Base 2009 – 2014, Website (http://adminpress.jllpress.com/Continental_Group/documents/EielsonAFBHRMA14-Jul-09.pdf) accessed November 3, 2013.

the number of military homeowners; while all other phases would have a higher conversion rate to maintain an overall average conversion rate of 75 percent in the study area.

Table 5.4 Single-Family Residential Willingness to Convert by Phase

Phase	Households	IGU Predictive Model WTC	Adjusted for Military Homeowners
Phase 1	4,388	73%	70%
Phase 2	2,915	78%	75%
Phase 3	2,069	78%	72%
Phase 4	1,820	76%	81%
Phase 5	2,136	75%	80%
Phase 6	1,803	76%	81%
Total build-out	15,132	75%	75%

5.3.1.1 IGU Survey Model (Method A) Results

The IGU predictive model was used to determine the number of households that are willing to convert within each project phase for Method A. As provided in **Table 5.5** below, of the total 20,077 single-family residential households within the study area, there are an estimated 15,120 single-family households willing to convert to natural gas. Therefore, Method A estimates that 75 percent of the total single-family homeowners would be willing to convert to natural gas.

Table 5.5 Service Area Willingness to Convert (WTC) to Natural Gas – Single-Family Residential Homeowners (Method A)

System Type	Households Using Oil	Capital Cost Conversion	Savings	Percent WTC	Estimated WTC
Oil/No Secondary					
Baseboard (Burner Switch only)	4,200	$2,700	$2,300	100%	4,200
Baseboard (new boiler)	2,100	$9,100	$2,300	55%	1,150
Furnace	1,900	$6,400	$2,200	68%	1,300
Other Oil Heater	780	$3,100	$1,400	87%	680
Oil/Wood					
Baseboard (Burner Switch only)	2,740	$2,700	$1,900	100%	2,740
Baseboard (new boiler)	1,370	$9,100	$1,900	50%	690
Furnace	1,240	$6,400	$2,500	71%	880
Other Oil Heater	510	$3,100	$1,400	87%	450
Wood/Oil					
Baseboard (Burner Switch only)	300	$2,700	$1,500	95%	280
Baseboard (new boiler)	150	$9,100	$1,500	45%	70
Furnace	260	$6,400	$1,900	65%	170
Other Oil Heater	1,240	$3,100	$1,500	89%	1,100
Oil/Other					

System Type	Households Using Oil	Capital Cost Conversion	Savings	Percent WTC	Estimated WTC
Baseboard (Burner Switch only)	660	$2,700	$1,900	100%	660
Baseboard (new boiler)	330	$9,100	$1,900	50%	170
Furnace	300	$6,400	$2,500	71%	210
Other Oil Heater	120	$3,100	$1,400	87%	110
Other/Oil					
Baseboard (Burner Switch only)	60	$2,700	$900	82%	50
Baseboard (new boiler)	30	$9,100	$900	33%	10
Furnace	50	$6,400	$3,600	80%	40
Other Oil Heater	230	$3,100	$300	50%	120
Total	18,570				15,120
Percent of Study Area Single-Family Residential	92%				75%

5.3.1.2 Adjusted IGU Survey Model (Method B) Results

Scenario B derives estimates for Fairbanks by adjusting the IGU model results based on its predictive ability for Homer. In this method, we apply the IGU predictive model to Homer (with Homer specific data on fuel costs and heating system usage) so as to compare the predictive model results for Homer to the actual willingness to convert estimate for Homer Phase 1 (98 percent). Approach B compares predictive modeling results with actual, observed conversion behavior to identify whether the IGU model may under- or over-estimate results. After accounting for differences between Homer and the study area, Method B findings indicate that the IGU model may underestimate conversion in Fairbanks by approximately 5 percent. Results from this method therefore indicate that conversion rates in Fairbanks would be approximately 80 percent.

To apply the model in Homer, we estimated the proportion of households in Homer that use oil or propane as a primary or secondary heating fuel and the proportion of households that use oil or propane boilers and space heaters. Unlike the FNSB, furnaces were not considered to be a conversion option since a minor number of Homer households use furnaces as a heating system. In addition, this approach also required estimating the conversion costs and natural gas savings (based on lower natural gas costs) associated with conversion in Homer.

The average Mcf of energy required for the four homes with space heating and water heating energy use modeled in the *Homer Case Study* is 123 Mcf per year. This is derived using the existing household heating expenditures provided in the *Homer Case Study* and dividing these expenditures by the price of $4 per gallon for those systems using fuel oil and $3.35 per gallon for those systems using propane. Using the average household energy use of 123 Mcf in conjunction with $4 per gallon for heating oil; total average annual expenditures for these households equates to $3,686 per household. Conversely, when these homes convert to natural gas, which is priced at $10.50 per Mcf, the total annual heating cost is $1,290, or a savings of $2,396 per year and a decrease of 65 percent in total annual heating expenditures.

In the Fairbanks/North Pole area, space heating and hot water energy needs are approximately 167 Mcf annually. Assuming all of this energy demand is met with $4 per gallon fuel oil the total annual heating costs for these homes is $5,039. Conversely, if all of this energy demand is met with $15 Mcf natural gas the total annual heating cost would equate to $2,520. Heating with natural gas priced at $15 per Mcf would save Fairbanks/North Pole residents $2,520 annually, or a decrease of 50 percent in total heating

expenditures. Fairbanks annual average savings from natural gas conversion is thus approximately $125 more than average cost savings in Homer.

5.3.2 Homer Conversion Economics

Homer conversion economics data are based on a combination of data sources. As provided in **Table 5.6** below, this research combined data from heating and plumbing experts from Homer and the FNSB alike. FNSB boiler conversion cost estimates were used for the Homer model due to the limited number of boiler installation costs obtained specific to Homer. The saving estimates used for this analysis were obtained from a previous analysis of natural gas conversion economics in Homer.[126]

Method B incorporates primary heating fuel type for Homer households as determined by the Census Bureau and applied these estimates to the proportion of households using a boiler/baseboard system or space heater to derive an estimate of heating systems that use oil or propane as a primary or secondary fuel. The proportion of households with a specific type of heating system is based upon personal communication with area heating system retailers and realtors.[127] In addition, these interviews indicate that the number of Homer households with furnaces is negligible and therefore these heating systems have been excluded from the Homer predictive model results.[128]

Table 5.6 Homer Natural Gas Heating System Conversion Cost Estimates

System	Heating and Plumbing Expert	Business #1	FNSB Estimates	Average Conversion Cost	Anticipated Annual Savings
Boiler high efficiency unit w/hot water	$14,147		$10,663	$12,405	$2,891
Boiler medium efficiency unit w/hot water			$8,963	$8,963	$2,891
Burners	$3,464 - $3,726			$3,595	$2,264
Convert propane boiler	$2,351			$2,351	$2,735
Space heaters	$2,615 - $4,158	$2,000 - $3,500		$3,068	$1,153
Convert propane space heater	$2,435			$2,435	$1,648

Smith, Bill, October 15, 2012, Homer Case Studies, Website (http://www.cityofhomer-ak.gov/sites/default/files/fileattachments/case_studies_conversion_comparisons_updated_10-15.pdf) accessed September 12, 2013.

Simpson, Lanny, Energy Resource Analyst, Eayr's Plumbing and Heating, Personal communication with Lee Elder, November 20, 2013

FNSB estimates provided in Table 3.4.

5.3.2.1 Method B Approach

As provided in **Table 5.7** below, the IGU model predicts that 84 percent of Homer households are willing to convert to natural gas.

[126] Smith, Bill, October 15, 2012, Homer Case Studies, Website (http://www.cityofhomer-ak.gov/sites/default/files/fileattachments/case_studies_conversion_comparisons_updated_10-15.pdf) accessed September 12, 2013.

[127] Pitzman, Denise, Alderfer Group Reality, Personal communication with Lee Elder, Cardno ENTRIX, November 18, 2013.

[128] Ibid.

Table 5.7 Homer, Alaska WTC to Natural Gas – Single-Family Residential Homeowners

Existing Prim./Sec Systems	% of Homer	Oil Heating System Types	Boiler Burner Switch and Propane Conversion				Oil Space Heater Replacement				Propane Space Heater Conversion				Boiler Replacement				Total WTC
			House holds	Annual Savings	Avg. Convt. Cost	% WTC	House holds	Annual Savings	Avg. Convt. Cost	% WTC	House holds	Annual Savings	Avg. Convt. Cost	% WTC	House holds	Annual Savings	Avg. Convt. Cost	% WTC	
Oil	66.1	Baseboard	394	$2,300	$3,600	93									197	$2,900	$9,300	60	484
		Other heater					1,182	$1,200	$3,100	84									988
Propane*	16.1	Baseboard	96	$2,700	$2,400	100									48	$2,900	$9,300	60	124
		Other heater					155	$1,200	$3,100	84	132	$2,700	$2,400	100					262
Electricity (Oil sec. assumed)	11.1	Baseboard	0	$2,300	$3,600	93									0	$2,900	$9,300	60	0
		Other heater					298	$1,200	$3,100	84									249
Wood (Oil sec. assumed)	4.2	Baseboard	0	$2,300	$3,600	93									0	$2,900	$9,300	60	0
		Other heater					114	$1,200	$3,100	84									95
Other (Oil sec. assumed)	2.5	Baseboard	0	$2,300	$3,600	93									0	$2,900	$9,300	60	0
		Other heater					68	$1,200	$3,100	84									57
Total																			2,259
Percent of Total																			84%

In Homer 98 percent of the total Phase 1 customer base has purchased a service line connection (approximately $1,290), indicating their commitment to convert to natural gas.

As shown in **Table 5.7** above, 84 percent of Homer households are willing to convert to natural gas. The nine percent difference in predictive model results between the study area (75 percent) and Homer (84 percent) are attributable to differences in the economics of conversion between the two areas: the lower price of natural gas in Homer (leading to higher per unit fuel savings with conversion) and the different types of heating systems in Homer that, on average, are less costly to convert. The lower price of natural gas in Homer accounts for an estimated 3.0 percent of the discrepancy between the two areas, while the difference between heating systems within the two areas accounts for 6.2 percent.

The remaining 13.3 percent difference between the predictive model results for Homer (84.2 percent) and the actual willingness to convert estimates for Homer Phase 1 (97.5 percent) is only partially explainable by the factors identified in this study to affect conversion rates. First, within the study area 2.6 percent of homeowners are military personnel that have higher mobility (and thus less ability to recoup conversion investment costs). In comparison, there are few military personnel in Homer. It is expected that study area military homeowners will not convert unless payback periods are less than three years as they are typically relocated within a two to three year period. Therefore, the number of military homeowners within the study area is expected to explain approximately 2.6 percent of the difference between the two areas (i.e., Homer's conversion rate may be up to 2.6 percent higher than the study area due to the military presence).

After adjusting for military, there is still 10.7 percent of unexplained difference between the observed rates in Homer and the IGU predictive model results. Some of the difference may be attributable to the assessment fee of $3,283 that every property owner in Homer was required to pay, which might increase conversion rates since people feel that they have already partially paid for the natural gas conversion. There are likely other factors that distinguish willingness to convert between Homer and FNSB residents. As a conservative estimate, Method B assumes that these other factors account for another 5.7 percent difference in Homer and Fairbanks conversion rates. With this assumption, we estimate that the IGU predictive model may be underestimating conversion by approximately 5 percent (approximately one-half of the unexplained difference provided in **Figure 5.1** below). Therefore, under Method B, willingness to convert within the study area is anticipated to be 80 percent.

Figure 5.1 below identifies the factors causing a difference in the willingness to convert estimates for the study area using the IGU predictive model (75.1 percent) and the actual Homer willingness to convert estimates (98%). An estimated 3.0 percent is due to the higher fuel cost savings in Homer (due to lower natural gas prices), another estimated 6.2 percent is due to heating system types in Homer that are less expensive to convert (lower capital cost of conversion), and 2.6 percent is estimated to be due to the military presence in the study area that is highly mobile and therefore less likely to convert due to the unlikelihood of recouping conversion costs. Of the remaining 10.7 percent, approximately 5.7 percent is expected to be attributable to other differences between the study area and Homer, including the property assessment fee in Homer paid by all property owners to finance the natural gas distribution system. The remaining 5 percent we expect may be due to the IGU model underestimating conversion rates. Therefore, based on the Method B analysis, we estimate that approximately 80 percent of study area homeowners will convert.

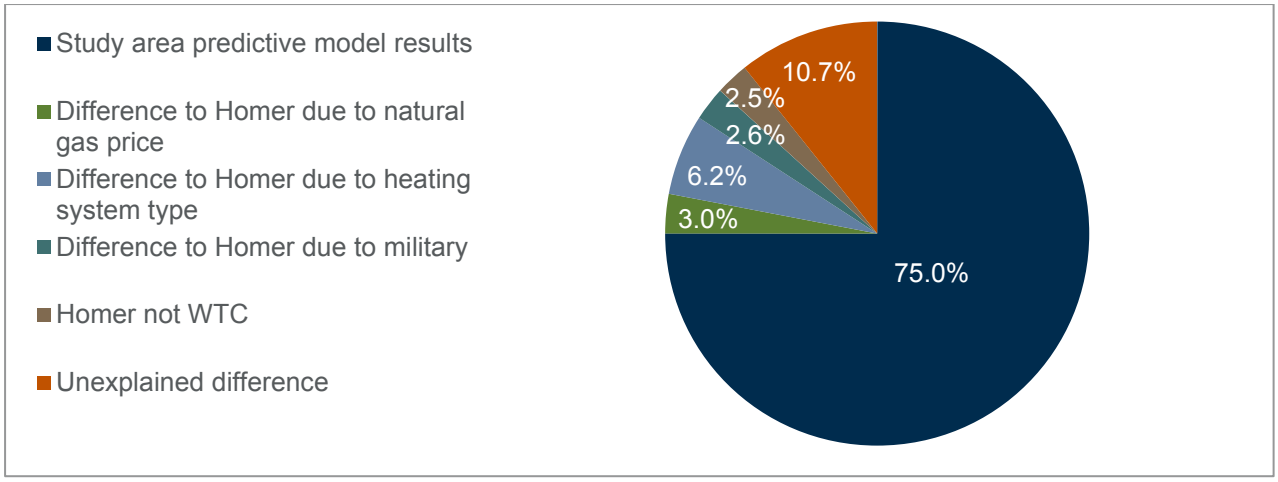

Figure 5.1 Sources of Discrepancy in Study Area Predictive WTC to Homer Actual WTC Rate

The application of the IGU model to the Homer area indicates that the IGU model (Method A) is a good predictor (likely within 5 percent) of study area conversion rates. Therefore this analysis uses the Method A methodology do derive conversion rate results and ultimately IEP natural gas demand estimates.

5.3.3 Multi-Family Residential Willingness to Convert

Available data indicates that 100 percent of multi-family residential units within the study area will convert to natural gas. Multi-family residential units are nearly all rentals, and since the landlord pays the fuel bills, this is essentially a business decision by landlords. Research indicates that most building owners invest in energy efficiency improvements when the simple payback period is less than ten years, and conversion to natural gas should provide a payback period in this range.[129] Furthermore, interviews with multi-family landlords indicated that all would convert within three years (see Section 4.1.5). Finally, previous research on multi-family residences concluded that 100 percent would be willing to convert in the FNSB.[130]

5.3.4 Commercial and Industrial Willingness to Convert

Available data indicates that 100 percent of business within the study area will convert to natural gas. This is based upon interviews with area businesses (90 percent conversion rate), the commercial willingness to convert estimates provided by ENSTAR, and by previous research on FNSB conversion rates, both of which predict a 100% conversion rate.[131] As provided in Section 4.1.3, ENSTAR anticipates that 100 percent of businesses will convert within three years of providing natural gas service to an area.[132] Previous research concluded that 100 percent of businesses will convert within five years of service being available.[133]

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[129] Johnson Controls, June 3, 2010, Johnson Controls 2010 Energy Efficiency Indicator Global Survey Results, Website ((http://pacenow.org/wp-content/uploads/2012/07/EEI-2010-Global-Executive-Summary-ENG.pdf) accessed December 13, 2013.

[130] Cuyno, Leah and Pat Burden, June 21, 2013, Estimated Natural Gas Demand for the NS LNG Project, Website (http://www.interiorenergyproject.com/Resources%20and%20Documents/Estimated%20Natural%20Gas%20Demand.pdf) accessed October 17, 2013.

[131] Ibid.

[132] Pierce, Charlie, Southern Division Manager, ENSTAR, January 13, 2012, City of Homer Natural Gas Distribution System, Core Area Construction Cost Estimate, Memorandum to Walt Wrede, Homer City Manager.

[133] Cuyno, Leah and Pat Burden, June 21, 2013, Estimated Natural Gas Demand for the NS LNG Project, Website (http://www.interiorenergyproject.com/Resources%20and%20Documents/Estimated%20Natural%20Gas%20Demand.pdf) accessed October 17, 2013.

5.4 Baseline Timing of Conversion

The timing of conversion is estimated below for single-family residential properties, single-family rental properties, multi-family residential properties, and commercial/industrial properties. Research 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. Natural gas pipeline construction would occur in the summer, or in those months when the ground is not frozen. Therefore, due to the timing of construction homeowners and businesses will have access to natural gas at different periods during the construction period.

The timing of conversion within the study area is based on the rate of conversion provided by ENSTAR and the estimated rates of conversion provided by the Northern Economic memo. 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 three 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. [134] Stated differently, of those single-family residential properties that are going to convert, all will have done so by year 7.

Table 5.8 Estimated Cumulative Conversion Rates by Customer Type by Year

	Construction (Year 0)1	1	2	3	4	5	6	7	8
Single-family residential[2]	15%	60%	75%	90%[3]	91%	93%	94%	95%	95%
Single-family renter occupied	15%	45%	60%	75%	90%	93%	95%	98%	100%
Commercial	15%	70%	85%	100%[4]	100%	100%	100%	100%	100%
Multi-Residential	15%	70%	85%	95%	100%	100%	100%	100%	100%

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

2 Unless noted; Pierce, Charlie, ENSTAR, Southern Division Manager, Personal communication with Lee Elder, September 23, 2013.

3 Starring, Coleen, Personal communication with Lee Elder, Cardno ENTRIX, Shanna Zuspan, Agnew::Beck and Shelly Wade, Agnew::Beck, September 18, 2013.

4 Pierce, Charlie, Southern Division Manager, ENSTAR, January 13, 2012, City of Homer Natural Gas Distribution System, Core Area Construction Cost Estimate, Memorandum to Walt Wrede, Homer City Manager.

5.4.1 Single-Family Residential

Currently, in Homer approximate 200 meters out of the 1,170 residents in Phase 1 willing to convert to natural gas are providing gas to area homes. This represents a conversion rate of 17 percent during the construction year during each phase of the project. Based upon the number of converted homes in Homer during the year of the natural gas systems' construction, we conservatively estimate that 15 percent of single-family residential properties will connect during the project construction year (Year 0), while a cumulative 60 percent of the customer base will convert in the first full year of system operation (Year 1).

As described in Chapter 2, heating expenditures for single-family rental properties are generally the responsibility of the tenant. [135] Further, landlords for these properties are anticipated to convert at a lower rate than owner occupied single-family homes, because owners of these properties would be less inclined

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

[135] Enoch, Phyllis, Northern Homes Owner, Personal communication with Lee Elder, Cardno ENTRIX, November 1, 2013.

to spend money on a new heating system when they would not experiencing any of the benefits of heating with a less expensive heating fuel. However, this may be offset by the fact that landlords need to provide competitive rental options in order to keep their properties rented.

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. This analysis assumes that single-family rental owners will take an additional year for these property owners to fully convert versus single-family residential properties that are not rentals.

In order to measure magnitude of this effect, this analysis applied the average rental occupancy rate for single-family homes in Fairbanks and North Pole to determine that 15 percent of single-family residential households within the study area are single-family rental properties.

5.4.2 Multi-Family Residential

Previous research finds that multi-family residential properties in the FNSB will convert to natural gas by a quicker rate than single-family residential properties (see **Table 4.4**).[136] This is supported by interviews with a large FNSB multi-family residential property managers, who noted that if natural gas was available they would convert their complexes quickly (all within three years).[137]

For all years, with exception to the construction year, this analysis uses the relationship between single-family residential and multi-family residential conversion rates from the Northern Economics memo in conjunction with the single-family residential conversion rates obtained from ENSTAR. The Northern Economics memo estimates that the cumulative multi-family residential rates of conversion are up to ten percent greater than residential rates over a ten year period. Given that residential conversion rates in this analysis were based upon ENSTAR's estimated rate of conversion (60 percent year one, 75 percent year 2, etc.), this analysis uses the relationship of multi-family to residential rates of conversion in the Northern Economics memo and applied this relationship to ENSTAR's single-family cumulative rate of conversion to estimate the conversion rate for multi-family properties within the study area (see **Table 5.8**).

5.4.3 Commercial and Industrial

This analysis assumes that commercial properties within the study area will fully convert to natural gas within three years. This estimated rate of conversion is based upon the ENSTAR memo to the City of Homer regarding the commercial rates of conversion.[138] The cumulative rates of conversion for years one and two use the same approach outlined above for multi-family conversion rates to estimate commercial/industrial property conversion rates within the study area.

The Northern Economics memo estimates that the cumulative commercial rates of conversion are ten percent greater than cumulative residential rates of conversion for years one and two. Given that residential conversion rates in this analysis were based upon ENSTAR's estimated rate of conversion (60 percent year one, 75 percent year 2, etc.), this analysis uses the relationship of commercial property rates of conversion to residential rates of conversion in the Northern Economics memo to estimate the rate commercial/industrial properties will convert in years one and two (see **Table 4.4**).

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[136] Cuyno, Leah and Pat Burden, June 21, 2013, Estimated Natural Gas Demand for the NS LNG Project, Website (http://www.interiorenergyproject.com/Resources%20and%20Documents/Estimated%20Natural%20Gas%20Demand.pdf) accessed October 17, 2013.

[137] Snell, Riley, JL Properties Property Manager, Personal communication with Lee Elder, Cardno ENTRIX, November 1, 2013.

[138] Pierce, Charlie, Southern Division Manager, ENSTAR, January 13, 2012, City of Homer Natural Gas Distribution System, Core Area Construction Cost Estimate, Memorandum to Walt Wrede, Homer City Manager.

5.4.4 Estimated Conversion by Year and Customer Type

Table 5.9 below summaries the conversion results. All conversion is estimated to be complete by Year 12, and is estimated to total 77 percent of all structures within the service area, or a total of 17,050 residential, multi-family, commercial and industrial structures.

Table 5.9 Number of Conversions by Customer Type and Year

Customer Type	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
All Phases													
Single-Family Residential	540	2,530	4,410	6,300	8,030	9,800	11,270	12,050	12,480	12,660	12,790	12,880	12,920
Single-family renter occupied	90	340	600	880	1,210	1,520	1,760	1,930	2,060	2,140	2,170	2,190	2,210
Multi-Family Residential	60	270	360	460	600	650	700	710	720	720	720	720	720
Commercial	110	550	730	940	1,060	1,130	1,170	1,180	1,180	1,180	1,180	1,180	1,180
Industrial	0	20	20	20	20	20	20	20	20	20	20	20	20
Total	810	3,710	6,120	8,590	10,920	13,120	14,930	15,900	16,470	16,720	16,880	17,000	17,050

Table 5.10 below provides the low estimate results by phase for each customer and year. As illustrated, the final year that any new customers are expected to covert to natural gas is Year 12. By that year a total of 17,050 customers within the study are expected to convert. This represents 77 percent of the total structures within the study area. Approximately 15,120 single-family residential structures or 75 percent of the total single-family residential structures are expected to convert by Year 12.

Table 5.10 Number of Conversions by Phase, Customer Type and Year

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
Phase 1 (Construction Year 0)													
Single-Family (minus single-family rentals)	540	2,170	2,720	3,260	3,350	3,440	3,530	3,620	3,620	3,620	3,620	3,620	3,620
Single-Family Rentals	90	280	370	470	560	570	590	600	620	620	620	620	620
Multi-Family Residential	60	260	310	350	370	370	370	370	370	370	370	370	370
Commercial	110	530	650	720	760	760	760	760	760	760	760	760	760
Industrial	0	10	20	20	20	20	20	20	20	20	20	20	20
Subtotal	800	3,250	4,070	4,820	5,060	5,160	5,270	5,370	5,390	5,390	5,390	5,390	5,390

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
Phase 2 (Construction Year 1)													
Single-Family (minus single-family rentals)		360	1,450	1,810	2,170	2,230	2,290	2,350	2,410	2,410	2,410	2,410	2,410
Single-Family Rentals		60	190	250	310	370	380	390	400	410	410	410	410
Multi-Family Residential		10	40	50	60	60	60	60	60	60	60	60	60
Commercial		10	70	80	90	100	100	100	100	100	100	100	100
Industrial		0	0	0	0	0	0	0	0	0	0	0	0
Subtotal		440	1,750	2,190	2,630	2,760	2,830	2,900	2,970	2,980	2,980	2,980	2,980
Phase 3 (Construction Year 2)													
Single-Family (minus single-family rentals)			250	980	1,230	1,470	1,510	1,550	1,590	1,630	1,630	1,630	1,630
Single-Family Rentals			40	130	170	210	250	260	270	270	280	280	280
Multi-Family Residential			10	30	30	40	40	40	40	40	40	40	40
Commercial			20	70	90	100	100	100	100	100	100	100	100
Industrial			0	0	0	0	0	0	0	0	0	0	0
Subtotal			320	1,210	1,520	1,820	1,900	1,950	2,000	2,040	2,050	2,050	2,050
Phase 4 (Construction Year 3)													
Single-Family (minus single-family rentals)				250	1,000	1,240	1,490	1,540	1,580	1,620	1,660	1,660	1,660
Single-Family Rentals				40	130	170	210	260	260	270	280	280	280
Multi-Family				30	140	160	180	190	190	190	190	190	190

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
Residential													
Commercial				20	100	120	140	150	150	150	150	150	150
Industrial				0	0	0	0	0	0	0	0	0	0
Subtotal				340	1,370	1,690	2,020	2,140	2,180	2,230	2,280	2,280	2,280
Phase 5 (Construction Year 4)													
Single-Family (minus single-family rentals)					290	1,170	1,460	1,750	1,800	1,850	1,900	1,950	1,950
Single-Family Rentals					50	150	200	250	300	310	320	330	330
Multi-Family Residential					0	20	20	20	20	20	20	20	20
Commercial					10	40	50	50	60	60	60	60	60
Industrial					0	0	0	0	0	0	0	0	0
Subtotal					350	1,380	1,730	2,070	2,180	2,240	2,300	2,360	2,360
Phase 6 (Construction Year 5)													
Single-Family (minus single-family rentals)						250	990	1,230	1,480	1,520	1,560	1,600	1,640
Single-Family Rentals						40	130	170	210	250	260	270	270
Multi-Family Residential						10	30	30	40	40	40	40	40
Commercial						0	20	20	20	20	20	20	20
Industrial						0	0	0	0	0	0	0	0
Subtotal						300	1,170	1,450	1,750	1,830	1,880	1,930	1,970
Total	810	3,710	6,120	8,560	10,920	13,120	14,920	15,890	16,470	16,720	16,880	17,000	17,050

Table 5.11 provides anticipated annual natural gas demand for each natural gas utility located within the service area. Results are provided over a 12-year period since it is anticipated that all of those willing to convert will do so by the twelfth year. The annual natural gas demand for each utility provided below assumes that expansion of the FNG service area will begin one year prior to the IGU system. It is assumed that construction of the IGU distribution system begins one year following FNG service area expansion. However, the timing of IGU natural gas demand could very well begin in the same year as FNG (2015). If IGU distribution system construction began at the same time as FNG, demand from the IGU system would begin in 2015 rather than 2016 as illustrated below.

Table 5.11 Natural Gas Demand by Service Area (Bcf)

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
FNG													
Single-family residential	0.1	0.4	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Multi-family	0.1	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Commercial	0.4	1.7	2.0	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Total FNG from Conversions	0.5	2.3	2.8	3.3	3.3	3.3	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Total FNG including existing customers and uninterrupted demand	*1.6*	*3.4*	*3.9*	*4.4*	*4.4*	*4.4*	*4.5*	*4.5*	*4.5*	*4.5*	*4.5*	*4.5*	*4.5*
IGU													
Single-family residential	0.0	0.1	0.3	0.5	0.8	1.1	1.3	1.5	1.6	1.6	1.6	1.6	1.7
Multi-family	0.0	0.0	0.1	0.1	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4
Commercial	0.0	0.0	0.2	0.5	0.7	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0
Total IGU	0.0	0.1	0.6	1.2	1.8	2.3	2.6	2.8	2.9	2.9	2.9	3.0	3.0

6 Conversion Benefits: Demand, Fuel Savings, and Net Value

The purpose of this section is to provide estimates of the following conversion effects:

1. Natural gas demand (in Mcf) by year and by type of customer,
2. Fuel cost savings from conversion by year and by type of customer,
3. The net present value of natural gas conversion.

Table 6.1 summarizes the findings on natural gas demand, fuel cost savings, and the net benefits when natural gas is available to study area residents and businesses. The net present value of fuel cost savings less conversion program costs is estimated at $835.1 million. Increasing the number of household conversions may reduce the price of natural gas by spreading the fixed investment costs of the LNG plant, storage, regasification and distribution over more units of natural gas sold. This could increase the benefits (and net present value) of natural gas being available within the study area.

Table 6.1 Net Present Value of Conversions without Incentive Programs

Scenario	Final Fuel Demand (Bcf, Year 12 +)	Fuel Cost Savings (Present Value, $ million)	Program Cost (Present Value, $ Million)	Net Present Value ($ million)
No Incentives	6.4	$835.1	$0.0	$835.1

Single-family residential natural gas demand is expected to be 2.3 Bcf by Year 12. Approximately 60 percent of total residential demand is anticipated to be obtained by Year 4, or nearly 1.4 Bcf of natural gas.

Table 6.2 Single-Family Residential Natural Gas Demand and Program Effects

Period	**Consumption (Bcf)**
Year 0	0.1
Year 1	0.4
Year 2	0.8
Year 3	1.1
Year 4	1.4
Year 5	1.7
Year 6	1.9
Year 7	2.1
Year 8	2.2
Year 9	2.2
Year 10	2.2
Year 11	2.3
Year 12	2.3

6.1.1 Methods and Data

This section summarizes the methods and data used to estimate natural gas demand and fuel cost savings obtained from converting.

6.1.1.1 Natural Gas Demand Estimation

In order to determine fuel cost savings, it is necessary to estimate the post-conversion demand for natural gas from single-family residential, multi-family residential and businesses, including small commercial, medium commercial, large commercial and industrial users. Based on data from the IGU survey, for residential heating systems, the average energy consumption for each residential property is estimated at 161 Mcf annually. Prior to converting, per household heating (across all homes) uses an average of 133 Mcf-equivalent of oil, 23 Mcf-equivalent of wood, and 5 Mcf-equivalent of 'other' fuel (for a total 161 Mcf). Post conversion, it is assumed total energy consumption will remain 161 Mcf (i.e. appliance efficiencies are not taken into account). However, for homes converting to natural gas, not only will they shift from oil to natural gas but they are estimated to reduce their use of wood due to the convenience and cost effectiveness of natural gas. For homes that convert, the average home (across all homes) uses 151 Mcf of natural gas, 5 Mcf of wood, and 5 Mcf of 'other' fuel (for a total 161 Mcf).

The natural gas demand by multi-family, small commercial, medium commercial, large commercial and industrial users was obtained from previous research, which provides the following estimates of energy consumption by business type.[139]

> Small commercial – 650 Mcf per year

> Medium commercial – 4,000 Mcf per year

> Large commercial – 8,000 Mcf per year

> Multi-residential – 1,000 Mcf per year

The 24 industrial users located within the study area as determined by the AEA (see **Table 5.2**) are assumed to have the same annual energy consumption patterns as large commercial users (8,000 Mcf annually). This is based upon interviews with a number of these industrial property owners and an on-line review of business located at the site address (drilling company, a freight transportation company, general contractor, etc.).

6.1.1.2 Fuel Cost Savings and Program Cost

The total energy use provided above was used in conjunction with the price of heating oil ($30 per Mcf), the price of natural gas ($15 per Mcf) and the price of wood ($14 per Mcf). The price for these fuels and average Mcf use per converted property by user type were used to estimate the total costs of heating within the study are pre- and post- conversion (see Section 3.3).

6.1.2 Number of Conversions

It is estimated that approximately 17,050 single-family residential structures will convert to natural gas by Year 12. This represents 75 percent of the total 20,077 residential structures located within the proposed service area.

[139] Cuyno, Leah and Pat Burden, June 21, 2013, Estimated Natural Gas Demand for the NS LNG Project, Website (http://www.interiorenergyproject.com/Resources%20and%20Documents/Estimated%20Natural%20Gas%20Demand.pdf) accessed October 17, 2013.

The total natural gas demand for single-family residential customers is 2.3 Bcf by the end of Year 12. We expect that within five years of IEP construction (end of Year 4) residential customers will be using 1.4 Bcf of natural gas (61 percent of the projected final natural gas demand for these users).

Table 6.3 Natural Gas Demand for All Study Area Customers Converting (Mcf)

Customer Type	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
Single-family residential	95,030	432,930	755,740	1,083,080	1,380,250	1,686,470	1,945,920	2,092,240	2,178,230	2,215,940	2,246,110	2,268,730	2,280,800
Multi-family residential	60,000	270,000	360,000	460,000	600,000	650,000	700,000	710,000	720,000	720,000	720,000	720,000	720,000
Small commercial	56,160	262,080	318,240	374,400	374,400	374,400	374,400	374,400	374,400	374,400	374,400	374,400	374,400
Medium commercial	310,200	1,447,600	1,757,800	2,068,000	2,068,000	2,068,000	2,068,000	2,068,000	2,068,000	2,068,000	2,068,000	2,068,000	2,068,000
Large/Commercial/Industrial	138,000	644,000	782,000	920,000	920,000	920,000	920,000	920,000	920,000	920,000	920,000	920,000	920,000
Total	659,380	3,056,540	3,973,660	4,905,310	5,356,010	5,719,720	6,027,630	6,180,910	6,275,370	6,314,580	6,338,720	6,355,310	6,364,360
Proportion of total demand attained each year	10%	48%	62%	77%	84%	90%	94%	97%	98%	99%	99%	100%	100%
Portion of total single-family demand attained each year	4%	19%	33%	47%	61%	74%	85%	92%	96%	97%	98%	99%	100%

Table 6.4 below highlights the fuel cost savings to area residents and businesses, estimated to reach $96.6 million annually (based on today's prices) in Year 12 and beyond. The largest savings are anticipated for commercial businesses, with an expected annual savings of $50.4 million, which is reached by Year 3. Single-family residential consumers are expected to save a total of $35.4 million by Year 12, the year in which all single-family consumers are expected to convert to natural gas.

Table 6.4 No Incentives Scenario: Annual Savings for All Study Area Customers Converting ($ millions)

Customer Type	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
Single-family residential	$1.5	$6.7	$11.7	$16.8	$21.4	$26.2	$30.2	$32.5	$33.8	$34.4	$34.9	$35.2	$35.4
Multi-family	$0.9	$4.1	$5.4	$6.9	$9.0	$9.8	$10.5	$10.7	$10.8	$10.8	$10.8	$10.8	$10.8
Commercial	$7.6	$35.3	$42.9	$50.4	$50.4	$50.4	$50.4	$50.4	$50.4	$50.4	$50.4	$50.4	$50.4
Total	$9.9	$46.1	$60.0	$74.1	$80.9	$86.4	$91.1	$93.6	$95.0	$95.6	$96.1	$96.5	$96.6

6.2 Total Study Area Demand

Table 6.5 below provides the estimated annual natural gas demand within the study area. The existing 1.1 Bcf of FNG natural gas demand has been included with the expected demand from conversions to account for all anticipated natural gas demand within the study area. We assume that the existing FNG natural gas demand within the existing service area remains constant at 1.1 Bcf between Year 0 and Year 12.

Table 6.5 Total Natural Gas Demand from Conversions and Existing FNG Customers (Bcf)

Year	Demand From Conversions	Demand from Conversions and from Existing FNG Customers (assuming uninterrupted)
Year 0	0.66	1.77
Year 1	3.06	4.17
Year 2	3.97	5.09
Year 3	4.91	6.02
Year 4	5.34	6.45
Year 5	5.70	6.81
Year 6	6.01	7.12
Year 7	6.16	7.28
Year 8	6.26	7.37
Year 9	6.30	7.41
Year 10	6.33	7.44
Year 11	6.35	7.46
Year 12	6.36	7.47

Notes: Each year includes existing FNG natural gas demand and assumes constant 2012 demand

7 Air Quality Effects and Timing

The EPA sets standards for air quality (National Ambient Air Quality Standards, NAAQS), including standards for particulate matter (PM) concentrations. Ambient concentrations of PM in Fairbanks exceed federal air quality standards for PM smaller than 2.5 micrometers ($PM_{2.5}$) to the extent that in December 2009 FNSB was designated a nonattainment area for $PM_{2.5}$. A primary source of $PM_{2.5}$ in the FNSB borough is residential heating. Of the primary fuel sources in use in Fairbanks (oil, wood, and natural gas), the use of natural gas results in the lowest levels of PM emissions.

Particulate matter is a mixture of liquid droplets and extremely small particles, including such components as soil, dust, metals, organic chemicals, and acids. $PM_{2.5}$ are particularly fine particles typically emitted from fires, or can form when gases emitted from power plants, industries, and cars react in the air. $PM_{2.5}$ are of particular health concern as they can affect the heart and lungs, and cause serious health problems. Furthermore, $PM_{2.5}$ has aesthetic impacts as it is a primary component of ozone, which decreases visibility (see **Section 9** for more detail on the benefits of decreasing ambient $PM_{2.5}$ concentrations).

This section focuses on $PM_{2.5}$, but reductions in wood burning and oil burning will also reduce other emissions of other contaminants that can adversely affect indoor and outdoor air quality, including: volatile organic carbons (VOC), carbon monoxide (MO), nitrous oxides (NOx), phenolics, benzene, formaldehyde, acrolein, and methane.

In the absence of air quality modeling specific to this analysis, we provide rough estimates based on existing data of how $PM_{2.5}$ emissions in the Fairbanks area may be reduced with conversion of residential heating to natural gas. We then estimate how air quality in Fairbanks may be improved, in terms of $PM_{2.5}$ concentrations and tons of emissions, due to the conversion of residential heating to natural gas. We make several simplifying assumptions. For example, we assume that air quality concentrations in the non-attainment area will decrease linearly with the decrease in wood burning. We also assume that the air quality improvement will be uniform across the non-attainment area, and not vary spatially.

As described below in **Section 7.3**, based on ADEC data and our estimates of the numbers of households converting and their energy use pre- and post-conversion, we expect that access to natural gas will result in reduced air emissions of approximately 45 percent during the winter months, which we estimate to equate to approximately 234 tons of reduced annual $PM_{2.5}$ emissions.

7.1 Current $PM_{2.5}$ Conditions and the NAAQS Standard

In 2012, the EPA established a new $PM_{2.5}$ NAAQS standard. This standard establishes an annual standard of $PM_{2.5}$ levels of 12 micrograms per cubic meter (µg/m3), averaged over three years, and a 24-hour standard of 35 (µg/m3) as the 98th percentile, averaged over three years. An area is in violation of the NAAQS when the 3-year 98th percentile average is greater than the 24 hour NAAQS for $PM_{2.5}$ or when the annual average value is greater than the annual NAAQS for $PM_{2.5}$. Portions of the FNSB, including the cities of Fairbanks and North Pole, were designated in 2009 as non-attainment areas for $PM_{2.5}$. The non-attainment area exceeds the health-based 24-hour exposure limit of 35 µg/m3.

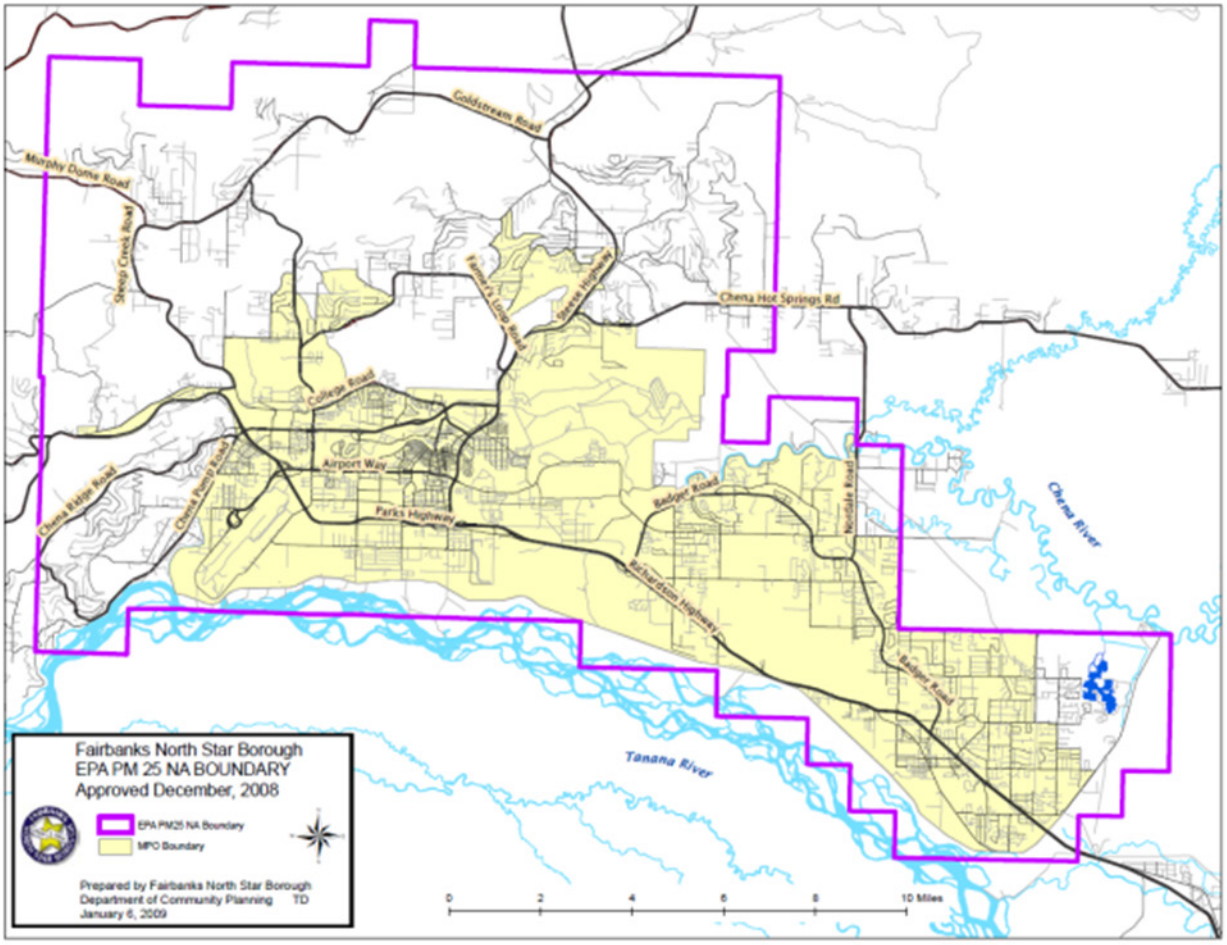


Figure 7.1 FNSB Non-Attainment Area

The EPA collects and analyzes air quality data for specific locations and time periods. This section presents annual average and daily $PM_{2.5}$ data for the FNSB for the last ten years. There are currently four monitoring stations in FNSB, all located in the non-attainment area: two in North Pole and two in Fairbanks. The site name, location, and installation date are provided in **Table 7.1**.

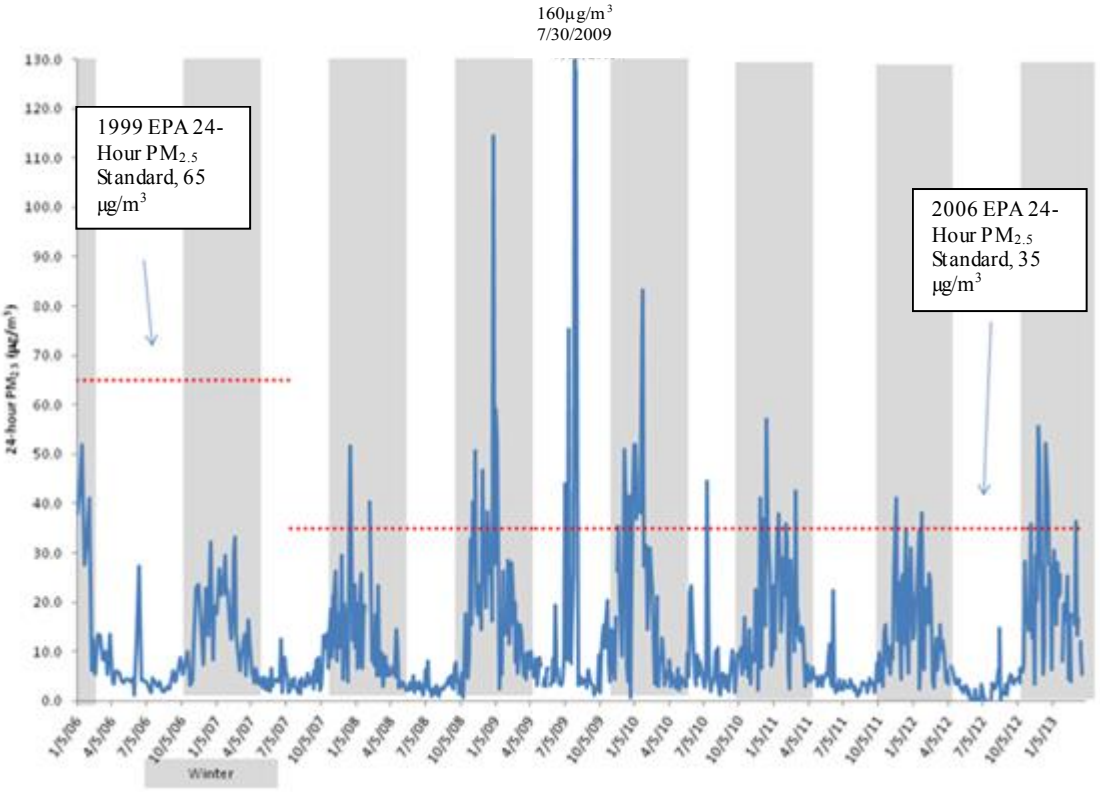
Table 7.1 FNSB Monitoring Stations

Site Name	Location	AQS ID	Install Date
State Office Building	Fairbanks	02-090-0010	Oct, 1998
North Pole Elementary	North Pole	02-090-0033	Nov, 2008
NCore	Fairbanks	02-090-0034	Oct, 2009
North Pole Fire	North Pole	not available	Mar, 2012

As indicated in **Table 7.1**, ADEC has collected measurements of fine particulate ($PM_{2.5}$) concentrations at the State Office Building in downtown Fairbanks for 15 years, and at three additional sites in North Pole and Fairbanks in more recent years. Measurements at these stations show that concentrations vary seasonally, with elevated levels during the winter months as well as at times during the summer months. Elevated concentrations in the summer months are largely due to wildfires, and are typically excluded by the EPA when considering attainment of air quality standards, since wildfire events are considered 'exceptional' and outside the reasonable control of air pollution control management.

Elevated levels of winter $PM_{2.5}$ levels in Fairbanks are due largely to high winter emissions from space heating, as well as air inversions that limit vertical dispersion of air pollution. Fairbanks is in a basin, surrounded by hills on three sides, and inversions often occur in the winter where a layer of cold air is trapped close to the ground by a higher layer of warmer air. During these inversions, air pollution is concentrated near the ground. Due to the typically low-speed or calm winds in Fairbanks, there is limited horizontal dispersion of pollutants. Furthermore, cold weather (below -10 or -15 degrees F) also increases the $PM_{2.5}$ levels as inversions generally strengthen with increasing cold, further compounding the air pollution problem.[140]

As shown in **Figure 7.2**, the 24-Hour standard of 35 µg/m^3 is typically exceeded in winter months (shown in grey in the figure). Winter exceedances most often occur between November and February. Occasionally, the 24-hour standard is exceeded in the summer months when there is smoke from a wildfire event, as in 2009 and 2010, but these were classified as 'exceptional event's and thus do not affect attainment status.



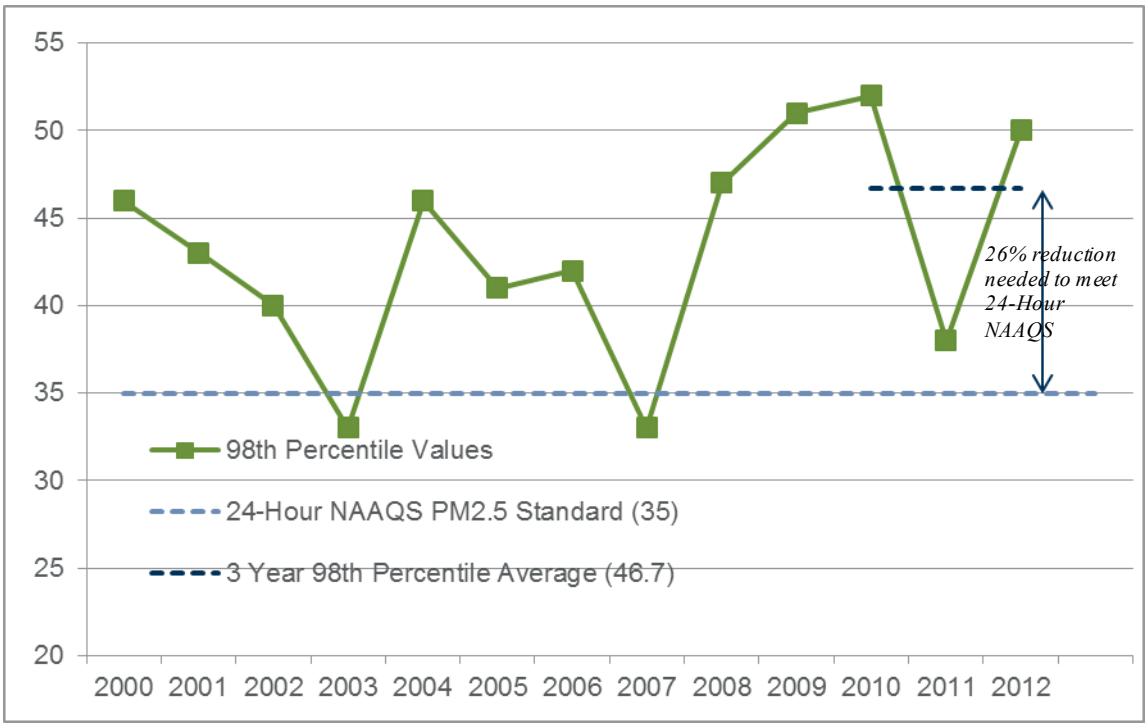
Source: ADEC, Division of Air Quality, 2013.

Figure 7.2 24-Hour $PM_{2.5}$ Data from Downtown Fairbanks (State Office Building, Primary Federal Reference Method Monitor

Figure 7.3 shows the 98th percentile $PM_{2.5}$ concentrations that are used to determine attainment with the 24-hour standard. As highlighted in the figure, the 2012 three year design value (three year average from 2010 to 2012) is 47.6 µg/m^3. To attain the 35 µg/m^3 standard, concentrations must be reduced by 26 percent. **Table 7.2** shows the three year design value for the last 10 years for three monitoring stations with adequate data. The 2012 design values for the two North Pole monitoring stations are similar to the

[140] State of Alaska, ADEC, Division of Air Quality, 2013, Air Non-Point Mobile Source, $PM_{2.5}$ and Fairbanks. Accessed online at: http://dec.alaska.gov/air/anpms/pm/pm2-5_fbks.htm.

Fairbanks station, with design value at the North Pole Elementary School measuring at 47.3 µg/m^3, and the value at the NCore station measuring at 44.7 µg/m^3.



Source: EPA Air Data, 2013. Chart based on Huff, 2012

Figure 7.3 98th Percentile $PM_{2.5}$ Concentrations, Fairbanks Office Building, 2000-2012

Table 7.2 $PM_{2.5}$ 98th percentile Concentrations, 3-Year Average Value (Design Value)

	Monitoring Site		
Year	Downtown Fairbanks	North Pole Elementary	NCore, Fairbanks
2003	38.7		
2004	39.7		
2005	40.0		
2006	43.0		
2007	38.7		
2008	40.7		
2009	43.7		
2010	50.0	63.0	
2011	47.0	62.7	42.7
2012	46.7	47.3	44.7

Source: EPA Air Data, 2013.

As shown in **Table 7.3**, the annual NAAQS $PM_{2.5}$ standard of 12 µg/m3 is also exceeded in some years at all monitoring stations, with particularly high annual average levels measured in some years at the North Pole Fire Station (25 µg/m3 in 2013, as measured through August) and North Pole Elementary (17.6 in 2013, as measured through August).

Table 7.3 Annual Average $PM_{2.5}$ Levels, FNSB Monitoring Stations (Exceptional Events Excluded)

Year	State Office Building	North Pole Elementary	NCore	North Pole Fire	Average, All Monitoring Stations
2001	12.8				12.8
2002	12.0				12.0
2003	9.8				9.8
2004	10.9				10.9
2005	10.9				10.9
2006	11.2				11.2
2007	10.5				10.5
2008	11.3	21.8			16.6
2009	11.5	15.8	22.7		17.7
2010	12.2	10.7	12.6		11.8
2011	10.7	4.2	10.4		8.0
2012	10.7	10.2	11.3	18.7	13.0
2013	10.1	17.6	10.3	25.4	17.7
Average, All Years	11.1	13.4	13.8	22.1	13.6

Source: EPA Air Data, 2013.

7.2 Sources of $PM_{2.5}$ and Relative Contribution of Residential Heating

Emissions from a variety of sources contribute to $PM_{2.5}$ levels in Fairbanks. These sources include: wood stoves, industrial sources, wildfires, and mobile emissions. As noted above, emissions of $PM_{2.5}$ from human activities (as opposed to exceptional events such as wildfires) are particularly a concern during winter months (October through March) when high emissions coincide with frequent temperature inversions that trap the particulate matter in the urban area.

Several recent studies have shown that space heating by wood-fired devices is the largest contributor to $PM_{2.5}$ emissions in Fairbanks during the period of wintertime $PM_{2.5}$ exceedances.[141] For example, a 2012 study sponsored by ADEC estimated the sources of $PM_{2.5}$ in Fairbanks (Ward et al, 2012). This study used chemical mass balance modeling for four locations in Fairbanks to estimate the source apportionment of $PM_{2.5}$ over three recent winters: of 2008/2009, 2009/2010, and 2010/2011. The four study locations were the air quality monitors located at the State Office Building in downtown Fairbanks, North Pole, a mobile trailer site (Relocatable Air Monitoring System or RAMS), and Peger Road. $PM_{2.5}$ concentrations at these sites exceeded the 24-hour NAAQS approximately 25 percent of the time. The modeling indicates that wood smoke is the major source of $PM_{2.5}$ during winter months, contributing between approximately 60 percent and 80 percent of the measured $PM_{2.5}$ at the sites. The other sources identified by the model include secondary sulfate (8 to 21 percent), ammonium nitrate (3 to 10 percent), diesel exhaust (9 percent or less), and automobiles (2 to 6 percent). Subsequent chemical analysis

[141] See for example, "Fairbanks $PM_{2.5}$ Planning, 4th in a Series: Control Measures," March 15, 2012; "Fairbanks $PM_{2.5}$ Planning: 5th in a Series: Plan Development & Control Measure Implementation," August 16, 2012; and "Status of FNSB $PM_{2.5}$ Air Quality Plan," March 21, 2013. Deanna Huff and Mark Hixson, "SIP Modeling for Fairbanks $PM_{2.5}$ Nonattainment," presented at the 2013 Western Air Quality Modeling Workshop, July 10, 2013.

indicated that one-third to two-thirds (32 to 66 percent) of the measured ambient $PM_{2.5}$ particles were from a 'contemporary carbon source', such as wood smoke (ADEC, 2013).

In terms of total emissions, ADEC in 2013 estimated that wood-fired space heating devices account for 3.18 tons of $PM_{2.5}$ emissions per day, or 56% of the 5.65 tons per day of emissions (ADEC, 2013).[142] In 2012, ADEC estimated 2.65 tons per day of emissions from wood space heating, which accounted for approximately 45 percent of source specific emissions in January and February air quality episodes (high pollution days). Wood burning is estimated to account for approximately 97 percent of residential heating emissions (Huff, 2012 and ADEC, 2013). As nearly one-third of emissions are from point sources that generally emit through stacks, these emissions may affect ground-level pollution levels less (which explains why residential heating sources appear to account for a much higher proportion of $PM_{2.5}$ levels at monitoring sites - as found in the Ward 2012 study - relative to their total emission proportion).

While $PM_{2.5}$ emissions will also be reduced from switching from oil burning to natural gas burning heating devices, since ADEC estimates that residential oil burning accounts for less than 1 percent of the winter $PM_{2.5}$ emissions, this analysis focuses on estimating the change in emissions from wood burning devices due to natural gas conversion.

Table 7.4 Source Specific Emission Totals (Jan-Feb Episode Average)

Emission Source	$PM_{2.5}$ tons/day	Percent
Point Sources	1.92	32%
On-Road Vehicles	1.11	19%
Space Heating – Total	2.73	46%
Space Heating – Wood	*2.65*	*45%*
Space Heating – Heating Oil	*0.05*	*<1%*
Space Heating – Other (coal, waste oil, etc.)	*0.03*	*<1%*
Other Sources	0.15	2%
Total	5.91	100%
Emission Reductions Needed for Attainment	1.95	~33%

Source: Huff, 2012.

In separate research in 2009, the Cold Climate Housing Research Center (CCHRC) estimated that residential heating accounts for 564 tons of emissions annually, of which 65 percent is from wood burning devices (CCHRC, 2009). However, this research was based on emissions data that were not specific to Fairbanks, and were not verified with air quality monitoring and modeling as with the ADEC research. This analysis therefore relies primarily on the ADEC estimates of the contribution of wood burning to $PM_{2.5}$ emissions. The data are presented below however supports another approach to estimating $PM_{2.5}$ emissions.

CCHRC estimates of $PM_{2.5}$ sources are based on a spreadsheet model that combines estimates of the number of wood-burning devices, the number of hours of operation of each device per year, and the emission rate for the various wood burning devices to estimate total emissions by source. The estimated $PM_{2.5}$ emissions, by major source, are reported below in **Table 7.5**.

[142] Although not specified, it is assumed that these figures refer to wintertime emissions rather than annual averages.

Table 7.5 CCHRC 2009 Estimates of $PM_{2.5}$ Emissions by Major Source in FNSB

Emission Source	Estimated Tons per Year of $PM_{2.5}$	Proportion of $PM_{2.5}$
GVEA North Pole Plant	1,215	38%
Residential	874	27%
Aurora Energy Power Plant	424	13%
US Army Fort Wainwright	256	8%
Commercial (Natural gas, coal, fuel oil)	138	4%
All other sources reported	293	4%
Total	3,200	4%

Source: Davies et al, 2009.

Residential sources of $PM_{2.5}$ are a significant contributor to total emissions. Based on the CCHRC's estimates, the majority of residential emissions results from wood-burning heating sources, but oil fired sources are estimated as a significant portion of emissions as well (see **Table 7.6**. If this is the case, then nearly 75 percent of residential oil-fired emissions would be eliminated (proportion of households converting in the study area), if these heating devices are replaced with natural gas burning units (depending on data source) which produce a range of 36 percent to 98 percent lower emissions than oil-fired devices.[143]

Table 7.6 Estimated $PM_{2.5}$ Emissions by Residential Space Heating System

Emission Source	Tons/year	Lbs/year household using device
Wood-fired hydronic heaters	350	467
Oil-fired	306	36
Natural Gas		2
Non-certified wood stoves	152	60
Commercial Oil-fired	134	
Certified wood stoves	61	17

Source: CCHRC, 2009.

ADEC has sponsored annual survey research on residential heating devices and fuel burning for several years that provides insight into the energy use, and potential emissions from residential heating. **Table 7.7** highlights residential heating characteristics in 2012 by heating device type. As shown in the table, approximately 36 percent of households in Fairbanks use wood burning devices, accounting for approximately 25.7 percent of fuel usage (BTU basis). (The bulk of the remaining fuel usage on a BTU basis is from fuel oil, providing 68 percent of home heating needs.) On average, survey respondents using wood stoves/inserts reported using 3.75 cords of wood annually, while fireplace wood users reported using 3.0 cords of wood annually.

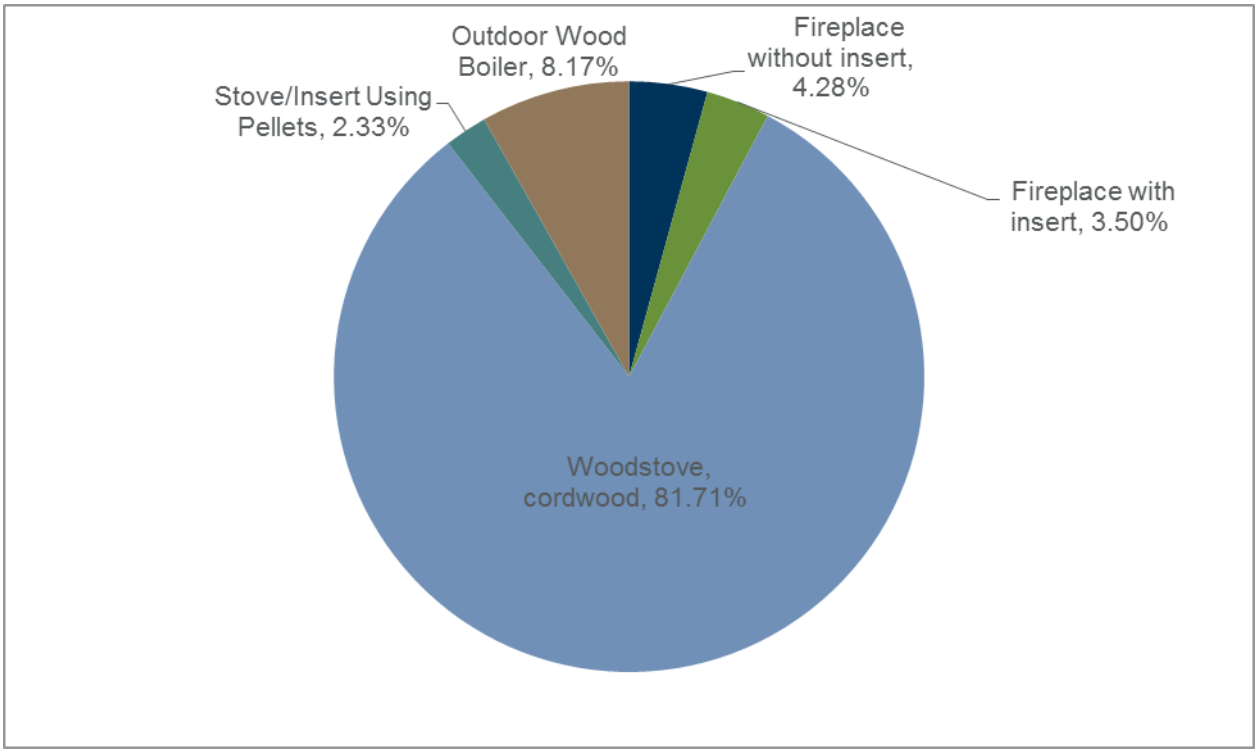
[143] Houck et al, 1998. CCHRC, 2009. EPA Burnwise, 2013.

Table 7.7 2012 Wood Heating Devices and Fuel Usage by FNSB Residents

Heating Device Type	Proportion Households With Device	Proportion Home Heating Fuel Use (BTU Basis)
Fireplace without insert	1.7%	1.1%
Fireplace with insert	1.7%	0.9%
Woodstove	31.7%	21%
All Inserts & Woodstoves	*33.4%*	
Stove/Insert, Uncertified	*6.6%*	
Stove/Insert, Certified	*25.1%*	
Stove/Insert Using Cord Wood	*31.6%*	
Stove/Insert Using Pellets	*1.7%*	0.6%
Outdoor Wood Boiler	1.1%	2.1%
Total Wood Burning Devices	36.3%	25.7%

Source: Sierra Research, 2012 (Draft), Prepared for ADEC.

In 2012, as highlighted in **Table 7.7** above and **Figure 7.4** below, over 80 percent of wood use in wood burning devices was by woodstoves burning cordwood, with fireplaces and outdoor boilers each accounting for roughly eight percent of wood use. The remainder of wood use was in stoves/inserts in pellet form (2.33 percent).



Source: Sierra Designs, Draft 2013.

Figure 7.4 Proportion of Wood Use by Wood Burning Device

7.3 Changes in $PM_{2.5}$ with Conversion

Air quality modeling is beyond the scope of this analysis; however, we use existing data to provide rough estimates of the potential $PM_{2.5}$ reductions due to natural gas conversion. This section estimates the change in $PM_{2.5}$ emissions from natural gas conversion using the data presented above on the proportion of ambient $PM_{2.5}$ concentrations from wood smoke coupled with our estimates of the reduction in wood burning due to natural gas conversion. We estimate both the percent change in ambient concentrations and the change in annual $PM_{2.5}$ emissions.

7.3.1 Reduction in Wood Use in Study Area

Both methods require an estimate of the change in wood use due to natural gas conversion. To estimate this change in wood use, we first identify the number of households currently using wood that may convert, and those that are predicted to convert to natural gas in each phase of a natural gas distribution system expansion (based on analysis in Section 5). **Table 7.8** summarizes these households by phase.

Table 7.8 Study Area Households Using Wood: Total Number and Projected Households Converting (Single Family Residential)

Phase	Number of Households using Wood and No Oil	Number of Households Using Wood and oil	Converting Households Using Wood (Method A)	Converting Households Using Wood (Method B)
1	670	1,650	1,350	1,420
2	170	1,580	1,280	1,350
3	120	1,120	910	960
4	170	920	750	790
5	220	1,440	1,170	1,230
6	170	970	790	830
Total	1,520	7,680	6,250	6,580

As discussed in Section 3.3.1, based on the cross price elasticity of wood demand, we estimate that the reduction in price per Mcf of natural gas versus fuel ($15 versus $30 per Mcf) will result in a 77 percent reduction in wood burning amongst those currently using wood as a space heating fuel source. This estimate is supported by recent survey research in FNSB, which indicates that approximately 74 percent of wood users would stop burning wood at natural gas prices of approximately $15 per Mcf (approximately $2 per gallon in equivalent of heating oil). This survey (*Wood "Tag" Survey* conducted by Sierra Research) also found that approximately 69 percent of FNSB residents who use wood for residential space heating would not need to burn wood at lower temperatures for warmth if natural gas were available.[144]

Based on data on the distribution and average energy use for single family residential households using primary/secondary fuel sources of either wood/oil or oil/wood (from IGU survey), we estimate that current annual average wood use per household varies from 124 Mcf in households with no oil burning devices, to 56 for those with oil burning devices. The willingness to convert of households burning oil as either a primary or secondary source and burning wood, is approximately 81 to 86 percent (see Section 5, depending on Method A or B. The conversion rate for wood and oil burning households is higher than for the general population). Combining these figures, we estimate that total wood use across all households

[144] Dulla, Bob, Personal communication with Nick Szymoniak, AIDEA, December 13, 2013.

in the study area using wood (including those who do not convert) would decrease by approximately 43 to 47 percent (see **Table 7.9**). We only evaluate single family residential as wood is not a significant heat source for multi-unit residential structures.

Table 7.9 Annual Wood Use by Study Area Single Family Residential Households (Mcf equivalent)

Type of Heating Systems	Per Household Use	Total Annual Wood Use (Method A)	Total Annual Wood Use (Method B)	Total Annual Wood Use, On-Bill Pay	Total Annual Wood Use, Rebate Program
Pre-Conversion					
Wood and No Oil	124	188,500	188,500	188,500	188,500
Wood and Oil (Pre-Natural Gas)	56	426,900	426,900	426,900	426,900
Total		615,400	615,400	615,400	615,400
Post-Conversion					
Wood and No Oil	124	188,500	188,500	188,500	188,500
Wood and Oil	56	79,500	61,100	171,500	169,100
Wood and Natural Gas	25	77,600	79,300	83,800	82,700
Total		345,600	328,900	323,300	328,200
Difference		269,800	286,500	292,100	287,200
% Reduction in Residential Wood Use		43.8%	46.6%	47.5%	46.7%

7.3.2 Change in $PM_{2.5}$ Emissions and Concentrations

In this method, we estimate the change in $PM_{2.5}$ concentrations using estimates of the proportion of $PM_{2.5}$ ambient concentrations due to wood heating, and the estimated percent reduction in wood use due to natural gas conversion. As discussed above, different analyses of the data collected for a 2012 ADEC sponsored study of $PM_{2.5}$ data collected in three recent winters found that wood smoke may account for 60 percent to 80 percent of concentrations (based on chemical mass balancing equations) or 32 percent to 66 percent of concentrations (based on chemical analysis), (ADEC, 2013 and Ward, 2012).

Table 7.10 summarizes the steps and results of this method. By applying the 43 to 47 percent reduction in wood use across study area households, we estimate that total emissions would fall somewhere between 14 percent and 38 percent, depending on the estimate used of the contribution of wood smoke to total ambient concentrations. As shown in **Figure 7.3**, a 26 percent reduction in the 98th percentile three-year average is required to reach the 24-hour NAAQS standard, while **Table 7.4** identifies the need for approximately a 33 percent reduction in wintertime PM levels. Based on this analysis, the necessary reduction to achieve $PM_{2.5}$ levels may occur, but does not appear at all certain. This is largely due to the fact that the analysis assumes that households that only burn wood as a heating source, and do not use oil will not convert. As noted earlier, this assumption is based on the fact that on a per heating unit basis, natural gas and wood are priced very similarly, and so there is little financial incentive for conversion.

The incentive programs reviewed in this assessment would likely result in only a nominal decrease in wood burning and so are not analyzed further here (as there are only a few additional households

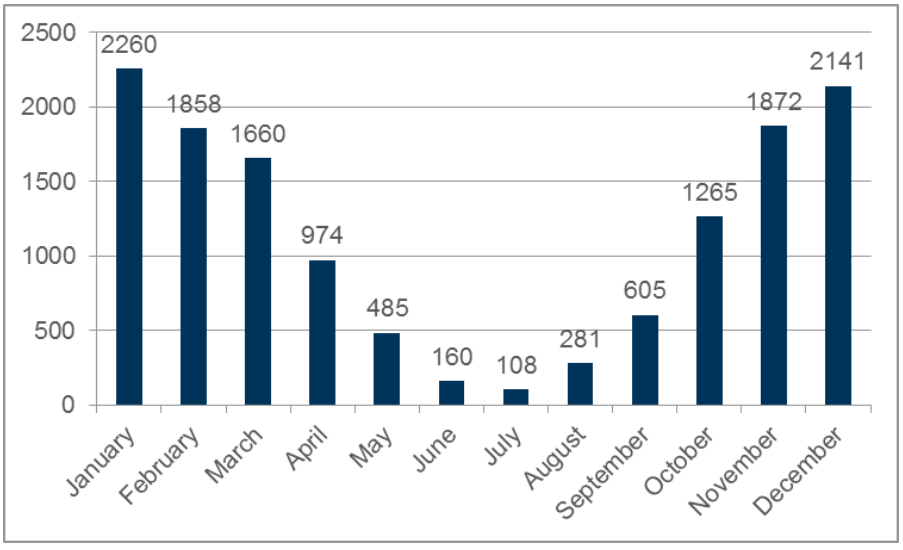
currently burning wood as a primary or secondary fuel system that would convert under the incentive programs).

Table 7.10 Data to Estimate Reduced Concentrations of $PM_{2.5}$ Due to Residential Natural Gas Conversion

Step in the Analysis	High Estimate	Low Estimate
Wood Smoke as % of Total Measured Winter $PM_{2.5}$ Levels[1] (A)	60%-80%	32%-66%
% Wood Use Reduction, All Study Area Households (converting and not converting) (B)	47% (Method B)	43% (Method A)
% Reduction in Measured $PM_{2.5}$ Levels (C=A*B)	28% -38%	14% - 28%
Existing Wood Smoke $PM_{2.5}$ Emissions (tons/day) during Jan/Feb Episodes[2, 3] (D)	3.18	2.65
Reductions in $PM_{2.5}$ Emissions (tons/day) (F=B* D)	1.49	1.14

Sources: 1/ Ward 2012 and ADEC 2013, 2/ Huff, 2012., 3/ADEC, 2013.

As provided in **Table 7.10**, we estimate that natural gas conversion will result somewhere in the range of 1.1 to 1.5 tons per day, or approximately 1.3 fewer tons of $PM_{2.5,}$ being emitted during January and February air quality episodes. To estimate the change in annual concentrations, we use data on the number of heating degree days (HDD) by month in Fairbanks, as highlighted in **Figure 7.5**. A HDD is a measurement of the demand for energy needed to heat a building. HDDs are based on outside temperature, with a higher HDD estimate reflecting higher energy demand to heat the building to a comfortable indoor temperature. Space heating requirements are considered to be directly proportional to the number of HDD at a location. As shown in the figure, the months with the highest HDD are November through February. This corresponds to the months with the highest $PM_{2.5}$ emissions due to non-excludable sources.



Source: Alaska Climate Research Center, Fairbanks AP

Figure 7.5 Distribution of Heating Degree Days in Fairbanks

Using the proportion of HDD in January compared to other months, we estimate the average daily $PM_{2.5}$ emissions from residential wood heating. For example, the HDD in March are 73 percent of the HDD in January: therefore, we estimate that the daily residential wood heating emissions are 0.73 in March. Multiplying by the number of days in each month, we estimate that natural gas conversion would reduce annual emissions of $PM_{2.5}$ by approximately 234 tons annually.

Table 7.11 Estimated Annual Emission Reductions from Natural Gas Conversion

Month	HDD	% HDD	Estimated Tons/Day Emissions	Estimated Annual $PM_{2.5}$
January	2260	17%	1.30	40.3
February	1858	14%	1.07	30.0
March	1660	12%	0.92	28.4
April	974	7%	0.54	16.1
May	485	4%	0.31	9.5
June	160	1%	0.08	2.3
July	108	1%	0.08	2.4
August	281	2%	0.15	4.7
September	605	4%	0.31	9.2
October	1265	9%	0.69	21.3
November	1872	14%	1.07	32.1
December	2141	16%	1.22	37.9
All Months	**13,669**	**100%**	**0.64**	**234.2**

7.3.3 Timing of Change in $PM_{2.5}$ Emissions and Concentrations

Table 7.12 presents the emission reductions that are expected to be achieved in each year after build-out. These figures are based on the conversion timing of households currently using wood. As shown in the figure, 88 percent of emissions reductions (28 percent out of 32 percent) are achieved by Year 3.

Table 7.12 Emission Reduction Achieved by Year

Year	Low Estimate (Method A)	High Estimate (Method B)	Tons of $PM_{2.5}$ Per Year
0	5%	5%	5.2
1	18%	19%	19.6
2	22%	23%	26.0
3	27%	28%	35.8
4	28%	30%	44.5
5	29%	31%	56.9
6	30%	31%	76.4
7	31%	32%	117.1
8	31%	32%	234.2

8 Economic Benefits of Air Quality Improvements

This section summarizes the benefits of lower concentrations of $PM_{2.5}$ in the FNSB. These benefits are primarily related to health benefits and improved visibility. There may also be benefits due to safeguarding federal highway and transit funding, and potential decreased permitting and operating costs for emitting facilities.

The economics benefits of air quality improvements are widely recognized. For example, the EPA Office of Air and Radiation completed a report in 2011 to quantify the costs and benefits of the 1990 Amendments to the Clean Air Act from years 2000 to 2020 across the United States. The study is the third report of its' kind that fulfills Congressional requirements to periodically update information related to the costs and benefits of air quality control programs. It found that benefits far exceeded the costs of implementation "under any reasonable combination of alternative assumptions or methods identified in the study". Costs, which were estimated to total $65 billion from 2000 to 2020, were minimal compared to the overall economic benefits realized by making air quality improvements, which equated to almost $2 trillion by 2020.[145]

The assessed benefits of reduced non-fatal health effects and improvements in visibility are valued at more than twice that of the cost to implement the Act, excluding the benefits of reduced premature mortality, a subject of research with strong evidence. Reductions in PM were found to decrease serious diseases like acute myocardial infarction, chronic bronchitis, as well as frequency of hospital admissions and emergency room visits. Economic benefits were projected due to better health and productivity and medical expense savings related to air pollution health problems.[146]

Specific to $PM_{2.5}$, in 2012 the EPA assessed the costs and benefits of revising the annual NAAQS standard. It estimated that lowering the annual standard from 15 µg/m3, based on the 3-year average of annual arithmetic mean $PM_{2.5}$ concentrations, to a variety of levels, including the current standard of 12 µg/m3. EPA estimated that improving air quality to this standard would result in economic benefits associated with improved health and longer lives of approximately $2.3 billion to $5.9 billion at a 3% discount rate and $2.0 billion to $5.3 billion at a 7% discount rate in 2020 (2006 dollars).[147]

Based on previous studies, this section provides general information on the potential magnitude of health and other benefits from improved air quality in FNSB. This section does not provide an estimate of the economic benefits of air quality improvement in Fairbanks due to the significant uncertainty regarding the applicability of previous studies to the Fairbanks context, and the wide range of values found in the literature. However, the information and values presented below do indicate the high value of air quality improvement in FNSB, possibly in the range of $64 million to $200 million (based on studies of the effect of air quality on property values, which can include both health and visibility benefits), to $66 to $172 million based on reduced all-cause mortality benefits.

8.1 Health Benefits

Research has identified numerous adverse health effects of elevated levels of $PM_{2.5}$. Particulate matter and wood smoke may affect everyone, but those most vulnerable are the elderly, children, diabetics, and people with lung or heart disease. The most significant adverse health effects include increased mortality

[145] U.S. Environmental Protection Agency, Office of Air and Radiation, March 2011, The Benefits and Costs of the Clean Air Act from 1990 to 2020 (http://www.epa.gov/air/sect812/feb11/summaryreport.pdf).

[146] Ibid.

[147] US Environmental Protection Agency, 2012, Regulatory Impact Analysis for the Proposed Revisions to the National Ambient Air Quality Standards for Particulate Matter.

for infants and young children,[148] increased numbers of heart attacks especially among the elderly and in people with heart conditions,[149] increased emergency room visits for patients suffering from acute respiratory ailments,[150] increased hospitalization for asthma among children;[151,152,153] and increased severity of asthma attacks in children.[154] The fine particles in $PM_{2.5}$ can get into the respiratory system and cause such problems as burning eyes, runny nose, and illnesses such as bronchitis. Diabetics have an increased risk for impacts due to the higher risk of cardiovascular disease.[155]

In addition to risks for sensitive populations, healthy people are also at risk from $PM_{2.5}$ exposure, including early death,[156,157] lung tissue inflammation,[158] and increased rates of cancer and reproductive and developmental harm.[159,160]

[148] Pope and Dockery, 2006.

[149] D'Ippoliti D, Forastiere F, Ancona C, Agabity N, Fusco D, Michelozzi P, Perucci CA. Air Pollution and Myocardial Infarction in Rome: a case-crossover analysis. Epidemiology. 2003;14:528-535. Zanobetti A, Schwartz J. The Effect of Particulate Air Pollution on Emergency Admissions for Myocardial Infarction: a multicity case-crossover analysis. Environ Health Perspect. 2005; 113:978-982.

[150] Van Den Eeden SK, Quesenberry CP Jr, Shan J, Lurmann F. Particulate Air Pollution and Morbidity in the California Central Valley: a high particulate pollution region. Final Report to the California Air Resources Board, 2002.

[151] Lin M, Chen Y, Burnett RT, Villeneuve PJ, Kerwski D. The Influence of Ambient Coarse Particulate Matter on Asthma Hospitalization in Children: case-crossover and time-series analyses. Environ Health Perspect. 2002; 110:575-581.

[152] Norris G, YoungPong SN, Koenig JQ, Larson TV, Sheppard L, Stout JW. An Association Between Fine Particles and Asthma Emergency Department Visits for Children in Seattle. Environ Health Perspect. 1999;107:489-493.

[153] Tolbert PE, Mulholland JA, MacIntosh DD, Xu F, Daniels D, Devine OJ, Carlin BP, Klein M, Dorley J, Butler AJ, Nordenberg DF, Frumkin H, Ryan PB, White MC. Air Quality and Pediatric Emergency Room Visits for Asthma in Atlanta, Georgia. Am J Epidemiol. 2000; 151:798-810.

[154] Slaughter JC, Lumley T, Sheppard L, Koenig JQ, Shapiro, GG. Effects of Ambient Air Pollution on Symptom Severity and Medication Use in Children with Asthma. Ann Allergy Asthma Immunol. 2003; 91:346-353.

[155] Pearson JF, Bachireddy C, Shyamprasad S, Goldfinre AB, Brownstein JS. Association Between Fine Particulate Matter and Diabetes Prevalence in the U.S. Diabetes Care. 2010; 10: 2196-2201

[156] U.S. Environmental Protection Agency, Integrated Science Assessment for Particulate Matter, December 2009. EPA 600/R-08/139F.

[157] American Lung Association, State of the Air, Particle pollution, website (http://www.stateoftheair.org/2013/health-risks/health-risks-particle.html) accessed November 19, 2013.

[158] Ghio AJ, Kim C, Devlin RB. Concentrated Ambient Air Particles Induce Mild Pulmonary Inflammation in Healthy Human Volunteers. Am J Respir Crit Care Med. 2000; 162(3 Pt 1):981-988.

[159] U.S. Environmental Protection Agency, Integrated Science Assessment for Particulate Matter, December 2009. EPA 600/R-08/139F.

[160] American Lung Association, State of the Air, Particle pollution, website (http://www.stateoftheair.org/2013/health-risks/health-risks-particle.html) accessed November 19, 2013.

Drawn from the EPA, **Table 8.1** summarizes the health and visibility effects of $PM_{2.5}$.

Table 8.1 Human Health and Welfare Effects of $PM_{2.5}$

Quantified Effects	Unquantifiifed Effects
Health	
> Premature mortality based on cohort study estimates > Bronchitis: chronic and acute > Hospital admissions: respiratory and cardiovascular > Emergency room visits for asthma > Nonfatal heart attacks (myocardial infarction) > Lower and upper respiratory illness > Minor restricted-activity days > Work loss days > Asthma exacerbations (asthmatic population) > Respiratory symptoms (asthmatic population) > Infant mortality	> Low birth weight > Pulmonary function > Chronic respiratory diseases other than chronic bronchitis > Nonasthma respiratory emergency room visits > UVb exposure (+/-)

Health benefits of air quality improvements can also be estimated with damage functions (DF) that identify the relationship between air pollution and health effects.[161] Based on the effect on health, the monetary value of health care costs and time lost for sickness caused by air pollution is then estimated.

8.1.1 Estimates of PM-Related Premature Mortality

In 2009 EPA conducted a review of the NAAQS for particulate matter (PM). To support that review, EPA's Office of Air Quality Planning and Standards (OAQPS) developed a quantitative health risk assessment (RA) that describes quantitative risks to public health that derive from PM exposure. The approach uses concentration-response (C-R) functions that describe the statistical relationship between concentrations of particulate matter and incidence of all-cause mortality and morbidity in epidemiological studies.

In its 2009 study, the EPA evaluated the expected change in mortality resulting from reduced $PM_{2.5}$ concentrations. The average reduction in expected $PM_{2.5}$-related all-cause mortality for these urban areas was 1 percent for an average reduction in $PM_{2.5}$ concentration of 2.8 $\mu g/m^3$. This implies a 0.36% reduction in expected all-cause mortality for a 1 $\mu g/m^3$ reduction in $PM_{2.5}$ ambient concentration.

In order to estimate the expected percent change in all-cause mortality from reduced PM 2.5 exposure, the concentration response relationship should be evaluated for the total change in concentration, as follows:

*Percent change in all-cause mortality from $PM_{2.5}$ exposure=0.0036 * Change in 3-yr 98^{th} percentile daily concentration of $PM_{2.5}$ concentration ($\mu g/m^3$)*

As described in Section 8, the change in wintertime PM concentrations is estimated to decrease by 14 to 38 percent due to natural gas conversion. If we assume that the 98^{th} percentile declines by an equivalent amount (reasonable given that the high values are during the winter, wood-burning months), then the three year average 98^{th} percentile value would decline from 44.7 $\mu g/m^3$ to 33.5 to 40.2 $\mu g/m^3$, or a reduction of approximately 6.3 to 17.0 $\mu g/m^3$. Using the relationship above between all-cause mortality and $PM_{2.5}$, all-cause mortality would decrease by approximately 2.3% to 6.1%. According to the Alaska

[161] Delucci, et al. 2002.

Department of Health and Social Services, in 2009 the mortality rate in FNSB was 448.9 people per 100,000. As the population of FNSB is approximately 100,000 there were approximately 450 deaths that year. A change in the mortality rate of 2.3 percent to 6.1 percent indicates approximately 10 to 27 deaths may be reduced due to air quality improvements associated with conversion to natural gas.

In its 2009 study, the EPA identifies the value of a statistical life (based on labor market studies identifying the pay premium for hazardous jobs and other types of studies) as approximately $9.5 million (adjusted to 2013 income levels and 2013 dollars). The annual value of 10 to 27 reduced deaths annually thus is estimated at approximately $95 to $256 million.

These estimated benefits are substantially higher than the average values identified in several other studies of the health benefits of reduced PM concentrations. Studies on the per ton value of air quality improvement estimate that the value of health benefits of PM reduction range from $50 to $3,700 per ton per year[162, 163, 164]). The large range of benefit estimates is primarily based on differences in the number of people who are affected by the pollution reduction (determined by study area population density and pollutant dispersal patterns), but most studies have limited transferability as they do not identify the assumed number of people who benefits. It is also important to note that these estimates are for health only and do not include any benefit related to increased visibility. As shown in **Table 9.2**, these values imply health benefits associated with the projected improvement in air quality of approximately $216,000 to $16.9 million. One factor that may be contributing to the discrepancy in the economic benefits from the applying the damage function to the estimated percent reduction in $PM_{2.5}$ (as above) versus the values per ton found in the literature may be that each ton of PM wood smoke emissions in Fairbanks likely has a larger effect on ambient concentrations than in other areas, due to the wintertime inversions and calm winds that limit dispersion, and the fact that all of these wood burning emissions are near ground level rather than from stacks in industrial structures.

Table 8.2 Damage Function Health Benefit Studies of Air Quality Improvements

			Value of 234 Ton Reduction	
Study	Value	Location	Annual Value	Present Value Over 30 Years, 3% Discount Rate
USEPA (1998)	$1,048-$3,675/ton PM	Eastern U.S.	$245,000 - $860,000	$4,800,00 - $16,900,000
Banzhaf et al. (1996)	$47-497/ton PM	Minnesota and Wisconsin only, rural, vs. urban	$11,000- $115,000	$216,000- $225,000
Burtraw, et al. 1998	$1,003/ton PM	Nationwide	$235,000	$4,600,000

Note: All values converted to 2012 dollars.

8.1.2 Morbidity (Sickness)

Short-term exposure to PM 2.5 has also been shown to lead to increased morbidity. Increased morbidity includes hospital admissions for cardiovascular and respiratory symptoms. EPA selected two key short-term studies to describe concentration-response curves for morbidity: Zanobetti and Schwartz (2009) and Bell et al. (2009). Bell et al., 2009 is cited on page 3-35 of EPA's health risk assessment as the best study

[162] EPA. 1998. Regulatory impact analysis for the NOX SIP Call, FIP, and Section 126 Petition, Volume 2: Health and Welfare Benefits.

[163] Banzhaf, et al. 1996. Assessing the externalities of electricity generation in the Midwest. Resource and Energy Economics (18): pp 395 – 421.

[164] Burtraw, et al. 1998. Costs and Benefits of Reducing Air Pollutants Related to Acid Rain. Contemporary Economic Policy 16(October): pp. 379 – 400.

to use for deriving C-R functions for short-term morbidity. The Bell et al., 2009 study examines the effects of short-term PM 2.5 exposure on respiratory hospitalization rates for individuals over 65 years of age.

The study concludes that a 10 μg/m^3 increase in winter $PM_{2.5}$ will increase respiratory hospitalization rates by 1.05% and cardiovascular hospitalization rates by 1.49%, respectively. As derived above, the $PM_{2.5}$ reduction may range from approximately 6.3 to 17.0 μg/m^3. Assuming a linear response function, then the decrease in $PM_{2.5}$ concentrations resulting from natural gas conversion may result in reductions in respiratory hospitalization of approximately 0.6% to 1.7% percent, and reductions in cardiovascular hospitalizations of approximately 1 percent to 2.5 percent. As with the all-cause mortality concentration-response curve presented above, a similar calculation can be made to estimate how reductions in $PM_{2.5}$ concentration will affect winter hospitalization rates for these sources of morbidity.

In morbidity research specific to Fairbanks, the State of Alaska Epidemiology published a study in 2010 identifying a positive correlation between air quality and hospital visits in Fairbanks. [165] The study evaluated $PM_{2.5}$ concentrations and hospital visit data from 2003 to 2008. For each 10 μg/m^3 increase in the mean 24-hr PM2.5 level 1 day prior to a hospital visit, the study found a seven percent increased risk for a cerebrovascular disease visit in persons under 65 years (95% confidence interval of 1 percent to 12 percent), a six percent increased risk for cerebrovascular disease visit in those over 65 (95% confidence interval of 1 percent to 12 percent), and a six percent increased risk for a respiratory tract infection visit in persons under 65 years of age (95% confidence interval of 1 percent to 12 percent).[166]

Due to lack of data on current rates of hospitalization, this study does not identify the change in hospital emissions due to natural gas conversion.

8.2 Aesthetic Benefits

This section describes impacts of $PM_{2.5}$ air pollutants of concern that have an impact on visual aesthetics within Fairbanks and the United States. Landscapes and views are affected by haze caused by air pollution. The aesthetics of a place is important to people and has been researched to show the value of clean air using several methods. Studies that analyze the perception of aesthetics through revealed preference as well as direct impacts on housing prices show potential economic impacts on the nonattainment status in Fairbanks and the value of improvements in air quality and are described in detail within this section.

The 2011 Benefits and Costs of the Clean Air Act from 1990 to 2020 Report completed by the EPA quantified the benefits to visibility. The EPA found improvements in visibility as the most significant non-health impact as a result of the Act. Visibility benefits were measured in metropolitan areas and large recreational parks within three regions. Quantifying both residential and recreational allowed the EPA to estimate value based on not only parks where people visit to see the outdoors, but also where people live. With the new methodology, residential visibility benefits were estimated to total $49 billion in 2020. The combined total value of residential and recreational visibility improvements were $67 billion in 2020, exceeding the benefits of health by $2 billion.[167]

The local health and visibility benefits of air quality improvements may also be measured by estimating how air quality contributes to property values. Numerous hedonic property value studies find that there is a statistically significant relationship between house price and air quality, controlling for all other factors

[165] Janes H, Sheppard L, Lumley T. Case-crossover analyses of air pollution exposure data: referent selection strategies and their implication for bias. Epidemiology 2005;16(6):717-26.

[166] State of Alaska Epidemiology, Bulletin, Association between Air Quality and Hospital Visits – Fairbanks, 2003-2008 http://www.epi.alaska.gov/bulletins/docs/b2010_26.pdf.

[167] U.S. Environmental Protection Agency, Office of Air and Radiation, March 2011, The Benefits and Costs of the Clean Air Act from 1990 to 2020 (http://www.epa.gov/air/sect812/feb11/summaryreport.pdf).

affecting house price. The price difference attributable to the level of air quality indicates people's willingness to pay for improved health or improved visibility near their home.

A good indicator of the average effect of improved air quality on property prices is provided by a 1995 meta-analysis (statistical analysis) by Smith and Huang of 86 hedonic property studies of different housing markets in the United States. Smith and Huang focused on PM, which is often used as a proxy for air pollution levels as it is a major contributor to haze (which reduces visibility) and also is a threat to respiratory health. Pollutants such as SO_2 and NO_x contribute to PM levels. Based on all studies reviewed, the average value of reducing one ton of PM pollution is approximately $230 per house in the affected area. As emphasized in their study however, the value per ton of improved air quality varies significantly based on the existing level of air pollution as changes in concentration at certain pollution levels is less detectable and thus less valuable.

Using this data, the 234 tons of reduction in $PM_{2.5}$ due to natural gas conversion, would be valued at approximately $42,320 per house, or approximately $1.1 billion for the 20,077 single family houses in the study area. Conversely, Bayer, at al (2006) estimated that property values would rise by up to $400 per house for every one percent improvement in PM levels, or $5,600 to $15,200 per house (based on a 14 to 38 percent improvement in air quality). Using this value, improved air quality to the 20,077 single family homes in the study area may be valued by up to approximately $300 million.

Table 8.3 Hedonic Studies of Air Quality Improvements

Study	Good Valued	Value	Value of 234 Ton Reduction
Smith & Huang (1995)	1 ton reduction PM	$237 per house	$1,113 million
Bayer, et al. (2006)	1% reduction in PM concentrations	$321-$399 per house	$112.4 million – $305.2 million
Delucchi, et al. (2002)	Cost of PM in residential areas across US	$91-$154 Billion, in 1990	

8.3 Other Benefits

Improvements in quality can also have positive impacts on funding for infrastructure and economic growth. This section outlines additional costs and benefits that could affect federal funding for transportation infrastructure, air quality permitting for new and operating businesses, and last economic growth.

Improved air quality can safeguard federal transportation funding. Nonattainment of federal air quality standards can lead to loss of federal highway and transit funding, unless it can be demonstrated that these projects will not result in an increase in emissions. According to the Alaska Department of Transportation (ADOT), there is the potential for funding cuts to major transportation projects due to nonattainment status, but no impacts will be realized for funding in years 2014 and 2015.[168] In order to maintain funding for potential transportation projects, however, projects included in the Metropolitan Transportation Plan (MTP) and Transportation Improvement Plan (TIP) must comply with transportation control measures of the State Air Quality Improvement Plan (SIP) for both $PM_{2.5}$ and carbon monoxide.

Nonattainment status can also lead to potential increased permitting and air quality compliance costs to facilities and businesses in Fairbanks. Permitting in Alaska is operated through the Alaska Department of Environmental Conservation. While there are no additional permits required specifically for nonattainment

[168] Personal communication with Margaret Carpenter, Alaska Department of Transportation and Public Facilities Northern Region. Olivia Welke, November 14, 2013.

areas, nonattainment status may result in additional limitations of pollutant levels and increase overall permitting costs.[169]

Finally, air quality affects quality of life and attractiveness of a region to new residents and businesses. For example, military personnel stationed in Fairbanks often cite air quality as a reason to apply for a transfer to a different location. However, this effect may be limited. As noted by the Office of the Dean, Admissions or Student Life departments, air quality likely has relatively low impact on the University's ability to attract students and faculty compared to other factors such as the climate.[170]

[169] Personal conversation with Rusty Gesin, Alaska DEC Division of Air Quality, Technical Services, with Olivia Welke, November 22, 2013.

[170] Personal conversation with Marmiam Grimes, University of Alaska Fairbanks, PIO Marketing Department, with Olivia Welke, November 15, 2013.

Fairbanks Natural Gas Conversion Analysis

APPENDIX A

IGU SURVEY PRIMARY SECONDARY FUEL PAIRS

Appendix A IGU Survey Primary Secondary Fuel Pairs

Table A.1 FNSB Primary and Secondary Fuel Pairs

Secondary Fuel Sources	Primary Fuel Sources						
	Heating Oil	**Wood**	**Gas**	**Other Fuels**	**Electricity**	**Coal**	**Total**
No secondary fuel	44.7%	3.1%	1.8%	0.6%	0.3%	0.2%	50.8%
Wood	29.2%	1.4%	0.0%	0.1%	0.2%	0.1%	31.0%
Heating Oil	1.4%	9.7%	0.0%	0.1%	0.2%	0.1%	11.4%
Other Fuel	2.9%	0.4%	0.0%	0.1%	0.0%	0.0%	3.4%
Electricity	1.7%	0.1%	0.0%	0.4%	0.0%	0.0%	2.3%
Gas	0.8%	0.0%	0.0%	0.1%	0.0%	0.0%	0.9%
Coal	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%
Total	81.0%	14.7%	1.8%	1.4%	0.7%	0.4%	100.0%

Kerr, Cal, Northern Economics, Personal Communication with Lee Elder, Cardno ENTRIX, November 25, 2013.

Table A.2 Primary and Secondary Fuel Pair for Zip Code 99701

Secondary Fuel Sources	Primary Fuel Sources						
	Heating Oil	**Wood**	**Gas**	**Other fuel**	**Electric**	**Coal**	**Total**
None	60.5%	3.1%	7.9%	1.1%	0.0%	0.6%	73.2%
Wood	13.3%	0.6%	0.0%	0.0%	0.8%	0.0%	14.7%
Heating oil	0.0%	1.9%	0.0%	0.0%	0.0%	0.0%	1.9%
Other fuel	0.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%
Electricity	5.1%	0.0%	0.0%	0.8%	0.0%	0.0%	5.9%
Gas	3.1%	0.0%	0.0%	0.5%	0.0%	0.0%	3.6%
Coal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total	82.6%	5.6%	7.9%	2.5%	0.8%	0.6%	100.0%

Kerr, Cal, Northern Economics, Personal Communication with Lee Elder, Cardno ENTRIX, November 25, 2013.

Table A.3 Primary and Secondary Fuel Pair for Zip Code 99705

Secondary Fuel Sources	Primary Fuel Sources						
	Heating Oil	Wood	Gas	Other fuel	Electric	Coal	Total
None	44.7%	1.3%	1.0%	0.0%	0.0%	0.4%	47.5%
Wood	29.3%	1.7%	0.0%	0.0%	0.0%	0.0%	31.0%
Heating oil	2.1%	12.7%	0.0%	0.0%	0.0%	0.0%	14.8%
Other fuels	4.2%	0.0%	0.0%	0.0%	0.0%	0.0%	4.2%
Electricity	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%
Gas	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%
Coal	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%
Total	82.8%	15.8%	1.0%	0.0%	0.0%	0.4%	100.0%

Kerr, Cal, Northern Economics, Personal Communication with Lee Elder, Cardno ENTRIX, November 25, 2013.

Table A.4 Primary and Secondary Fuel Pair for Zip Code 99709

Secondary Fuel Sources	Primary Fuel Sources						
	Heating oil	Wood	Gas	Other fuel	Electricity	Coal	Total
None	48.8%	2.8%	1.3%	0.2%	0.0%	0.0%	53.2%
Wood	30.6%	1.4%	0.0%	0.4%	0.0%	0.0%	32.4%
Heating oil	1.2%	7.8%	0.0%	0.0%	0.4%	0.3%	9.7%
Other fuels	2.2%	0.0%	0.0%	0.0%	0.0%	0.0%	2.2%
Electricity	0.9%	0.0%	0.0%	1.0%	0.0%	0.0%	1.8%
Gas	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%
Coal	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%
Total	84.3%	12.1%	1.3%	1.6%	0.4%	0.3%	100.0%

Kerr, Cal, Northern Economics, Personal Communication with Lee Elder, Cardno ENTRIX, November 25, 2013.

Table A.5 Primary and Secondary Fuel Pair for Zip Code 99712

Secondary Fuel Sources	Primary Fuel Sources						
	Heating oil	Wood	Gas	Other fuel	Electricity	Coal	Total
None	34.3%	3.2%	0%	0%	1.2%	0.0%	38.6%
Wood	37.3%	1.2%	0%	0%	0.0%	0.4%	38.9%
Heating oil	1.2%	13.1%	0%	0%	0.0%	0.0%	14.3%
Other fuels	4.1%	1.2%	0%	0%	0.0%	0.0%	5.4%
Electricity	2.3%	0.5%	0%	0%	0.0%	0.0%	2.8%
Gas	0.0%	0.0%	0%	0%	0.0%	0.0%	0.0%
Coal	0.0%	0.0%	0%	0%	0.0%	0.0%	0.0%
Total	79.1%	19.2%	0%	0%	1.2%	0.4%	100.0%

Kerr, Cal, Northern Economics, Personal Communication with Lee Elder, Cardno ENTRIX, November 25, 2013.

Fairbanks Natural Gas
Conversion Analysis

APPENDIX

B

APPENDIX B IGU SURVEY SECONDARY HEATING SYSTEMS

Appendix B IGU Survey Secondary Heating Systems

Table B.1 Secondary Heating System Use by Zip Code

	99701	99705	99709	99712	99714	Total
Boiler/baseboard	77.0%	63.9%	65.7%	51.6%	25.0%	62.8%
Furnace	18.0%	22.6%	16.0%	19.9%	18.8%	19.0%
Other	5.0%	13.5%	18.3%	28.6%	56.3%	18.2%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Kerr, Cal, Northern Economics, Personal Communication with Lee Elder, Cardno ENTRIX, November 25, 2013.

Table B.2 Secondary Heating System Use by Zip Code

System	99701	99705	99709	99712	99714
Boiler/Baseboard	2.3%	12.7%	4.9%	4.8%	0.0%
Fireplace	4.2%	6.0%	9.9%	4.3%	0.0%
Fixed heater	19.0%	12.4%	13.1%	14.2%	34.8%
Furnace/Forced air	0.0%	2.7%	5.1%	4.5%	13.1%
Masonry oven	3.1%	0.0%	0.0%	0.0%	0.0%
Pellet stove	5.9%	18.5%	12.2%	10.0%	7.2%
Portable heater	18.9%	3.2%	2.5%	4.1%	8.3%
Propane cook stove	0.0%	0.0%	0.0%	1.0%	0.0%
Wood stove	46.6%	44.4%	52.3%	57.1%	36.6%
Total of Secondary	100.0%	100.0%	100.0%	100.0%	100.0%

Kerr, Cal, Northern Economics, Personal Communication with Lee Elder, Cardno ENTRIX, November 25, 2013.

Fairbanks Natural Gas Conversion Analysis

APPENDIX C

HEATING AND PLUMBING EXPERT INTERVIEWS

Appendix C Heating and Plumbing Expert Interviews

C.1 Heating and Plumbing Expert Interviews

In order to understand the process and identify the costs of converting a home's oil heating system to a natural gas system, five FNSB area heating and plumbing businesses and one Homer area heating and plumbing business were interviewed.[171] To avoid disclosure of sensitive information for individual businesses, this research provides these cost estimates in **Table 3.4** without identifying the business providing the specific estimates (**Table 3.4** sources are not provided in any particular order). Furthermore, the summary of each business interview does not provide any identifying information for these businesses. The objective for these interviews was to obtain a range of heating system conversion cost estimates, understand how heating systems operate, and request input about how residents may decide to convert to natural gas. A summary of these interviews, organized by major theme, is provided below.

C.1.1 Existing Heating Systems

> Most mobile homes or manufactured homes in Fairbanks have furnaces. They are not as energy efficient as boilers, (about 90 percent).

> Most homes in the Fairbanks area use fuel oil boiler systems to heat their homes with baseboards.

> Forced air (furnaces) are probably in 10 percent of the homes. Mobile homes have them and some of the older, smaller homes in Fairbanks.

> Baseboard systems are the most common way to circulate heat through the home in Fairbanks. This system uses a boiler system that heats water to 180 degrees.

> Dual fuel systems are normally done for commercial users who cannot be without power. If there is a disruption in the natural gas, then fuel oil can be used.

> There are more homes with baseboards than radiant heat…approximately 80% have baseboards. A 3 to 1 or maybe 4 to 1 ratio.

C.1.2 Heating System Specifics

> The Alpine Burnham boiler is a nice boiler. It's small and compact and can hang on the wall. The boiler itself costs about $4,500 without the water heating component and about $5,100 with the water heating component. These devices are very energy efficient (about 97%).

> Alpine Burnham stainless steel boilers have efficiencies in the 97% to 98% range.

> The type of circulation system used for home heating is important because it impacts the effective energy efficiency of the appliance. The 97% energy efficiency rating for the Alpine Burnham assumes that the system water is heated to less than 140 degrees. This temperature is adequate for radiant heat systems and allows the user to achieve a quantum leap in efficiency. This is why we often recommend customers go with the natural gas, cast iron boiler. Running an Alpine Burnham with baseboards brings the efficiency levels down to about 88 percent. So you pay a lot more for one more point of efficiency unless you use radiant floor heat or even panel radiators.

> Radiant heat systems use plastic pipes and heats up the concrete in the floor. This way of circulating heat throughout the home is very efficient since the water can be less than 140 degrees. However, it is very

[171] The FNSB area businesses contacted for this analysis include Frontier Heating and Plumbing, Rocky's Heating Service, Altrol, Portwine Plumbing and Heating, and Kraft Heating. The Homer area business interviewed for this research was Eayrs Plumbing and Heating. These interviews were conducted during the fall of 2013.

expensive to install this system in homes if retrofitting is necessary. It might make sense to do for new construction, but not a good plan to retrofit existing homes because of cost.

> Panel radiators are a new technology from Europe that mounts to the wall. It's a flat rectangular devise and it is more efficient because the water has to heat to between 150 and 170 degrees. The price for the system is moderately expensive, but very expensive to switch out your house if you already have baseboards.

> A direct water heater has its own natural gas burner and is less expensive and less efficient than an indirect water heater. An indirect water heater is the most energy efficient, but more expensive. The boiler heats the water for an indirect water heater and the heater is treated as a zone.

> The boiler is not as efficient when you convert by switching the burner.

> Oil systems have to be serviced every year or there will be problems. The combination of lower heating efficiency and yearly maintenance costs for oil systems make switching from an oil system to natural gas heating system highly beneficial to people.

C.1.3 Conversion Options

> There are a wide variety of conversion choices for natural gas. When gas becomes available, the range of costs could be huge.

> Someone would not purchase a furnace if their house is set up to use a boiler. Most people heat with fuel oil in Fairbanks and most people have a boiler system that routes heat through baseboards. Even the new houses use this type of technology, but the large baseboards are not required anymore so you can now move your furniture closer to the wall.

> You can change out the gun (also called the burner), but you have to have a more current boiler.

> A boiler in the moderate efficiency range (a cast iron atmospheric gas boiler for an existing cast iron fuel oil boiler) is a good conversion option. We install a lot of these and they're about 86 to 87 percent efficient.

> There are cheaper boiler options that are less efficient (in the 70s), but our company doesn't install these because of the poor quality.

> You can switch out the gun on models as old as 10 years. We won't switch the gun out on any boilers older than 10 years because it can cause problems.

> It is reasonable to expect that most people who have a boiler now would switch the burner (assuming the unit is 10 years or less of age). It depends on how the unit has been maintained over the years. If someone cannot afford to buy a new system, they are likely to not have maintained the unit either.

> Radiant/slab heating is superior to baseboard. Once you have a big slab that is heated, it does not take much to maintain it. Most new homes have slab heat. There is a low percentage of homes with slab heat…maybe 75% of homes have baseboards.

> If natural gas comes in 50% lower than fuel, then yes, people would convert from a Monitor stove to a natural gas space heater.

> Boilers have not changed much in 10 years. People would replace the burners when converting to natural gas.

> Almost all oil boilers can be converted to natural gas by replacing the burner. Some boilers will lose efficiency after this conversion. It can be a significant loss and depends on how old the burner is**.**

> The biggest problem with converting burners is that the right burner is needed to match the boiler. Midco makes conversion burners. UL listing will be lost when converting the burner. For both furnaces and boilers, there could be liability issues if the burner is converted because the boiler is no longer being used with the burner for which it was designed.

> If they have an old boiler, then yes they would replace the unit. The older boilers are not as efficient.

> Cast iron units last a lot longer, but are not as efficient. If 50% of the people had a newer cast iron unit, they would only change out the burner.

> The likelihood of someone replacing their Monitor stove with a natural gas unit depends on price of natural gas.

> Burner conversions are a waste of money. The homeowner is constrained by what the boiler can do, even when converting the burner. A brand new system could be purchased with much higher efficiency while converting the burner only will result in ~80% efficiency (the efficiency level of the original oil boiler).

> Newer oil boilers are only 87% efficient when the burner is replaced. With the efficiency loss (relative to boilers designed for natural gas) and lower cost of natural gas, individuals may as well purchase a whole new system rather than just convert.

> Individuals with wall mounted oil space heaters would look for a replacement natural gas space heater.

C.1.4 Heating System Installation Process

> To get the gas line to the new meter there may be some piping costs associated with conversion.

> The installation of boilers in Fairbanks and North Pole require purchasing a permit. Permits are not necessary if you install a boiler within the Borough as long as it is outside city limits.

> Most residential homes are going to need a 40 to 50 gallon water tank.

> Furnaces are a lot easier to replace and require less labor for installation. They have a lower upfront cost.

> Installation costs depend on whether piping has to be redone and how far the natural gas line is away from the boiler.

> A good estimate for installing between $2,000 and $3,500. A natural gas space heater is pretty easy to install if they already have a monitor stove

> Only one-man shops would replace the burner on a furnace. Our company does not replace the burners on furnaces.

> For most natural gas equipment, a separate water heater would be needed.

Fairbanks Natural Gas Conversion Analysis

APPENDIX D

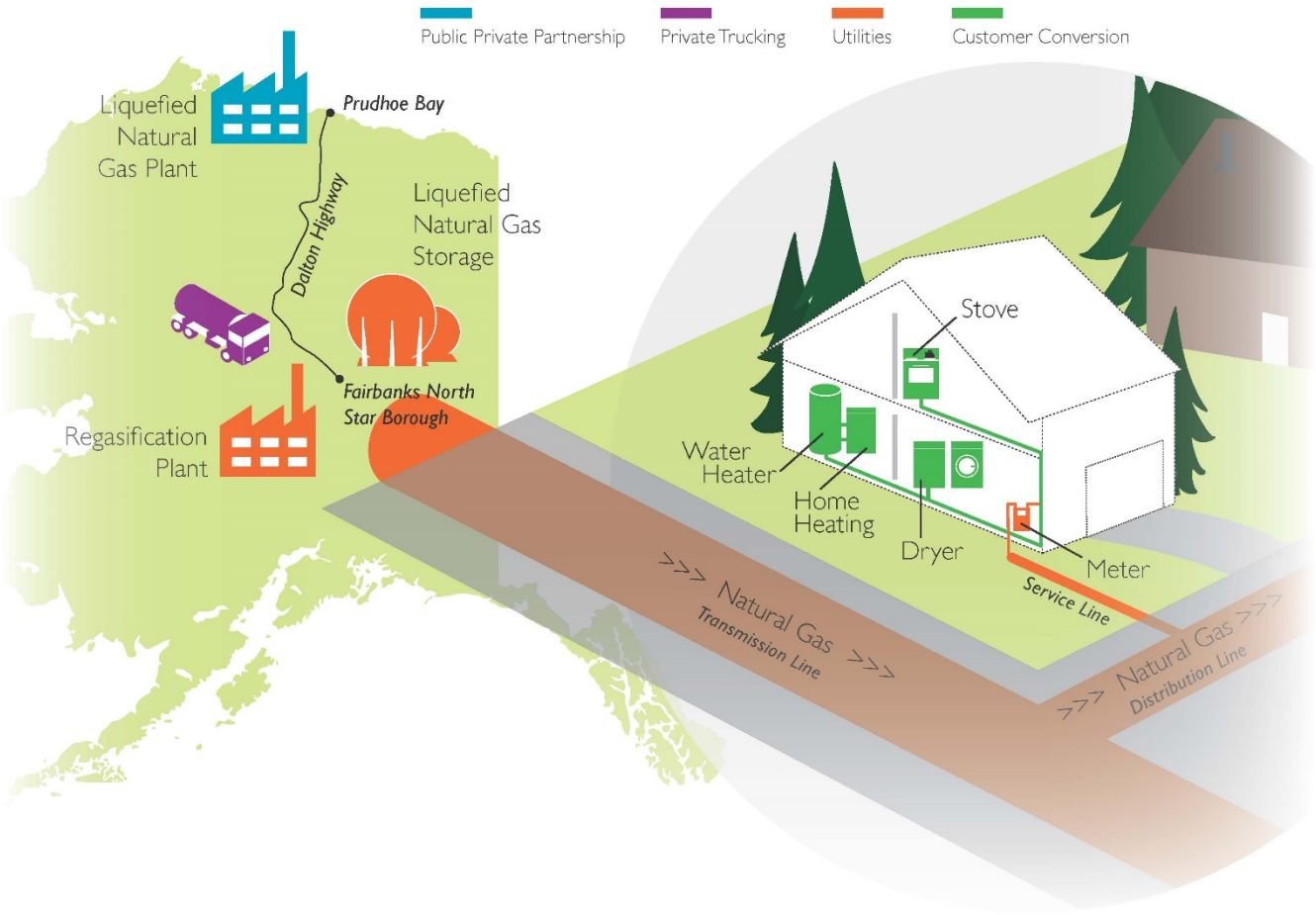
FOCUS GROUP SUMMARY REPORT

FOCUS GROUP SUMMARY REPORT

FAIRBANKS LIQUEFIED NATURAL GAS DEMAND AND DISTRIBUTION ANALYSIS

December 2013

Prepared By: Agnew::Beck Consulting under subcontract to Cardno
Prepared For: Alaska Industrial Development and Export Authority (AIDEA)



ACKNOWLEDGEMENTS

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- The staff at the Noel Wien Library and the Fairbanks North Star School District for their assistance with meeting facilities.
- Fairbanks Natural Gas (FNG) for their feedback on the focus group presentation.
- The Interior Gas Utility (IGU) for sharing their survey questions and for their feedback on the focus group presentation.
- Gene Therriault of the Alaska Energy Authority for presenting the project overview at each focus group and for his knowledgeable responses to questions from participants.

LIST OF ABBREVIATIONS

AEA	Alaska Energy Authority
AHFC	Alaska Housing and Finance Corporation
AIDEA	Alaska Industrial Development and Export Authority
BAH	Basic Allowance for Housing
BTU	British Thermal Unit (unit of heat)
EPA	Environmental Protection Agency
FNG	Fairbanks Natural Gas
FNSB	Fairbanks North Star Borough
GVEA	Golden Valley Electric Association
IEP	Interior Energy Project
IGU	Interior Gas Utility
LNG	Liquefied Natural Gas
MCF	Thousand Cubic Feet
RCA	Regulatory Commission of Alaska
SETS Fund	Sustainable Energy Transmission and Supply Development

TABLE OF CONTENTS

1. INTRODUCTION + KEY FINDINGS

For years, Fairbanks residents and businesses have struggled with high energy costs, particularly for home heating. Additionally, Fairbanks has poor air quality due partly to the use of wood burning stoves to cope with high heating costs. Poor air quality led the Environmental Protection Agency (EPA) to declare Fairbanks a PM 2.5 non-attainment area, which means that the air quality does not meet health-based standards for fine particle pollution. The implication of being a non-attainment area is that the state risks losing federal transportation dollars for road improvements. In an effort to solve these problems, Governor Parnell introduced legislation that was passed during the 2013 Alaska legislative session called the Interior Energy Project (IEP). The IEP is a plan to liquefy natural gas on the North Slope, truck it to Fairbanks, regasify it, and distribute natural gas to homes and businesses in the Fairbanks North Star Borough (FNSB). The IEP legislation provides the financial tools to bring natural gas to the FNSB.

The Alaska Industrial Development and Export Authority (AIDEA) and the Alaska Energy Authority (AEA) are charged with implementing the IEP. In order to asses project feasibility, AIDEA is examining the likely rate of household conversion to natural gas. In August 2013, AIDEA contracted with Cardno and Agnew::Beck Consulting (the project team) to prepare the Fairbanks LNG Demand and Distribution Analysis. As part of the study, in October 2013 focus groups were held in the FNSB to discuss the conversion process and better understand the likelihood that homeowners would convert to natural gas.

FOCUS GROUP OBJECTIVES

The objectives of the focus groups were to obtain information on the following:

- Rate of household conversion to natural gas.
- What percent of households will make the switch?
- Factors impacting the rate of household conversion.
- Incentive programs that will increase the rate of conversion.

While focus groups are not designed to provide statistically representative data, they provide considerable qualitative information to help understand the key issues. These key issues include potential obstacles and different incentives that affect how consumers will respond to the option of converting to natural gas. The results of the focus groups are meant to complement data from a quantitative, statistically valid household survey conducted by Interior Gas Utility (IGU) and the Fairbanks LNG Demand and Distribution Analysis.

KEY FINDINGS

The following is a list of key findings. More detailed results are included in the following chapter.

- **Participants were eager to convert**. Almost all (95%) of participants said they are certainly, very likely, or somewhat likely to convert their homes to natural gas. This was the response from participants before incentives were presented. The percentage who would certainly or very likely convert increased from 68 to 70 percent after incentives were introduced. None of the participants indicated that they were "not likely" to convert when asked the first or second time. Some participants indicated that they did not know if they would convert (5%).
- **Participants indicated that they would likely convert quickly**. Sixty-two percent of participants said they would convert within one year when asked the first time. After incentives were introduced, 74 percent of participants indicated they would convert within one year of when natural gas was introduced to their neighborhood.
- **Paying cash was a popular option.** Participants were asked to rank their preferred payment option relative to paying cash. Relative to taking out a private loan, a low interest loan tied to an individual, or a low interest loan tied to the property, participants preferred to pay cash approximately 59 percent of the time. However, participants preferred to use tax incentives instead of cash 65 percent of the time and with some qualifiers (e.g., modifications to the AHFC Home Energy Rebate program); direct payments were also a favorable option. Fifty-six percent of participants preferred direct payments instead of cash.
- **Participants identified four preferred characteristics for an incentive program.** Offering the cheapest conversion, providing the most annual savings, reliability and ease of use, and providing upfront funding were the top four characteristics of an incentive program according to a weighted number of focus group participant votes.
- **Overall there was a lot of excitement and interest in the project.** Participants expressed a lot of interest in the project. Some questioned whether it would happen because they have been waiting a long time for natural gas. Many people discussed the details of the conversion process and it was clear that the cost to convert would be different for different people, depending on the age of their home, the type of heating system they chose, whether they switch out their water heater and heating system, among other factors.

METHODOLOGY – RECRUITMENT + MEETING FORMAT

The recruitment process was intended to bring together homeowners from various areas of the FNSB with diverse backgrounds, representing a range of ages, incomes and other characteristics.

Participants were recruited in two ways. First, the project team used a phone list obtained from Motznik Information Services and contacted homeowners in the FNSB to share some background on the project and to invite them to the meetings. Approximately half the participants were contacted this way. Secondly, a newspaper notice was published in the Fairbanks Daily News-Miner for four days and people who responded to the listing were invited to the meeting. The newspaper notice can be found in Appendix B. To encourage participation, each household received $50 after the meeting. Once participants were selected, they were emailed or mailed a letter containing additional project information. Additionally, the letter asked participants to familiarize themselves with their current heating fuel and heating systems and to review the costs of their heating bills. This letter is contained in Appendix A.

The four meetings were conducted on October 24, 25, and 26, 2013. Three of the focus groups were held at the Noel Wien Public Library in Fairbanks and one was held at North Pole High School in North Pole. The meeting format was similar across all four focus groups. After a round of brief introductions, the facilitator shared information about the purpose of the focus group. The group was also provided a handout packet (Appendix C) to reference throughout the presentation that included the following:

- Agenda
- Common Terms + Definitions
- Conceptual drawing of the production and distribution system
- FNSB Home Heating System Cost Comparison
- Fuel Oil Costs vs. Natural Gas Costs
- Converting Home + Water Heating: Range of Costs
- Example: Total Home Conversion Cost
- Things to Think Bbout

- Potential Options to Pay for Conversion to Natural Gas

After reviewing the handout packet, Gene Therriault of AEA introduced the IEP and reviewed the project background. This was followed by a basic overview of heating costs with a focus on fuel oil and natural gas. The presentation also included an overview of the conversion process and presented preliminary cost estimates for converting a home heating system to use natural gas. An audience response system was used to capture background information on participants and to learn more about their likelihood to convert. A list of potential incentive options was also introduced and meeting attendees were asked whether particular incentive options would make them more likely to convert. It is important to note that participants were asked about their likelihood to convert twice; once before there was mention of incentives and then again after incentives were introduced. This was done to test whether introducing incentives changes responses to the conversion question. After each round of questions, there was an opportunity for discussion.

WHO PARTICIPATED

There were 46 participants representing 41 households at the meeting. Each household received one audience response clicker. Demographic characteristics of the focus group participants, as well as information specific to their current heating system, are summarized below. This information was gathered using the audience response system.

PARTICIPANT DEMOGRAPHICS

- Compared to the general population, the focus group participants are older, have higher household income, and are all homeowners.
- Length of residence in the FNSB – Over 70 percent have lived in the FNSB for more than 20 years. Only 3 percent have lived in the area under 5 years.
- Location – Zip codes include Airport: 99709 (38 percent), North Pole: 99705 (28 percent), Downtown Fairbanks: 99701 (23 percent), Steese: 99712 (10 percent), and Harding-Birch Lakes: 99714 (3 percent). With exception of Harding-Birch Lakes, all participant zip codes are within the proposed service area. No focus group participants were from the proposed service are zip codes of 99775 (University), 99703 (Wainwright), or 99702 (Eielson).
- Age – 68 percent are between 56 and 75 years old; the remaining 32 percent are between 36 to 55 years old.
- Gender – 24 out of the 41 (59 percent) are male and 17 (41 percent) are female. That number does not account for the additional five focus group participants, all of whom are significant others, living in the same household as participants who had access to the audience response clickers. Focus group sign-in sheets indicate that 25 out of 46 total attendees are male (54 percent) and 21 are female (46 percent).
- Income – More than half (26 out of 41) have a household income of $80,000 or more.
- Home ownership – 100 percent are homeowners.

- Residential properties owned – Approximately 66 percent own only one residential property in the FNSB, while 25 percent own two to five residential properties. The rest own more than five residential properties.
- Type of residence – 93 percent, or 38 out of 41, live in single family residences.
- Sizes of residence – 13 out of 41 homes are between 1,501 to 2,000 square feet; 11 live in homes over 3,000 square feet; 10 live in 2,001 to 3,000 square feet.
- Length of occupancy – Over half (28 of 41) have lived in their home for ten or more years; and, over half (28 of 41) are unlikely to move within the next five years.

PARTICIPANT HEATING SYSTEMS

- Primary heating system – Boiler/baseboard or radiant heat is the primary heating system for the majority (84 percent) of participants. Focus group participants have a higher proportion of boiler/baseboard primary heating systems (84 percent) than exhibited throughout the borough (63 percent of households).[1]
- A similar proportion of focus group participants (83 percent) use heating oil as their primary fuel. Borough wide, 81 percent of households use heating oil as their primary fuel.[2]

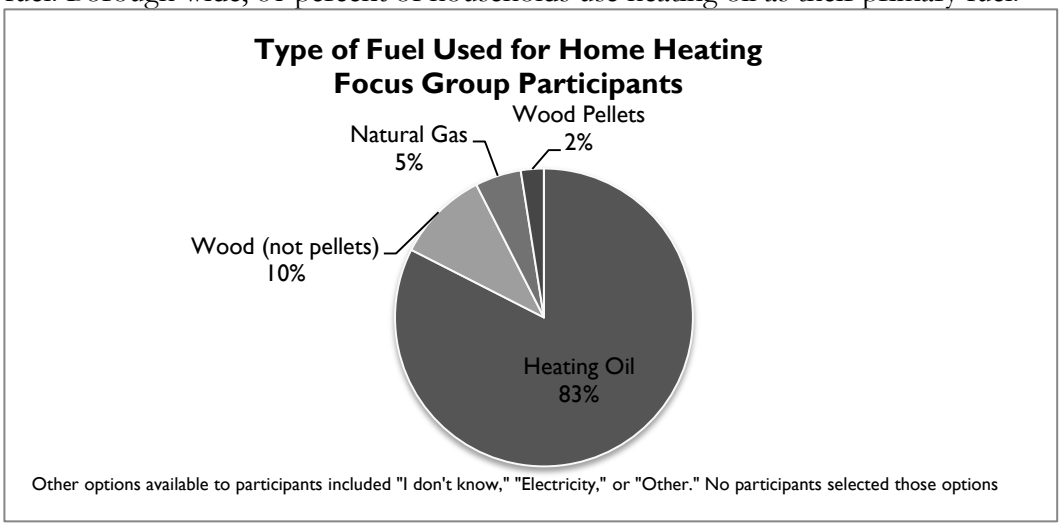


Figure 1 Fuel Type

- Age of heating system – Over 60 percent (25 out of the 39 who responded) have a primary heating system that is less than 11 years old. Nearly one-quarter (9 out of the 39 who responded) households have heating systems that are over 20 years old. Most use fuel oil as their primary heating source (83 percent). The age of primary heating systems for focus group participants is similar to boilers and furnaces throughout the entire borough.[3]
- Over half have heating systems that provide both heat and hot water for their homes (68 percent).

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

- As indicated by Figure 2, average annual primary heating system expenditures vary across focus groups. On the low end, only two households are paying less than $1,000 a year to heat their homes. On the high end, six households are paying an average of $7,000 a year or more. The highest number of households (8 out of 41) pay in the $6,000-6,999 range annually. Interestingly, results from the North Pole focus group indicated those residents are paying less for their heating. In North Pole, half of the respondents are paying less than $5,000 per year to heat their homes. More than half of respondents from the Fairbanks-based focus groups said they pay more than $5,000. This may be linked to the fact that North Pole residents indicated having newer home heating systems (all ten households have heating systems that are less than 10 years old).

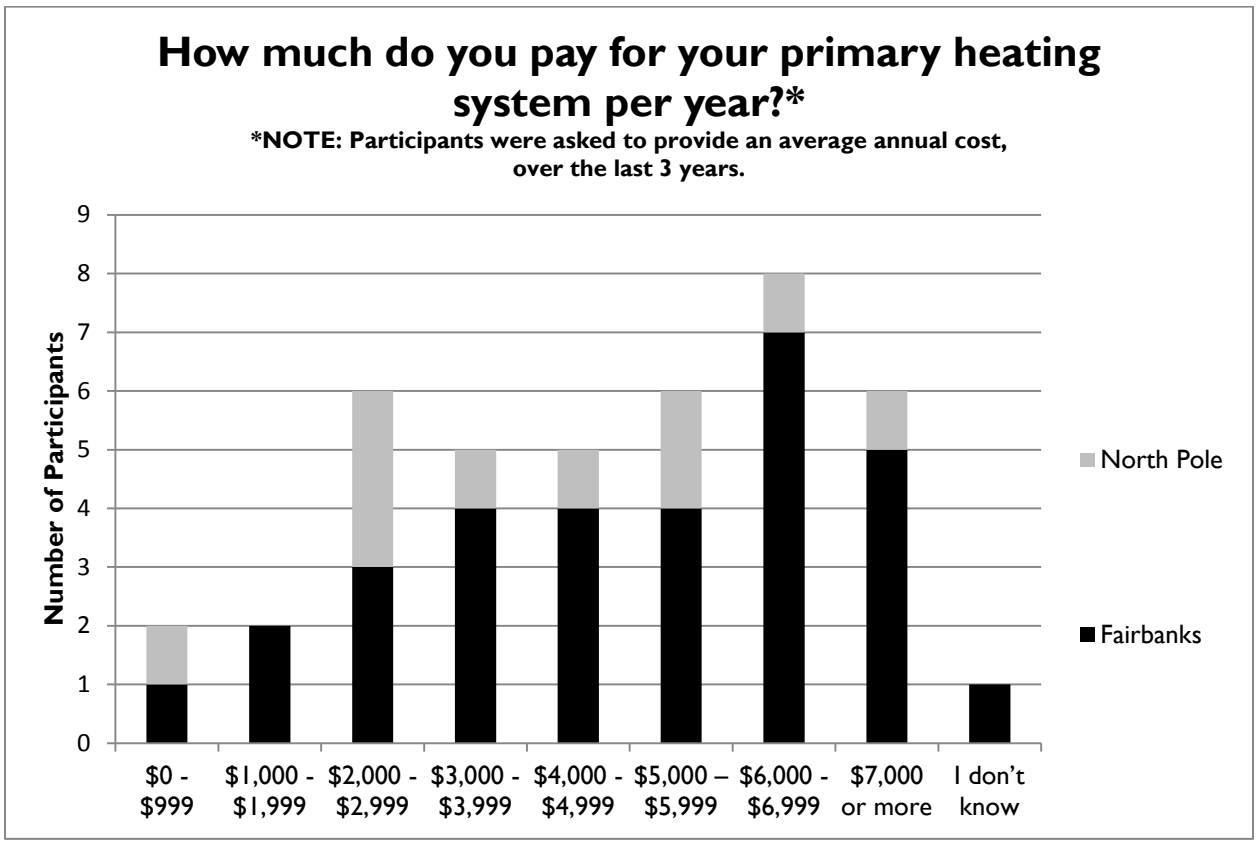


Figure 2 Annual Fuel Expenditures for Primary Heating System

- 14 out of 40 (35 percent) of households do not have a secondary heating system. Of the 26 that have a secondary heating system, 19 (73 percent) use a wood stove or pellet stove, 12 percent used a boiler, 8 percent used a fixed or portable heater, 4 percent used a furnace, 4 percent use another type of secondary system and no respondent reported using either an electric or fireplace as a secondary heating system.
- Of the 26 households with a secondary system, 42 percent reported paying less than $499 in annually heating expenditures for these secondary systems (primarily wood and pellets), while 23 percent pay between $2,000 and $2,999 annually for their secondary systems (see Table 1 below).

Table 1 Annual Secondary Heating System Expenditures (Percent of Total Secondary Systems)

Secondary Heating System	**$0-$249**	**$250-$499**	**$500-$999**	**$1,000-$1,999**	**$2,000-$2,999**	**$3,000-$3,999**	**Don't know**	**Total**
Boiler/Baseboard				4%	8%			12%
Furnace							4%	4%
Wood Stove	19%	15%		4%	12%			50%
Pellet Stove		4%	12%		4%		4%	23%
Fixed Room						4%		4%
Portable				4%				4%
Don't have								0%
Other		4%						4%

2. RESULTS

This chapter provides a summary of both quantitative and qualitative focus group results, including participant feedback on likelihood to convert, effects of incentives, technical components of home conversion, and general comments, questions, and concerns regarding the IEP, in general.

CONVERSION

At each focus group, participants were presented with a range of potential conversion costs. While the actual conversion cost for a particular home is dependent on many variables, participants were still able to provide valuable feedback and comment on their likelihood to convert. Most participants indicated that they would convert their home heating system if natural gas was available, and most would convert in less than two years after the gas was available (see Figures 3 and 4). No participants indicated that they were "not likely" to convert. Below we summarize key themes from focus group conversations, including quotes from focus group participants. The questions on likelihood and timing of conversation were asked twice during the focus group – the first time, after the home heating and conversion facts presentation/discussion, and a second time, after the incentives presentation/discussion. Results from these sets of questions are summarized in the graphs below.

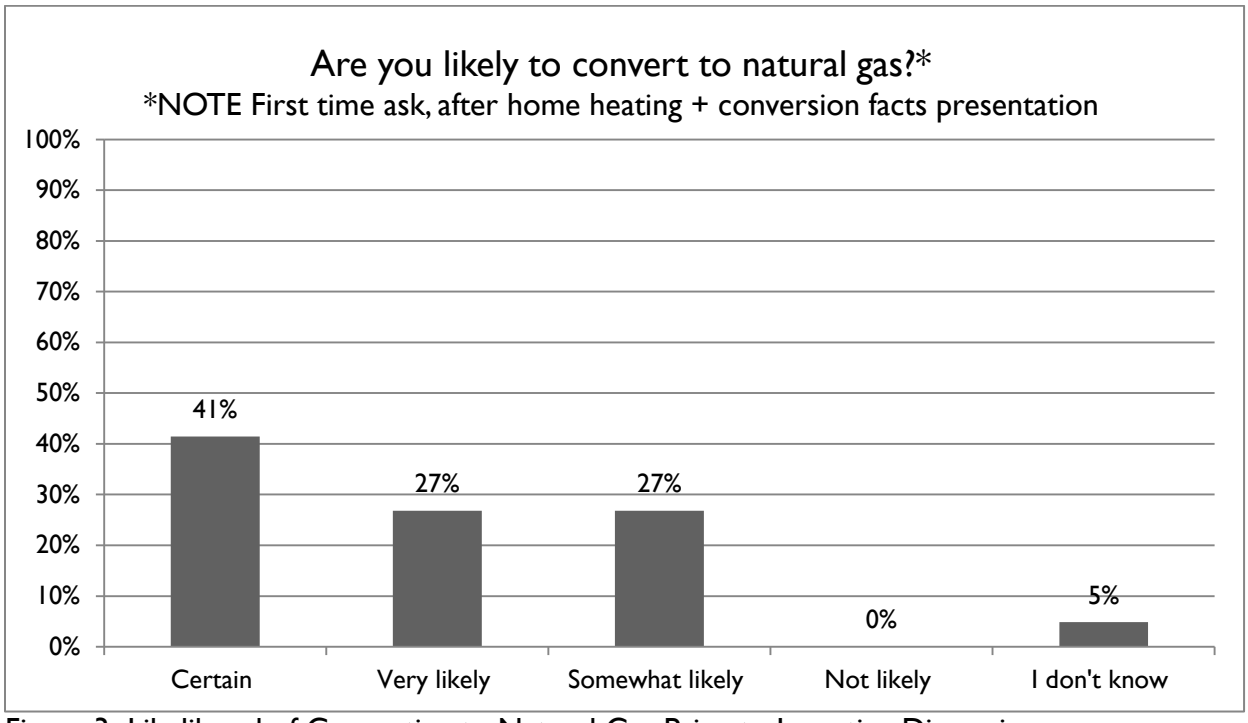


Figure 3 Likelihood of Converting to Natural Gas Prior to Incentive Discussion

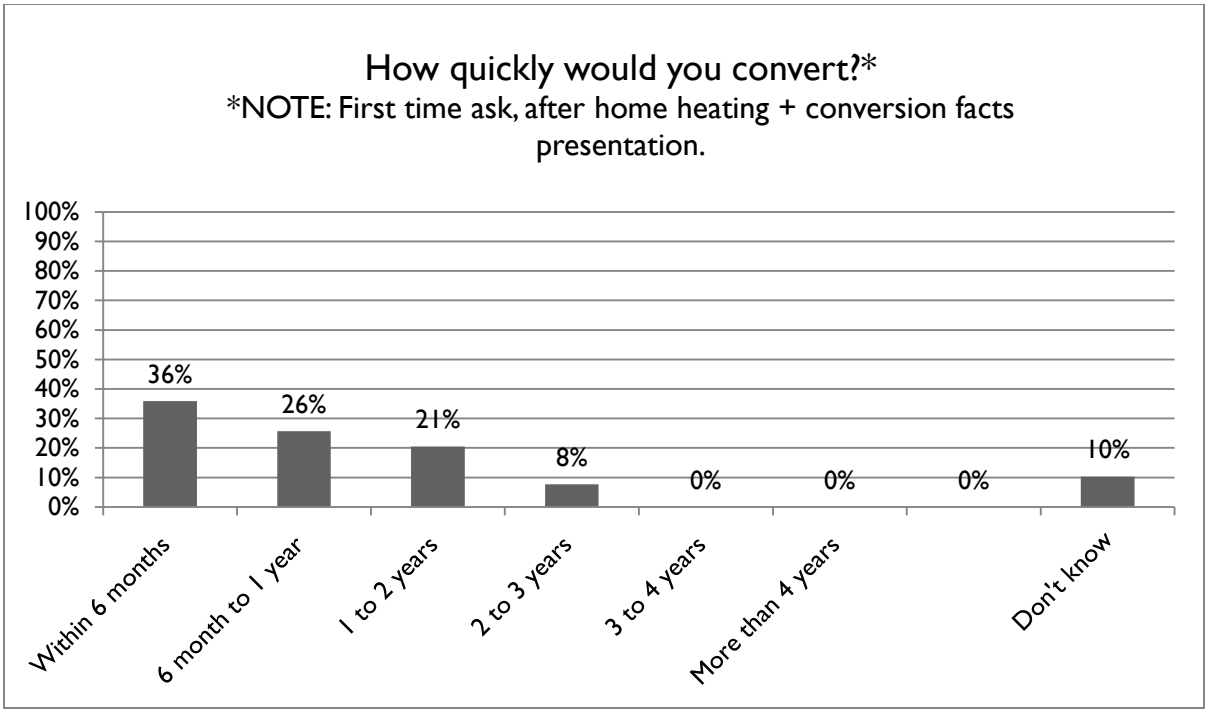


Figure 4 Rate of Conversion to Natural Gas Prior to Incentive Discussion

HOW LIKELY ARE YOU TO CONVERT (FIRST TIME ASK, AFTER HOME HEATING AND CONVERSION FACTS PRESENTATION)?

Most participants, 39 out of 41 households (or 95 percent) of participants said they are certainly, very likely, or somewhat likely to convert their homes if natural gas were made available to them. The most frequently cited reason for not converting was the potential cost. Elderly residents were particularly concerned about cost, and said they were not sure they could afford it and were not sure they would recoup the cost savings soon enough. Residents who recently purchased new heating systems generally said that they would be less inclined to convert, especially if their new heating system was not easily convertible.

What Focus Group Participants Had to Say

"For the property I'm looking to convert, I have less than 10 year old boilers and I run the numbers and at Fairbanks natural gas prices, if I could get the same prices it would pay my conversion costs in 6-8 months. So in one winter, it would pay for it. So I would do it as fast as I could."

"The initial conversion cost might be an obstacle for me. I just put in a new boiler a year ago. If it's convertible, fine...but if it needs to be a whole new boiler; that would stink."

"Could you offer a package deal? Do I have to do four separate conversions, one for each?
If I can afford it I would convert, it's easy to do when you're working, but when you're our age and on a fixed income..."

"Before converting I'd like to see a little history of how it goes for others."

"I probably wouldn't convert. I get almost 6 months out of a propane tank and it's a lot cheaper than fuel oil. Converting my stove, water heater and dryer isn't an extraordinarily significant savings right now, even if the propane costs go up."

WHEN WOULD YOU CONVERT? (FIRST TIME ASK, AFTER HOME HEATING AND CONVERSION FACTS PRESENTATION)

Of the participants who were interested in converting their homes, most (82 percent) would convert within two years. More than one-third (36 percent) would convert in less than 6 months. There were three primary reasons for delaying conversion: more time to see actual conversation prices and programs offered, and waiting to convert in the summer when it is warmer. Participants agreed that it would be best to convert all appliances at once, if the homeowner can afford it. Some focus group attendees said that they would likely have to convert one appliance at a time in order to spread the costs out.

What Focus Group Participants Had to Say

"I would convert as soon as possible. I have multiple properties, and in one winter I would recoup my costs."

"I'd take some time since I'd want to see what the gas agreements and all the rest of that stuff looks like. If it was available and all of the other paperwork looked okay I would probably do it in six months. If it's not and I don't agree with what went on I might take a little longer. Just like how you don't buy new software right away. So I'd like to see what the program is and see that it's operational before I convert."

"I would probably only convert during the summer."

"You could convert appliances over time to spread out the costs...you could exchange out your boiler this year, and if you want to change out your stove in two years, all you have to do is run the gas pipe to the stove."

"The problem with converting one appliance at a time is that you have to pay installation costs each time instead of a one-time installation for someone to come do it all at once."

"Can there be a package deal for converting all your appliances at once? Otherwise it's confusing and inconvenient. Converting all at once would be best."

CONVERSION COST AND SAVINGS CHOICE EXERCISE

We gathered information from focus group participants on how their likelihood to convert varied based on different annual savings and upfront costs of converting. We presented participants with a series of questions in which they were asked to select one of two potential conversion scenarios for their household, identify if they were indifferent to either scenario, or if they did not know which scenario they prefer. The scenarios differed in the up-front costs and annual savings. We analyzed

results (in a regression analysis) to estimate how focus group participants weigh the up-front costs and annual savings.

The focus group responses indicate that participants are willing to pay roughly $4.38 more in upfront-costs for every additional dollar in annual savings. This result can also be interpreted to indicate that focus group participants, on average, will convert if they will recoup capital costs within 4.38 years. However, some focus group participants were indifferent to the conversion scenarios. Figure 5 illustrates how the likelihood of conversion increases with increased annual fuel savings. The graph displays the likelihood to convert at different savings rates with upfront conversion cost fixed at $6,000.

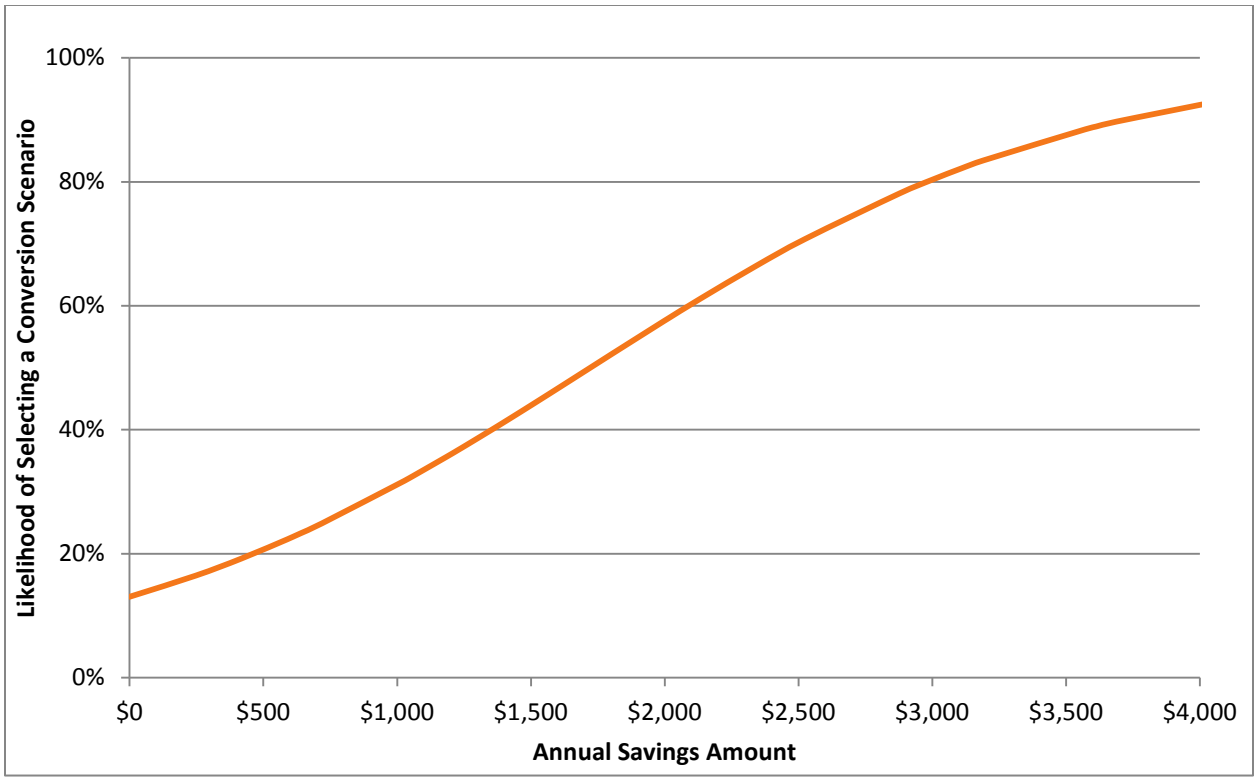


Figure 5 Likelihood of Converting at Different Annual Savings Levels (At $6,000 Conversion Cost)

Figure 6 highlights how the likelihood of converting decreases with rising capital costs. The Figure shows the proportion of focus groups opting to convert at different capital cost levels, given an annual savings of $1,800.

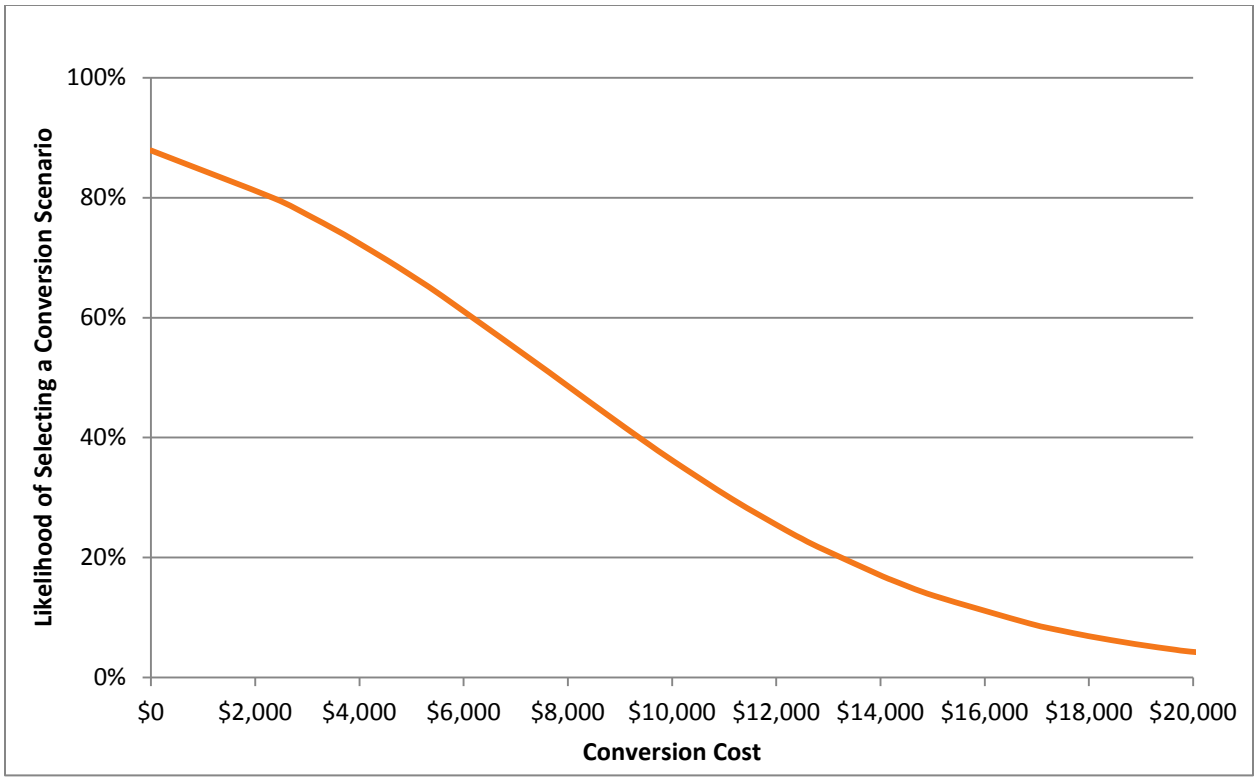


Figure 6 Effects of Conversion Cost on Likelihood of Converting (At $1,800 Annual Savings)

WHAT ARE SOME OF THE BIGGEST CONCERNS? – *CONVERSION*

Participants voiced a couple of different concerns about converting to natural gas. One resident wanted to know more about the fire safety risks and whether the local fire department would be prepared to handle the potential increase in gas fires. Other residents wanted to learn more about the long-term pricing outlook for gas; people said they do not want to convert to a new, cheaper fuel source only to have the price for that fuel increase. Some residents said they would consider keeping a backup fuel source in case of price increases. Participants at two of the four meetings inquired about any challenges of using natural gas when it gets cold (for example, propane can be difficult to use at very cold temperatures) and were relieved to hear that this would not be an issue with natural gas.

What Focus Group Participants Had to Say

"My concern...I grew up in the Lower 48 and gas was one of those things that was a little scary. For me, I would have safety questions but if [my husband] says we change then I change...but I would have some safety questions myself."

"When GVEA (Golden Valley Electric Association) brought in lower electric costs, thousands of people converted their homes to electrical heating and it killed them. I think there are a lot of people who know that history and are a little skeptical about this."

"My daughter lives in Georgia and a lot of people there are converting to electric because gas is getting more expensive."

"Will natural gas pose any problems when it gets cold? Will it freeze?"

"A lot of it has to do with how your house is set up. My house doesn't have a crawl space, I am sitting on a concrete foundation...my stove is sitting in the middle of my kitchen in an island. Having to install a new pipe there would be extremely difficult but a lot of the homes are built with crawl spaces so it could be very easy. There are a lot of variables to take into consideration when you want to have this stuff installed."

"Installation costs should go down because they won't need to special-order supplies. The equipment will be more readily available...it's like solar. Five years ago you couldn't buy a solar panel in this town for $5,000, now they're $249."

"How much could you save by doing installation yourself? Is this easy to do?"

WHAT DO PEOPLE WANT TO KNOW? – *CONVERSION*

Participants communicated very clearly they want to make the most informed decision possible regarding natural gas conversion. As such, they would like to have the most useful, relevant information available to them as they are making their choice whether and/or how to convert. Some participants specified they would like the State to provide this information. People were also curious about the cost of the hookup; when they will need to convert relative to the arrival of gas in their neighborhood; whether it would affect property values, rental prices or taxes; and what the construction for pipe installation will look like.

What Focus Group Participants Had to Say

"Would the house have to be converted over before the pipes would be run from the street to the house?"

"How long do I have to decide if I want to convert?"

"The houses built across the street from me were all built with natural gas, but they put in the wrong boilers. The gas is free-burning in grills at the bottom. They started ripping them out and putting oil back in…the boilers were installed by a company from the lower 48. They had a 5-star energy efficient home but were spending over $1,000/month on fuel. So part of the incentive program should be to share the range of options. Otherwise people will say, 'I want the cheap choice' not realizing the long run is going to cost them a fortune."

"My concern is what will this do to the street in front of me? What's the infrastructure going to do? Are they going to tear up everything? Is the city going to have to pay a whole bunch of money to clean up the asphalt? Do they need easements?"

"If the whole community converts, I think the rental prices will drop."

"You know what? I've got a lot of military, and if the cost of the utilities start dropping they will change their BAH [Basic Allowance for Housing] and it will affect what they are

able to afford in rent. If they can get a nicer place and have cheaper utility costs because of the natural gas, that's what they're going to do."

"Would a full conversion improve the resale value of my house?"

"I've been married to a real estate agent for a long time. It doesn't really affect the value of your house. Even the houses that are still on electric aren't really negatively affected. It might factor in between 1 to 5 percent of value."

"I'll bet it would raise your property taxes though...the assessed value might change, since it's an improvement on the house."

INCENTIVES

At each focus group, participants were presented with an overview of potential payment options for converting to natural gas, including existing incentives programs in Alaska and the Lower 48. Most participants said they would convert their homes to natural gas, as indicated by Figure 7 below, after hearing a short presentation and discussion about payment options and incentives, which included; loans, low interest second mortgage, low interest loan through utility, direct payments, and tax incentives, (see Slide 42 and 43 in Appendix D). Compared to the first time the question was asked, there was only a slight increase in the number of participants who were "certain" to convert, with an increase of one person (18 versus 17). Unlike the first time the question was asked, no participants indicated they "didn't know" if they were likely to convert.

Rate of conversion was slightly faster after the payment options and incentive programs presentation and subsequent discussion (see Figure 8). When asked about the rate in which they would participate assuming that some generalized incentive program was available to assist with upfront conversion costs (Figure 8), five additional participants said they would convert within six months, resulting in 37 out of 41 households stating they would convert in less than two years with an incentive program in place (versus 32 out of 41). Also, fewer people responded "I don't know" on the timing question (1 versus 4).

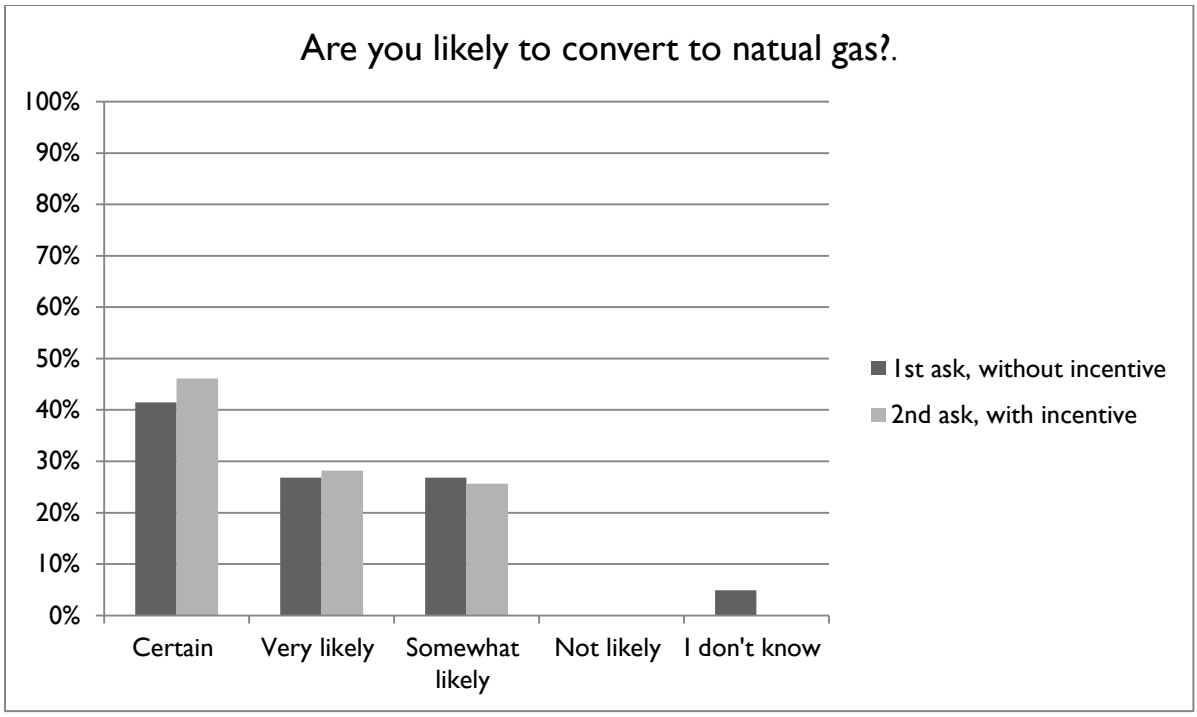


Figure 7 Likelihood of Converting to Natural Gas Following Incentive Discussion

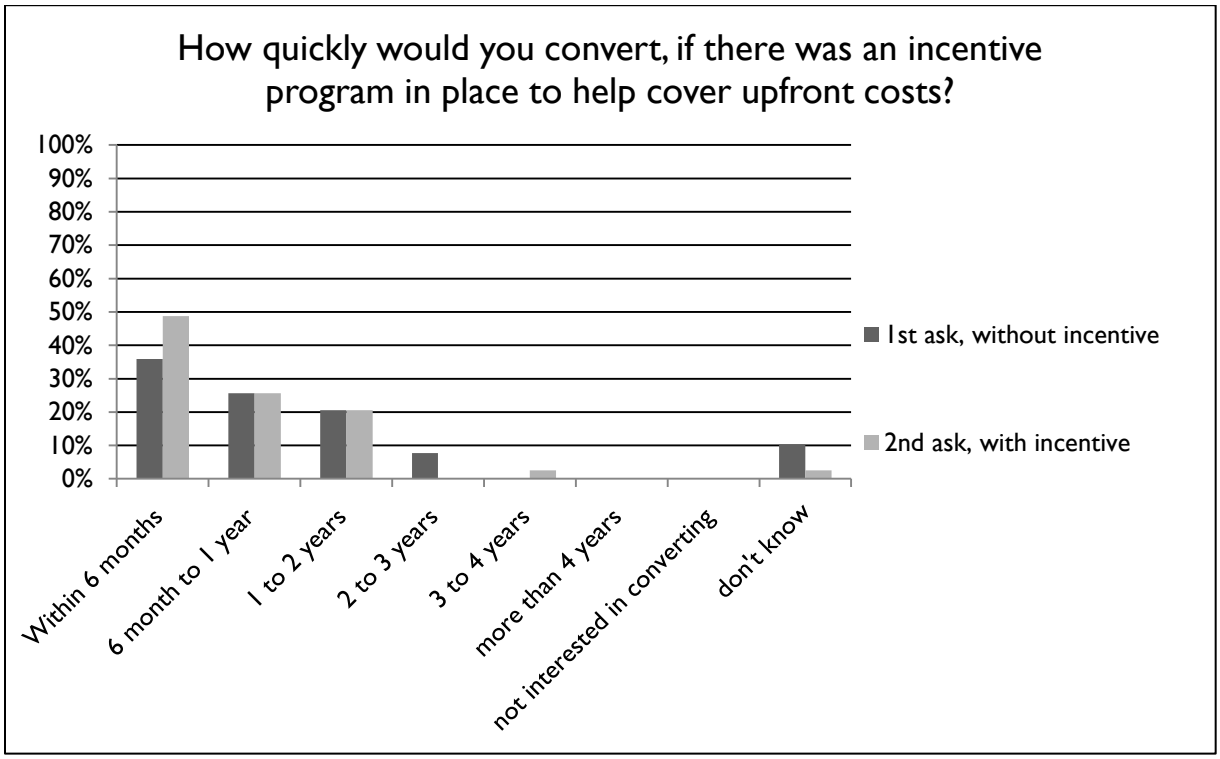


Figure 8 Rate of Conversion to Natural Gas Following Incentive Discussion

THOUGHTS ON THE POTENTIAL PAYMENT OPTIONS + EXAMPLE INCENTIVE PROGRAMS

Outlined below is a summary of participant feedback on household conversion payment options, incentive program characteristics, and preferences for different incentives.

After a presentation on options to pay for upfront costs of conversion, participants were asked to indicate their preferred option, relative to paying cash. The payment options included paying for the conversion with a private loan, paying with a low interest loan tied to the individual, paying with a loan tied to the property, paying with a direct payment, or paying for the conversion with a tax incentive. In general, many participants preferred paying with their own cash versus taking a loan to finance upfront costs (average of 59% preferred cash to one of the three loan options suggested). Additionally, several participants shared the desire to see a fairly quick return on their cash investment. For example, one participant said she would like to either break even or start to see the real savings on conversion within five years.

Tax incentives were also popular with 65 percent of participants indicating they would prefer a tax incentive to using cash. Direct payments (rebates that reduce upfront costs) were also a favorable choice (56% preferred direct payments to cash). However, there was some skepticism regarding the AHFC Home Energy Rebate Program, as a potential example of a direct payment. As it currently stands, several participants did not consider this program convenient or worth the time necessary to participate. Participants shared their experiences with the program, including the perception that the upfront investment was not worth the long-term savings, and conveyed the difficulty of attaining a two star-improvement. Participant feedback on potential conversion payment options and example incentive programs, in general, as well as comments/questions regarding specific options are outlined below.

What Focus Group Participants Had to Say

General

"We're all old people with money…You'll see different numbers if you talk to younger people…who need the assistance."

"The incentives will be useful for younger families who need to convert."

"I did the conversion on my own without any incentive program. I tied a thing around my boiler, dragged it out of my garage and put a new one in. The economics made sense."

"I would not convert. I just bought a new boiler and we just finished converting our home. We used the rebate program, so we probably couldn't use it again. Our current boiler is not available for conversion."

"There's going to have to be a lot of people moving in, younger families with new houses being built. And there's going to have to be a really good incentive for them to build homes with this already in it."

"Need incentives to bring young people here. Not a lot of incentives for young married couples to move here."

“I think people think they're going to get something for nothing. When you bring up these tax incentives, talking about the wood change-out program - done that, home energy rebate - done that, it's free money for Alaskans. I think that's where people are going to wait to see, 'what's in it for me?”

“I look at my break-even point. How quickly I will get a return on my investment. I go around with my mental mouth hanging open at the cost of how much it costs just to live up here. Our wages have not kept pace with that any extra thing that I can get I'm going to try and grab, whether it’s a direct payment or a tax credit because I'm fighting to stay here financially. It's hard.”

“For me, I'm really tight on cash right now. I tried to do the AHFC program but you have to pay the cash up front and you might get it back. There's no guarantee on that. For me to convert my furnace...if there's a loan or a government agency that could help that would be great.”

On Paying Cash

“It looks like using my savings account is a lot cheaper than paying for the interest under the other incentive options.”

“If I can afford to pay cash, that’s what I’ll do.”

“If I can pay cash, I would probably do that so I don't have to pay the interest.”

On Direct Payments

"I was part of the last rebate incentive program. I think it's really important that if the State is going to do that, that they put out good information to people. I went to those talks, I went to the meetings, I participated. But they didn't tell us. They didn't give us a good rundown at all about different kinds of boilers. I don't think they wanted to advertise any particular type of boiler. However, I needed information about boilers! They didn't tell us we had to have a permit. I got caught, I had no idea that you needed a permit. I got caught because a guy just happened to be driving down the street when my garage door was open and they were taking the old one out...it should have said that in there. 'Here are the steps you need to take.'"

"I'm not a plumber, I'm not an engineer, I'm not a heating and cooling guy – give me a book, a website, something. I need to know what is available. That was missing in the [AHFC] rebate program."

“I think the direct payment option works well. You put down the direct payment and they send you $5,000 back. That's better than having that money go anywhere else. The homeowner puts some skin in the game. It's better like that."

"Yeah, there's some kind of investment from the homeowner."

“I think people who didn’t participate last time (in AHFC Energy Rebate Program) will do it this time because you save energy AND lower your cost of fuel.”

On Tax Incentives

"If you look at the bottom there, one of the options is tax incentives that will 'reduce tax obligations'. If you're over a certain age, then your tax obligation for a lot of folks is already reduced or $0, so this incentive only works for younger folks."

"For me, since I have multiple properties, paying cash would be a huge cost. I think that for property owners, the tax incentives would make the most sense, even more than the direct payments....I could probably pay cash for one, but not for my income properties."

"Tax incentives will really help property owners. You have to keep properties rented, especially in the winter so you don't have to pay for the heating costs. Right now, I was looking on the military website and anybody that has a local rental can post it on there. I have seen it go in the last 2 months from 180+ (August) to over 300 right now. And half of those are in North Pole."

WHAT IS MOST IMPORTANT TO YOU IN AN INCENTIVE PROGRAM?

Following the payment options presentation and discussion, participants were also asked to rank, in order of importance, their top three most important characteristics from a list of nine potential incentive program characteristics (see slide #53 in Appendix D for complete list). A person's first choice received 3 points, the second choice received 2 points and the third choice 1 point. Figure 9 shows the weighted results. For a detailed breakdown of votes (weighted and unweighted), see Appendix E. Collectively, across the four focus groups, the top four most import characteristics of an incentive program, when votes are weighted, include:

1. Offering the cheapest conversion possible (22% of all possible weighted votes)
2. Offering the most annual savings possible. (20% of all possible weighted votes)
3. Reliability and ease of use (tie, 14% of all possible weighted votes)
3. Providing upfront funding (tie, 14% of all possible weighted votes)

These results show that participants believe that economic incentives are important components to include in an incentive program. According to respondents, incentive programs should help offset upfront costs and should help to increase long-term savings. The remaining priorities align with participant comments above regarding the challenges of existing programs that currently: 1) are hard to understand or provide little/no educational materials; 2) do not provide upfront funding; and 3) and are generally perceived as a lot of work without the desired savings. "Improving neighborhood air quality" ranked in the top five with 10% of all possible weighted votes.

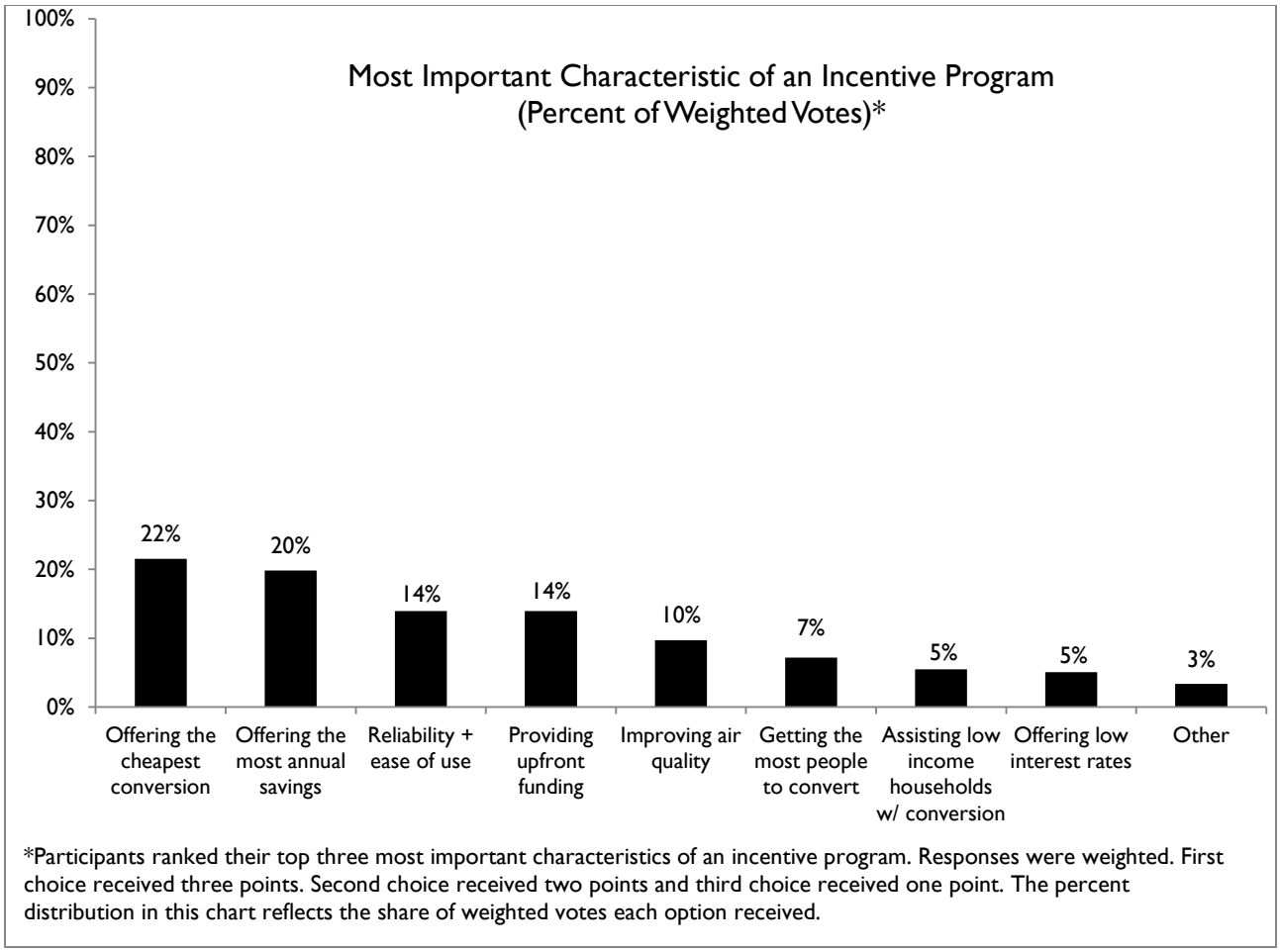


Figure 9 Most Important Aspect of an Incentive Program Discussion

WHAT DO PEOPLE WANT TO KNOW ABOUT INCENTIVE PROGRAMS?

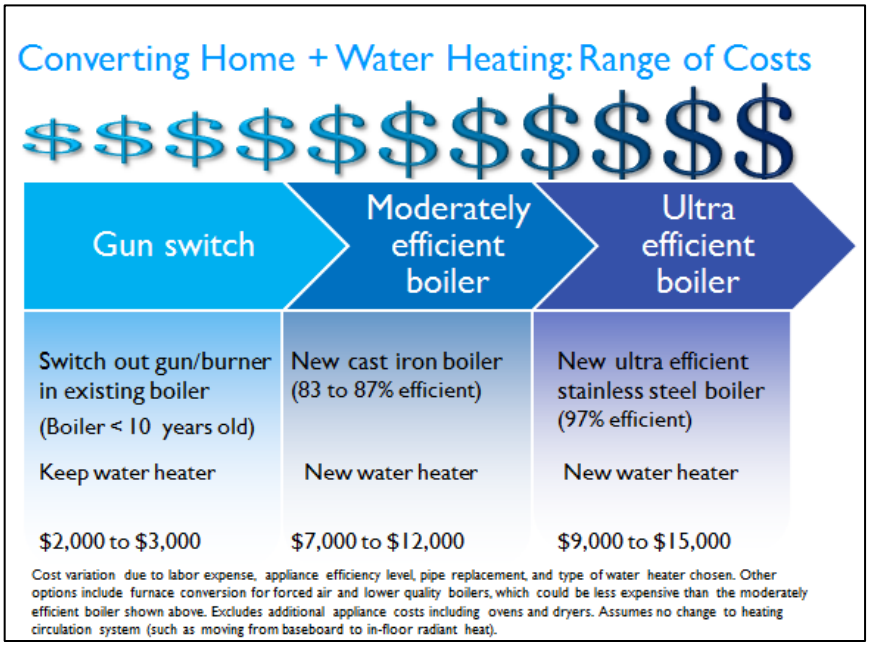
Of the 41 focus participants, 22 have participated in one or more of the following energy programs for their current home:

- AHFC Home Energy Rebate Program – 13 out of 41 have participated.
- AHFC Weatherization Program – 3 out of 41 have participated.
- FNSB Wood Stove Change-out Program – 3 out of 41 have participated.
- Two or more of the above programs – 3 out of 41 have participated in two or more of the above programs.
- 19 out of 41 participants have not used any of the programs above.

Specific feedback regarding the AHFC and FNSB programs are highlighted below.

> "How likely are you to get a 2-star improvement rating if you put in a gas heater?"
>
> "With the amount of people who don't take advantage of one of the rebate program before, if this is offered, will people still be eligible?"

TECHNICAL ASPECTS OF CONVERSION



There were local plumbers and pipefitters at all but one of the focus groups. These participants shared their experiences with conversion and their thoughts on some of the more technical aspects. The intention of the focus groups was not to go into detail about the mechanics of conversion. Nonetheless, there was some useful information shared back by these local experts. While the project presented conversion according to three main categories (gun switch out, moderately efficient boiler, ultra efficient boiler), the suite of conversion options can be very complex. There was some disagreement about which boilers would be eligible for the simplest conversion (the gun/burner swap) and whether the convenience of a burner swap outweighed the challenges. There was also disagreement over which boilers were the cheapest and the most efficient.

What Focus Group Participants Had to Say

"The gun/burner swap is not always a good option. The entire system needs to be taken apart and cleaned and polished…I bought a gun, and I was going to do that until I got talked out of it, so I kept the gun, I'm going to do stained glass and build a kiln for it but you've got to literally pull the whole thing apart."

"With a cast iron boiler it has to stay hot all the time, even in the summer. So you really only want that last choice there, the ultra-efficient stainless steel boiler."

"The ultra-efficient boiler is only ultra-efficient if you have the right system. With baseboard heat it's almost the same efficiency as the cast iron boiler so I don't know why you'd spend all that extra money."

"I upgraded my boiler a couple years ago and when I did that, I bought one that is easily converted to gas. That was the whole intention for buying the one that I did. It's a stainless steel boiler and it's just a gun switch-out to convert once natural gas shows up."

"If you buy a cheap boiler it doesn't last as long, so I wonder about the savings for that. I'd rather pay more for one that will last."

"I don't see anything as far as maintenance for fuel oil vs. gas entered into anything in this. I know oil boilers take some regular maintenance at $150 / pop if not more. That's a

big positive for natural gas since NG maintenance costs are almost nonexistent unless it mechanically breaks."

PERSPECTIVES ON THE INTERIOR ENERGY PROJECT

Participants were generally enthusiastic about the prospect of natural gas coming to the Fairbanks North Star Borough. While most of the attendees had heard a little bit about the project, not very many people knew about the specifics and almost everyone had a number of questions and concerns. The questions are organized into broad categories below. Each category has a short summary paragraph and some representative quotes from participants.

TIMING

Participants were very interested in the project timeline. In particular, people wanted to know when the gas would be available and how quickly the build out would happen. There were attendees at each of the focus groups who voiced significant skepticism around the project timeline, largely due to the fact that bringing natural gas to Fairbanks has been talked about for close to 40 years with little result. Multiple participants mentioned that either they or someone they knew was considering leaving the FNSB due to the high cost of living, including the high heating costs.

What Focus Group Participants Had to Say

"I think that all of the consumers would love to have the natural gas but it's been 15 years of, 'oh, another five years, another year, another year, another five years…' you guys are trucking it and then somebody else is piping it and they can't make up their mind whether they're going to Canada or Valdez or China, or whether they're going to cut out Fairbanks completely."

"A lot of us that have been here a long time, we've heard "gas line" for 35 years, and it's starting to seem like a pipe dream. Now we're coming out with this new project that will be here in two years. Well, we'll wait and see..."

"I sometimes wonder if I will live long enough to see natural gas come in Fairbanks."

"I want to get these prices down so we can still live here. The longer it takes to address this problem, the more people will leave."

"I know two families who have moved out this year...they couldn't deal with the heating costs."

PRODUCTION AND DISTRIBUTION

Each focus group had a number of questions about the natural gas production and distribution system. Many of the questions were easily answered with existing information while other questions highlighted some of the remaining unknowns on the project. The types of questions varied greatly from meeting to meeting. Some participants were concerned about the security of the supply: Is there enough gas to meet demand? Are there contingency plans so that demand can be met in the event of an accident or an avalanche on the road? Others were curious about the capacity of the Dalton Highway and whether the trucks themselves could operate on natural gas. Some attendees

asked questions about the Regulatory Commission of Alaska (RCA) deliberation process and whether there would be an advantage or a disadvantage to having two utilities. Finally, participants were interested in who was involved on the project and whether the supply could be guaranteed for the long-term future. Despite these occasional uncertainties, most participants agreed that there was enough information for them to comfortably speculate about their household's future energy choices.

What Focus Group Participants Had to Say

"It seems like the government should hold the North Slope oil producers more accountable. If they want to drill they should have to help cover costs, such as help pay for the plant and pipe to Fairbanks."

"The majority of small towns in America have natural gas trucked in anyway. It's not by pipeline."

"Homer only has one utility. We might have two. Why? Is this good or bad?"

"Will the trucking component require any construction or improvements on the Dalton Highway?"

ANTICIPATED PRICES AND LONG-TERM SECURITY OF THE RESOURCE

Nearly all the focus group attendees were interested to hear about the anticipated prices of natural gas once it starts arriving in FNSB. People wondered how the prices would be determined, whether they would fluctuate, and how they would compare to natural gas prices elsewhere.

What Focus Group Participants Had to Say

"Currently there are daily rate fluctuations for fuel oil. Will there be rate fluctuations for natural gas?"

"How will these be addressed?"

"If both utilities are selected, will they charge the same amount for fuel?"

"Will this gas be at Alaska prices or lower 48 prices?"

IMPACT ON FUEL OIL PRICES AND USERS

Participants at all but one meeting asked about what the effects would be on the fuel oil prices once natural gas becomes readily available in Fairbanks. There was concern for both the fuel oil distributors and for those who would be unable to convert their homes, either due to expense or geographic location. Attendees recognized that it despite these concerns they still supported the project but thought that this topic needed to be further explored.

What Focus Group Participants Had to Say

"What will this do to people who use fuel oil? What will it do to those people who are already on the edge of desperation and who will not be able to afford to convert their homes?"

"Will fuel oil prices go up because there is less supply? Down because there is less demand?"

"Can we use Anchorage and/or Homer as a model to learn how the introduction of gas influenced fuel oil prices?"

"What do the fuel oil companies think?"

IMPACT ON ELECTRICITY PRICES

The topic of electrical utility prices came up at all of the meetings. Focus group participants were curious to know whether electrical prices would drop as a result of natural gas being made available to the community. At one meeting a participant wondered whether or not electrical prices would drop anyway in the future as a result of the prospective Susitna-Watana dam and whether natural gas would be less helpful if electricity was so readily available.

What Focus Group Participants Had to Say

"Places in the lower 48 are using gas to generate electricity. They haven't been considering this in-state use until recently. We're being held ransom by the electrical company here."

"The problem with Golden Valley is not the cost of their electricity, they're just as cheap as anybody else on their meter rate...where we get in trouble with them is their cost of doing business that they pass on, which is usually double their rates."

"Golden Valley Electric should definitely look into using the natural gas to generate power. That would lower our electric bills tremendously. That's another killer here [in FNSB], is the electric right now. Especially with the surcharge, which is often more than my usage charge."

"What happens when the Susitna-Watana dam comes online? That should slash electrical costs in half."

"I think the one thing that people take into consideration is that we have a double whammy here. Golden Valley really socks it to us. I have converted all of my appliances, they are all energy efficient I have new floors, a new roof and good insulation and there's just two of us. I don't see any difference in our electrical bills, they still sock it to us. I want to know when it gets to converted to gas, will they actually pass the savings on to us?"

PROPANE USE

There was some interest in the potential production of propane as a byproduct from the natural gas plant, especially for North Pole residents. Participants wanted to know how much propane would be

produced, when it would be available and what the costs are like for converting your appliances to accept propane.

RELATED APPENDICES

Appendix A: Introductory Letter to Participants

Appendix B: Ad in the Fairbanks Daily News-Miner

Appendix C: Handout Packet

Appendix D: Power Point Presentation slides

Appendix E: Audience Response Survey Results

Appendix A: Introductory Letter to Participants

Bringing North Slope Natural Gas to Alaskans

Dear [Insert Participant's Name],

Thank you for agreeing to participate in a focus group to discuss the costs and benefits of converting your home heating fuel source to natural gas. I am following up to remind you about the focus group and to share some additional background information about the project.

We will be meeting at **noon on Friday, October 25th at the Noel Wien Library**, located at 1215 Cowles Street. We will start with a short presentation to share details on the project and to explain the process to convert a home heating fuel source to natural gas and highlight some of the potential costs and benefits. Then we will spend the remainder of the time hearing from you. In particular, we are hoping to learn:

- whether you would consider converting your home to natural gas
- what factors might influence your decision to convert or not convert
- what additional information you would like to have to make that decision

In order to have a more focused discussion, we are requesting you bring the following information to the focus group:

- ☐ What type of home heating fuel source do you currently use?
- ☐ What is the brand, model and year of your home heating system? (This information should be on the side of the boiler/furnace).
- ☐ How much do you typically pay for heating per month in the summer, in the winter, and on average? If possible, please bring in copies of past bills.

This focus group will last about 2 hours. We value your time. As a thank you, we will provide each household with a $50 Visa gift card at the end of the meeting.

I have included below some additional information about the Interior Energy Project as well as answers to some frequently asked questions. There is more information available on the project website www.interiorenergyproject.com.

Thanks, and please let us know if you have any questions! We look forward to meeting with you in a few weeks. If you have any questions, please call Molly Mylius at (907-744-5422) or email mmylius@agnewbeck.com.

What is the Interior Energy Project?

Fairbanks is the second-largest city in Alaska and faces high heating costs due to dependence on fuel oil for heating. Interior residents and businesses are facing winter utility bills that often exceed their monthly rent or mortgage payments. Additionally, the Fairbanks area does not comply with some federal air quality standards due, in part, to emissions from heating with wood and fuel oil. In spring 2013, in an effort to bring relief to Interior Alaska, the Governor and the State legislature passed Senate Bill 23, which created the Interior Energy Project (IEP). The State of Alaska authorized the Alaska Industrial Development and Export Authority (AIDEA) and the Alaska Energy Authority (AEA) to implement this project.

The IEP is assessing the feasibility of trucking liquefied natural gas (LNG) from the North Slope to homes and businesses in the Fairbanks North Star Borough. The IEP includes a financing package to start the development of a natural gas plant on the North Slope, a LNG storage facility in the Fairbanks region, and a re-gasification and distribution system to bring natural gas to customers in the FNSB. Project benefits include lower energy costs, particularly for home heating. Other anticipated benefits include air quality improvements resulting from natural gas conversion, which is a cleaner fuel source than oil or wood. AIDEA requires a clear understanding of the residential demand for natural gas and the rate of household conversion in the Fairbanks area in order to assess project benefits and financing risks.

Who are AIDEA and AEA?

The Alaska Industrial Development and Export Authority (AIDEA) is a public corporation of the State of Alaska. AIDEA's mission is to provide various means of financing to promote economic growth and diversity. To learn more about AIDEA, please visit www.aidea.org.

The Alaska Energy Authority (AEA) is a public corporation of the State of Alaska in the Department of Commerce, Community, and Economic Development. AEA's mission is to reduce the cost of energy in Alaska. AIDEA and AEA work collaboratively on projects and share the same Board of Directors. To learn more about AEA, please visit www.akenergyauthority.org.

Appendix B: Ad in the Fairbanks Daily News-Miner

Calling all Homeowners

$50 to Participate in a Focus Group

The State of Alaska needs your help to understand how quickly Fairbanks and North Pole residents would convert their homes to natural gas, if a new natural gas system comes to the Fairbanks region. To learn more about the project, please participate in a two hour focus group and share what it will take for you to convert your property. Participants will be paid $50 for their time. Focus groups are October 24, 25, and 26 in Fairbanks and North Pole. Call 907-744-5422 or email mmylius@agnewbeck.com to reserve your spot. Participation is limited. Please call right away.

AGENDA

TOTAL MEETING TIME: 2 HOURS

1. What is a Focus Group?
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3. Common Terms and Definitions
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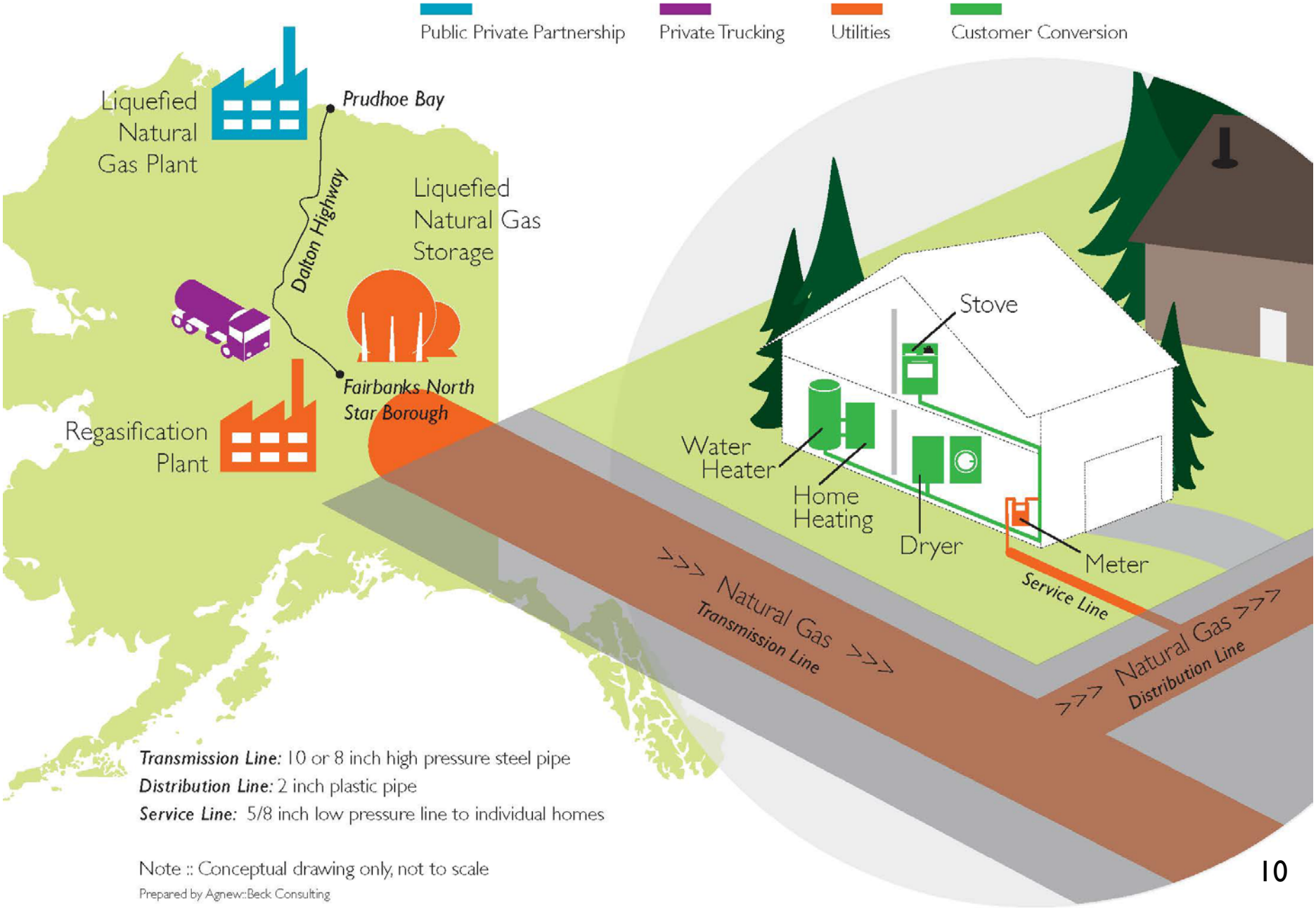
Common Terms + Definitions

TERMINOLOGY	
Boiler for home heating	Heating system that uses hot water to heat your home. Requires baseboards, panel radiators, or radiant floor heat to circulate (see definition of circulation options below). Fuel oil boilers with baseboards are most common in Fairbanks.
Circulation Options for Heat Produced by a Boiler	1. Baseboards. Placed along the floor. Used to circulate water warmed to 180 degrees. Least efficient. Most common in Fairbanks. 2. Panel radiators. European technology. Replaces baseboards and are placed on the wall. Circulates water warmed to 150 to 170 degrees. More efficient than baseboards. Expensive to retrofit homes. 3. In-floor radiant heat. Plastic pipes in floor concrete to circulate water warmed to 140 degrees. Most efficient. Very expensive to retrofit.
Efficiency	The rate of energy use. More efficient uses less energy. Less efficient uses more energy.
Fuel oil	Liquid petroleum product burned in a boiler or furnace and used to heat buildings or water.
Furnace	Type of heating system that blows forced warm air throughout your house. Uses vents to circulate warm air. Less efficient than boilers.
Home heating system	Describes the type of heating system used in your house to keep you warm
Water heater	Device that heats your water. Indirect water heater uses heat from your whole house boiler. Direct water heater has its own boiler to heat the water.

BRINGING NATURAL GAS TO FAIRBANKS



Transmission Line: 10 or 8 inch high pressure steel pipe
Distribution Line: 2 inch plastic pipe
Service Line: 5/8 inch low pressure line to individual homes

Note :: Conceptual drawing only, not to scale

Prepared by Agnew::Beck Consulting

Fairbanks Home Heating System Cost Comparison

BTU = unit of heat	**Wood (dry)**	**Oil + Birch (green) (50/50)**	**Fuel Oil**	**Natural Gas**
Annual heat load for home (Btus)	*190 million*	*190 million*	*190 million*	*190 million*
Btu Per Fuel Unit (Gallon, Cord, Mcf)[1]	20.9 million[5]	134,000 and 23.6 million [6]	134,000	1 million
Heating System Efficiency [2, 3, 4]	67.5%	90% and 67.5%	90%	90%
Cost per fuel unit (Gallon, Cord, Mcf)	$375[7]	$4.00 and $250	$4.00	$14.00 - $17.00
Average annual home heating costs {[(A/B)*D]/C}	**$5,063**	**$4,642**	**$6,302**	**$2,956 - $3,589**

Sources and notes:

1 University of Alaska Fairbanks, Cooperative Extension Service, Wood Energy Content, Website (http://alaskawoodheating.com/energy_content.php)

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4 Assumes the average efficiency between a catalytic (72%)and non-catalytic woodstove (63%)

5 Assumes a 50/50 mix of dry spruce and dry birch.

6 Assumes green wood is cured for an extended period (less than a year) to achieve a moisture content of 20%

7 Average price for a dry cord of spruce and birch, $300 and $450 per cord, respectively.

Fuel Oil Costs vs. Natural Gas

Natural gas is forecasted to be approximately 50% less expensive than fuel oil

Item	Fuel Oil	Natural Gas	Estimated Savings
Per Year	$6,300	$3,300	$3,000
Per Month ,Winter	$1,000	$500	$500
Per Month, Summer	$200	$100	$100
Per Month, Average	$525	$275	$250

However, there is a cost to convert your heating system and appliances…

Estimates only.

Source: See slide 18 from this presentation and the Interior Energy Plan Legislative Presentation from 28th Legislative Session, 2013
http://www.interiorenergyproject.com/Resources%20and%20Documents/Interior%20Energy%20Plan%20Legislative%20Presentation.pdf

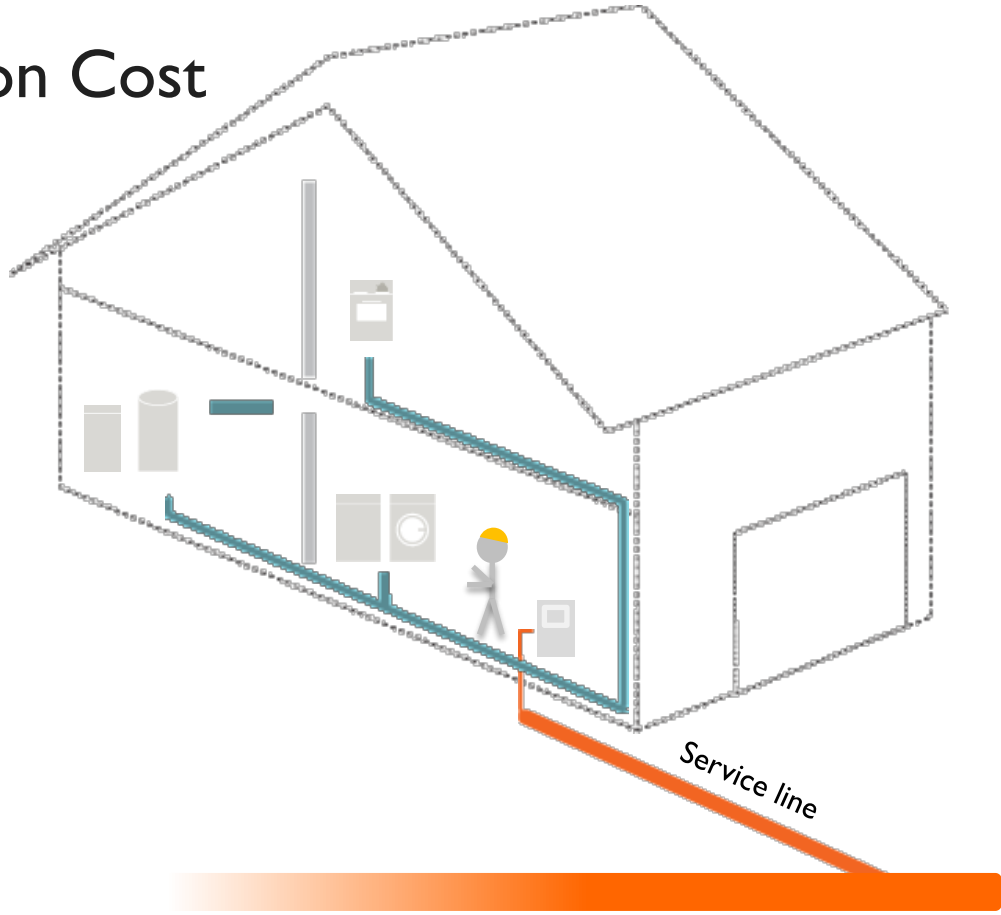
Converting Home + Water Heating: Range of Costs

Gun switch	Moderately efficient boiler	Ultra efficient boiler
Switch out gun/burner in existing boiler (Boiler < 10 years old)	New cast iron boiler (83 to 87% efficient)	New ultra efficient stainless steel boiler (97% efficient)
Keep water heater	New water heater	New water heater
$2,000 to $3,000	$7,000 to $12,000	$9,000 to $15,000

Cost variation due to labor expense, appliance efficiency level, pipe replacement, and type of water heater chosen. Other options include furnace conversion for forced air and lower quality boilers, which could be less expensive than the moderately efficient boiler shown above. Excludes additional appliance costs including ovens and dryers. Assumes no change to heating circulation system (such as moving from baseboard to in-floor radiant heat).

Example: Total Home Conversion Cost

Home Heating (Boiler)	$5,000
Water Heater	$1,000
Piping + Materials	$1,500
Labor	$1,500
Permitting, Testing, Misc.	$400
TOTAL	**$9,400**
Stove	$500
Dryer	$500



Estimates based on interviews with home heating contractors in Fairbanks.

Actual costs will vary.

Things to think about …

- Does my house use a furnace or a boiler?
- Can I switch out the gun in my boiler or do I need a new boiler?
- What type of boiler or furnace do I want? How energy efficient?
- Should I change out my circulation system?
- Do I need a new water heater?
- Will I do the installation or will I hire a contractor? Do I live in the City of Fairbanks and need a permit?
- Will I replace other appliances, such as a range or dryer?

Options to Pay for Conversion to Natural Gas

#	Option	Description	Examples
1	Pay cash	Take money out of savings	Household purchase
2	Private loan (market dictates interest rate)	• Bank loan or credit card • Loan from family or friends	AlaskaUSA Extra Credit Loan

3	Low interest loan tied to individual	• Homeowner borrows money at reduced interest rates
		• Examples include:
		  • Personal loan
		  • 2nd mortgage on your home
			AHFC Second Mortgage for Energy Conservation

4	Low interest loan tied to property	• Homeowner borrows money at reduced interest rates • Example includes: • Utility bill repayment	New York has a statewide program

5	Direct payments	• Offsets conversion costs
		• Examples include:
		  • Rebate to homeowner
		  • Direct to vendor
			AHFC Home Energy Rebate

6	Tax incentives	• Reduces future tax obligation • Typically reduces property taxes	Phase I of Wood Stove Changeout Program in Fairbanks

Pros + Cons

#	Option	Pros	Cons
1	Pay cash	Quick + easy No requirements on appliances or eligibility	Lack of funds. Need to save for other reasons
2	Take out a loan	Simple. Few requirements. Upfront costs covered.	Interest payments. Credit score can impact eligibility. Loan stays with you if you sell the house.
3	Low interest second mortgage	Interest expenses reduced. Upfront costs covered.	Lengthy process. Eligibility may be limited. Loan stays with you if you sell the house.
4	Low interest loan paid back on utility bill	Interest expenses reduced. Upfront costs covered. Loan stays with house if sold.	Process might be lengthy.
5	Direct Payments	Grant funds. No interest expense.	Funding provided after installation. Process can be lengthy.
6	Tax Incentives	Grant funds. No interest expense.	Complicated process. Funds provided in later tax years.

Bringing North Slope Natural Gas to Alaskans

Interior Energy Project

What will it take for you to convert your home to natural gas?

Fairbanks Focus Groups

October 2013

AIDEA Alaska Industrial Development and Export Authority

ALASKA ENERGY AUTHORITY

Agenda (Total meeting time: 2 hours)

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Water heater	Device that heats your water. Indirect water heater uses heat from your whole house boiler. Direct water heater has its own boiler to heat the water.

What is a Focus Group?

- Place to share information about a program or project
- Opportunity to hear input from a small group of people on a complicated policy or issue
- Helps policy makers design programs and projects that make sense for communities
- Opportunity to discuss the details on an issue and have a conversation with participants
- People are often paid for their time (as you all are)

What it is not…

- Not a public meeting and not meant to reflect broad stakeholder input
- Not a statistically valid survey sample

How will this information be used?

- Help estimate the rate of household conversion to natural gas
  - What percent of households will make the switch?
- Identify the factors impacting the rate of household conversion
- Help determine what programs to use to help facilitate the conversion process

Focus Group – Meeting Guidelines

- Stay on Topic
- Listen
- Attack Issues, NOT People
- Be Positive, Be Problem Solvers
- Cell phones should be off or on vibrate

Information to Share, Part I: Overview of the Interior Energy Project

What is the Issue?

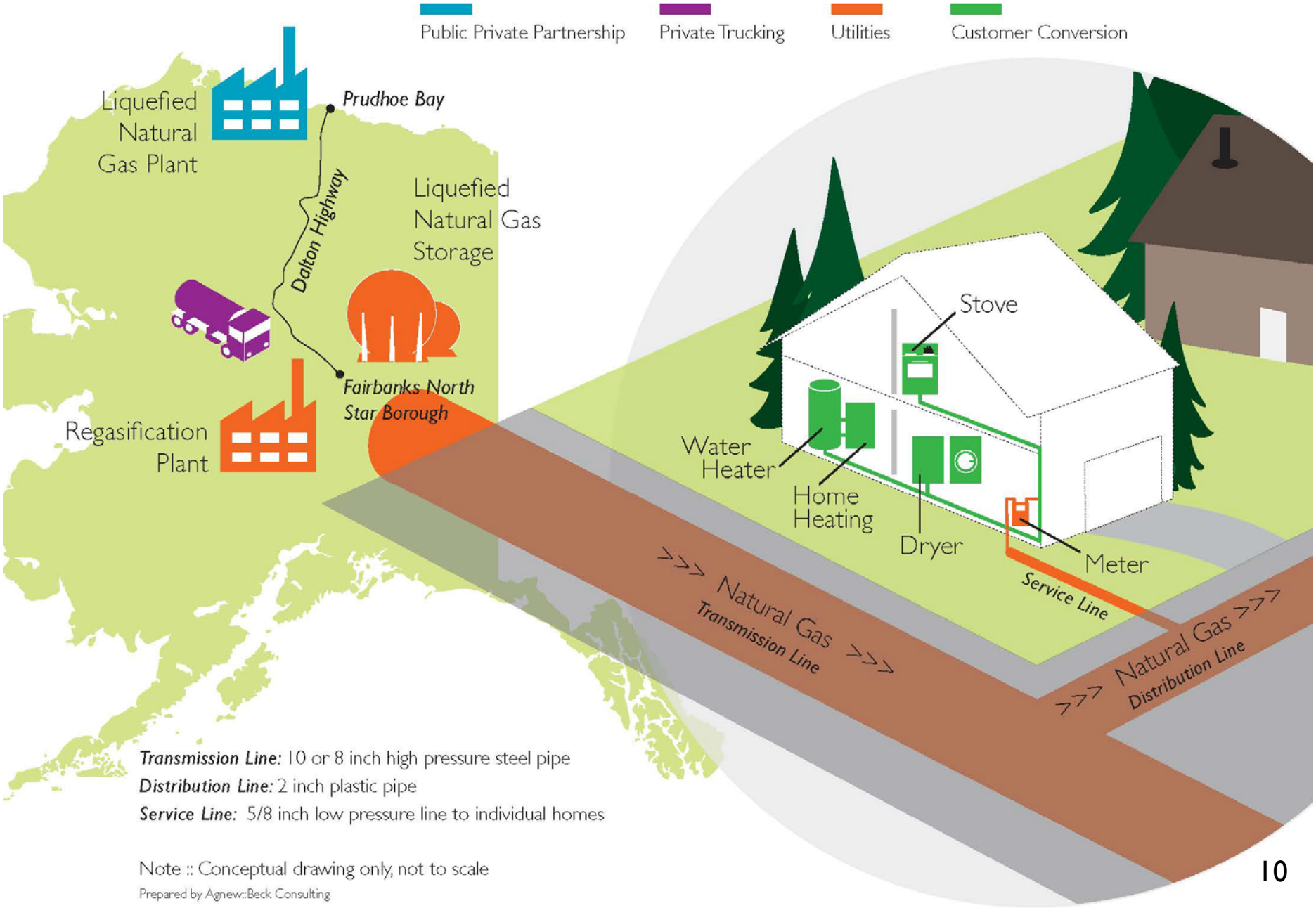
- Home heating costs are expensive in the Fairbanks North Star Borough.
- No widespread access to natural gas in the Borough.
- Portions of the Borough do not meet federal air quality standards.
- Energy costs are an issue statewide.

What is the Solution?
Interior Energy Project

- Provide lowest-cost energy to Interior Alaska.
- Get gas to the Interior.
- Assure long-term access to gas and propane for all Alaskans.
- Use private sector tools as much as possible.

What would this look like?

BRINGING NATURAL GAS TO FAIRBANKS



Transmission Line: 10 or 8 inch high pressure steel pipe
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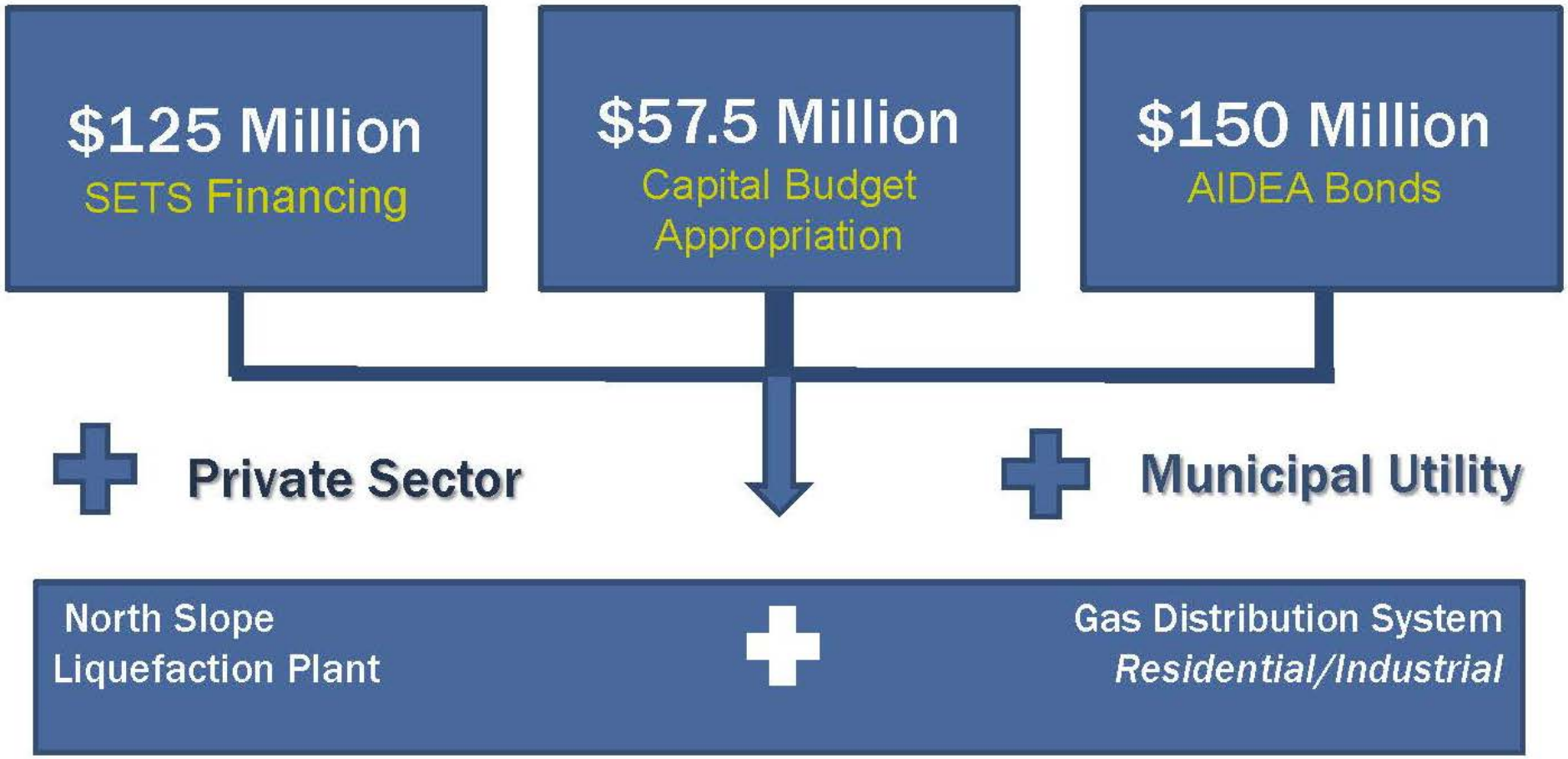
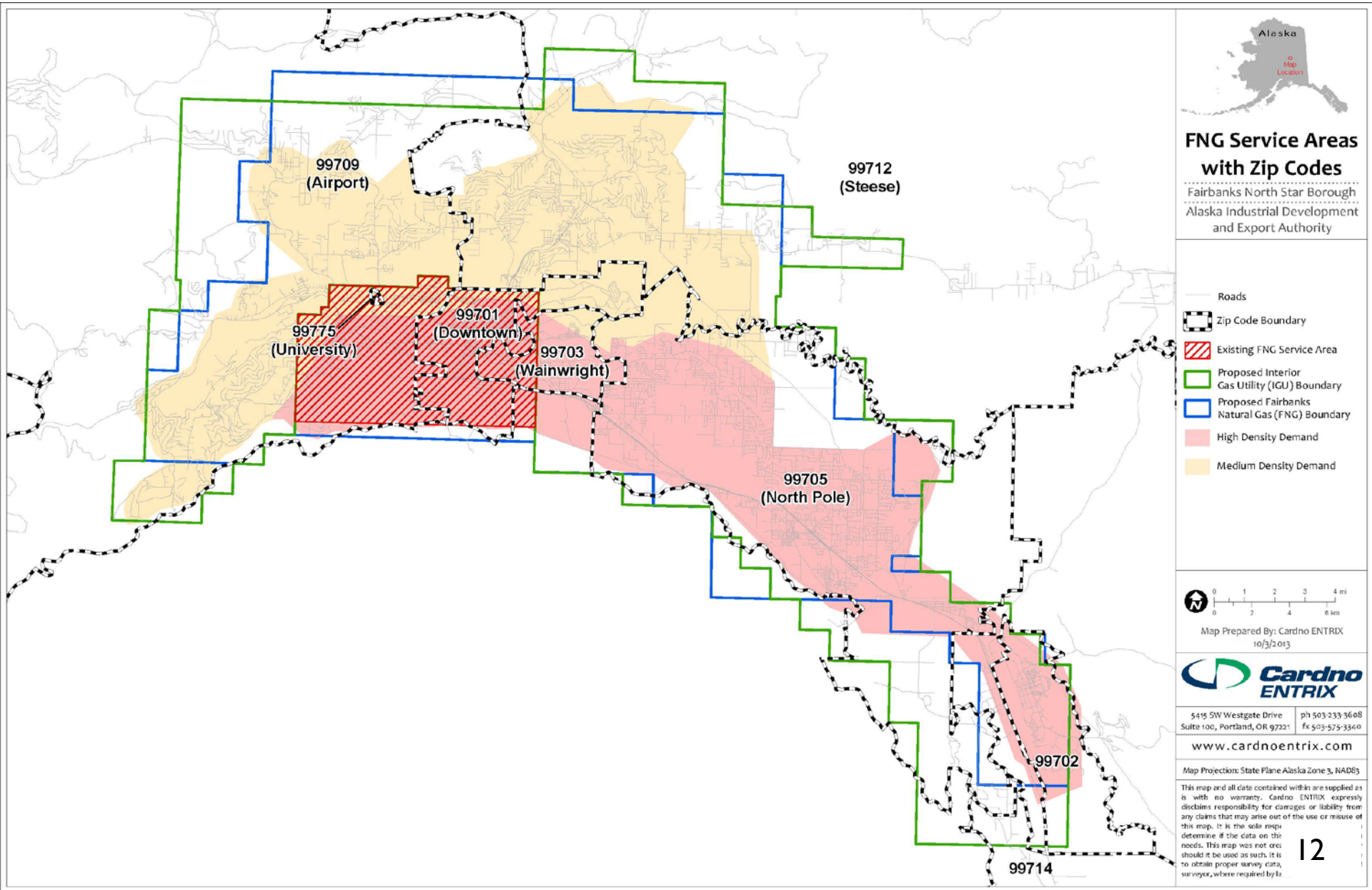
Prepared by Agnew::Beck Consulting

Interior Energy Project Financing Plan

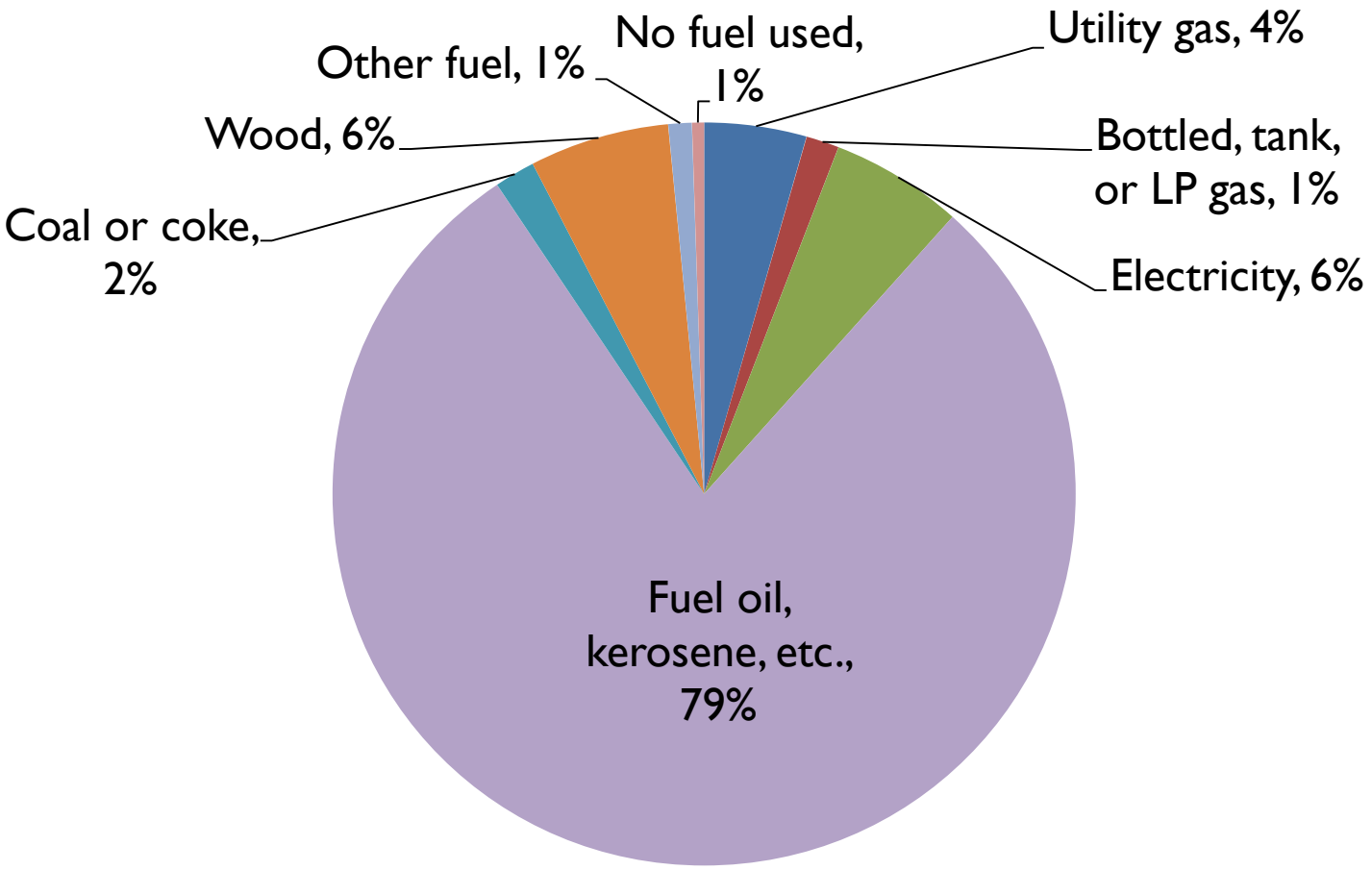


Potential Natural Gas Service Area



Information to Share, Part 2: Basic Facts about Home Heating + Conversion Costs

Most Homes in FNSB use Fuel Oil as their Primary Heating Source



Source: U.S. Census Bureau, 2007-2011, House Heating Fuel, American Community Survey 5-Year Estimates, Website (https://www.census.gov), accessed October 15, 2013.

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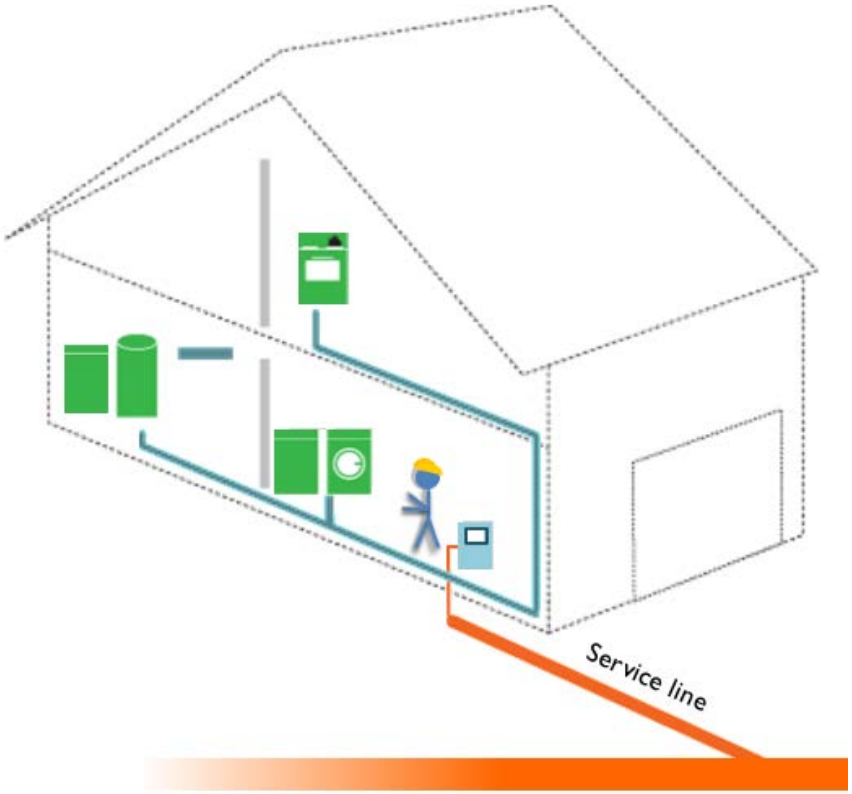


Basic Home Conversion Facts

Conversion Includes Natural Gas Appliances

Home Heating System

$2,000 to $15,000*

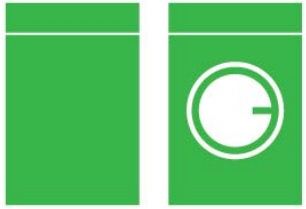
Water Heating

$600 to $5,000*

Other

Dryer

$500 and up*



Stove/Oven

$500 and up*

*One time expense to convert appliances.

Home heating + water heating are most expensive to convert but provide the most savings in energy costs. Costs could be higher or lower depending on the home.

Converting Home + Water Heating: Range of Costs

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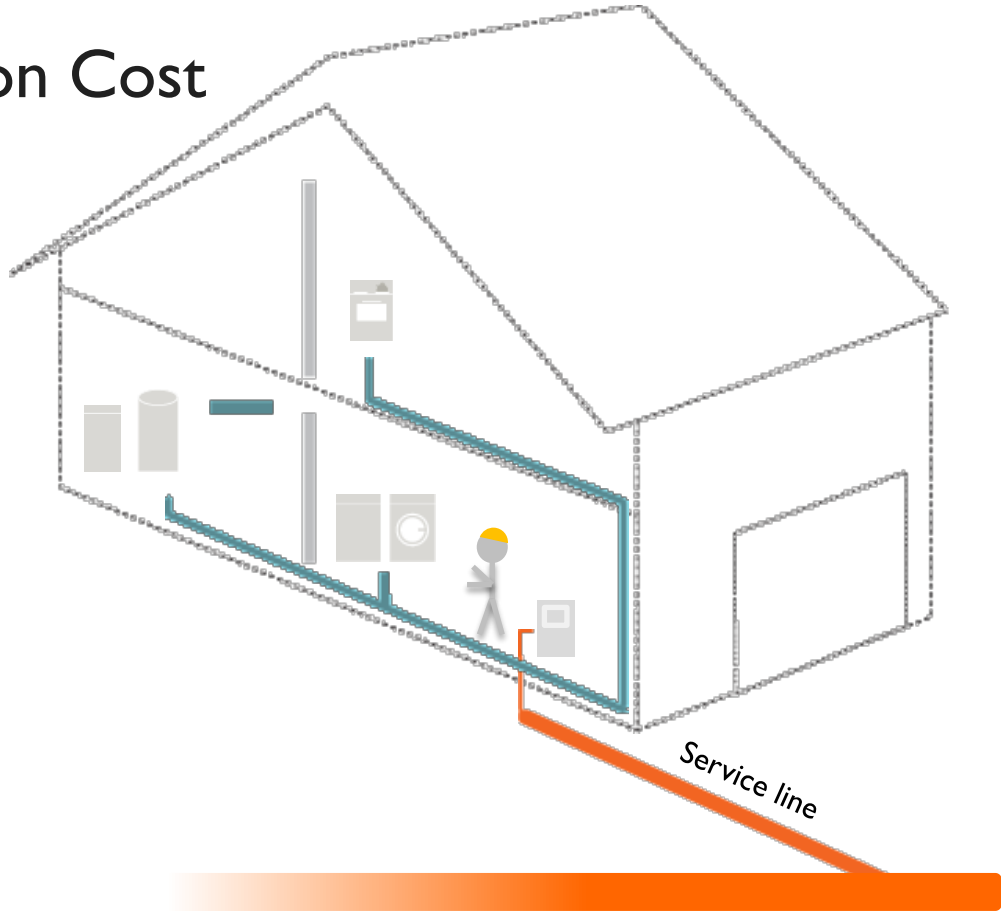

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Things to think about …

- Does my house use a furnace or a boiler?
- Can I switch out the gun in my boiler or do I need a new boiler?
- What type of boiler or furnace do I want? How energy efficient?
- Should I change out my circulation system?
- Do I need a new water heater?
- Will I do the installation or will I hire a contractor? Do I live in the City of Fairbanks and need a permit?
- Will I replace other appliances, such as a range or dryer?

Questions for You + Discussion

Your House + How You Use Energy

Please pull out your clicker and
wait for instructions!

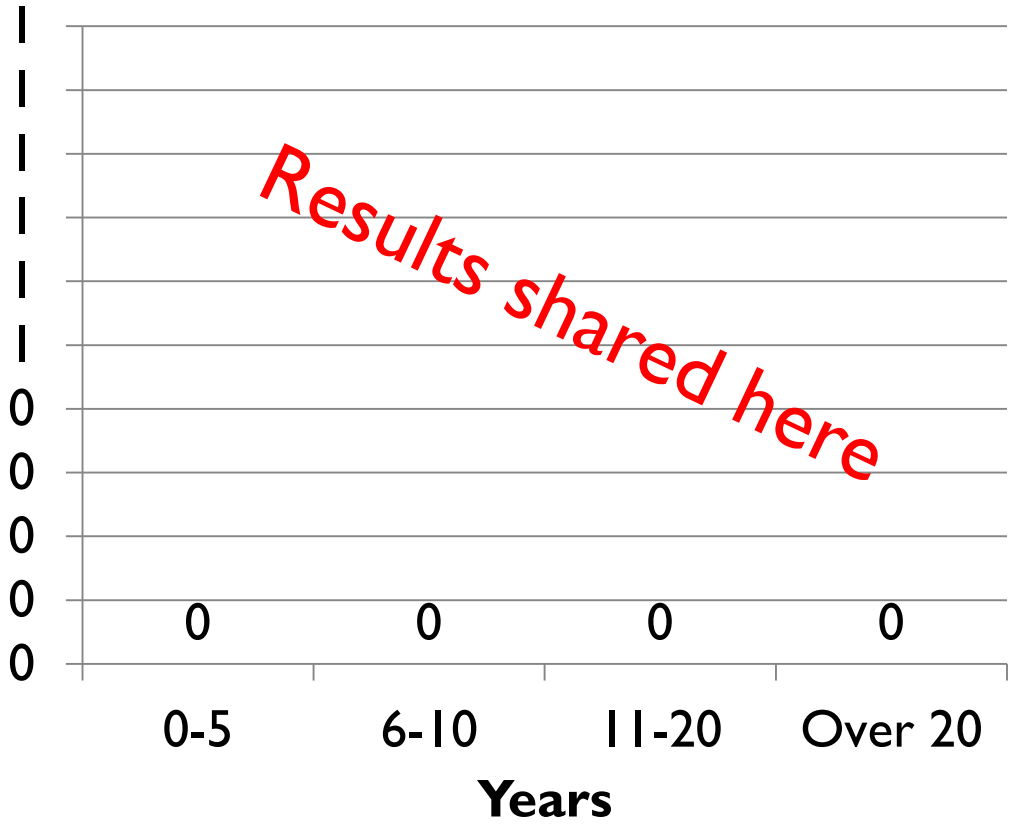
How to use the clickers

1. Point clicker at laptop.
2. After entering your response, hit "Send."
3. One response per question.
4. Tracker at the bottom.
5. Raise your hand if you have questions.

 = slide has an audience response component

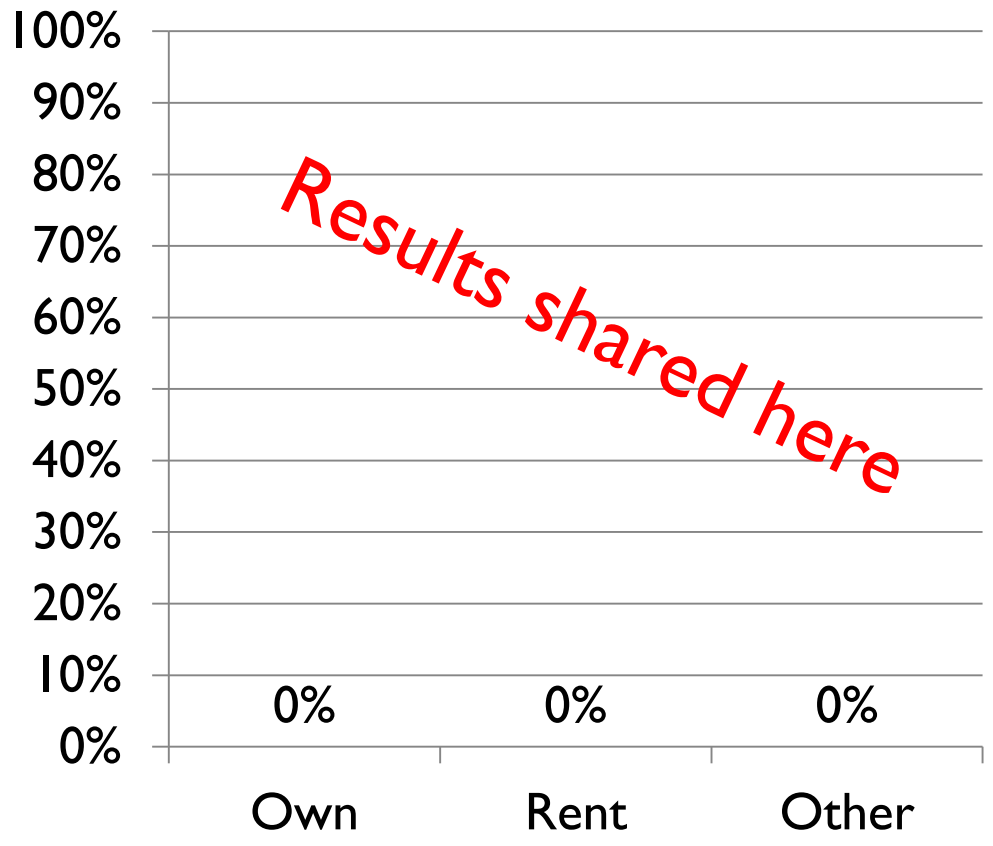
Test: How long have you lived in the Fairbanks North Star Borough?

1. 0-5 years
2. 6-10 years
3. 11-20 years
4. Over 20 years



Q.1/11 Do you own or rent the house you live in?

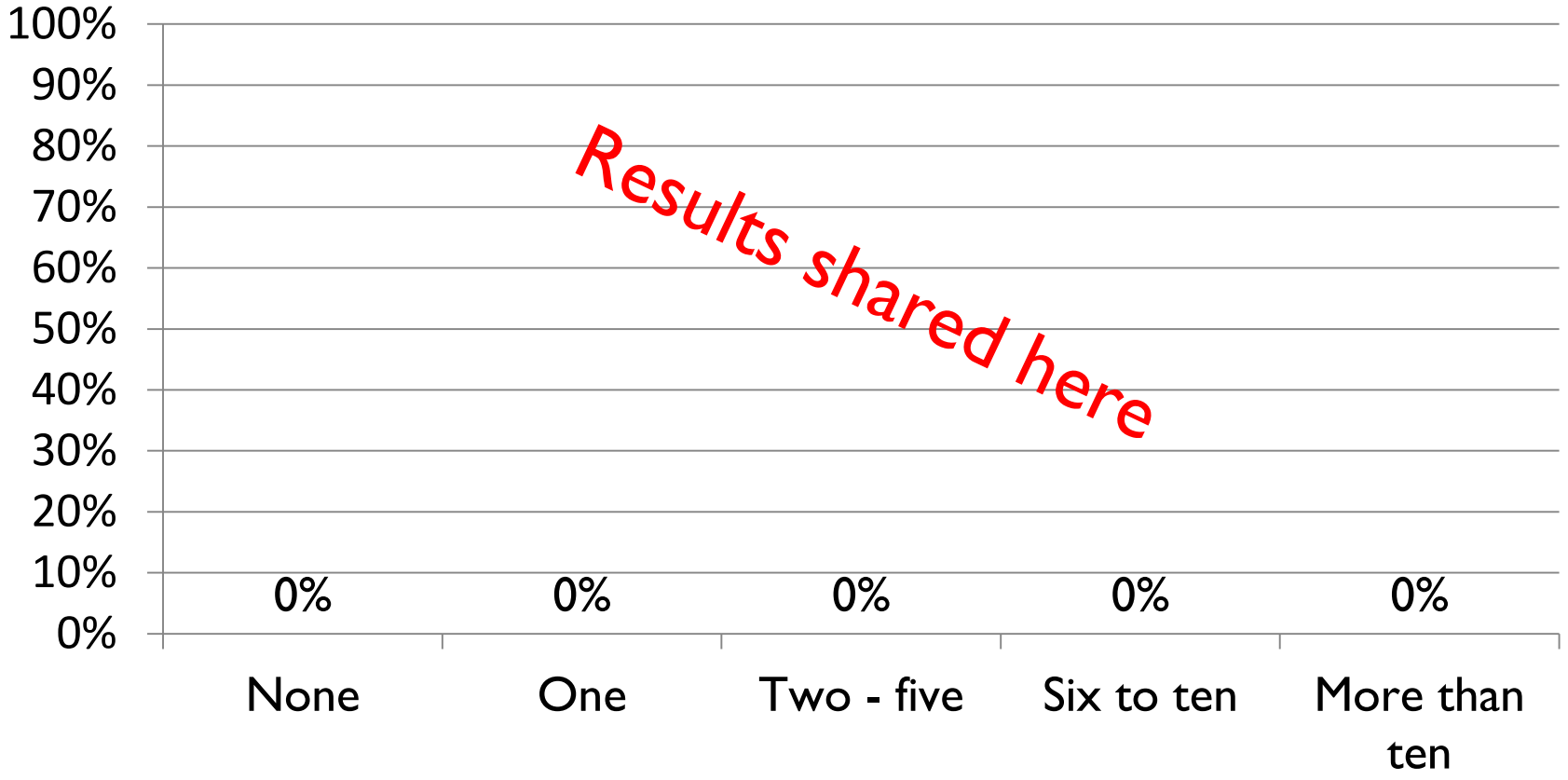
1. Own
2. Rent
3. Other



Q2/11 How many residential properties do you own in the Fairbanks/North Star Borough?

1. None.
2. One (my current home).
3. Two to five properties.
4. Six to ten properties.
5. More than ten properties.

How many residential properties do you own in Fairbanks/North Pole? RESULTS

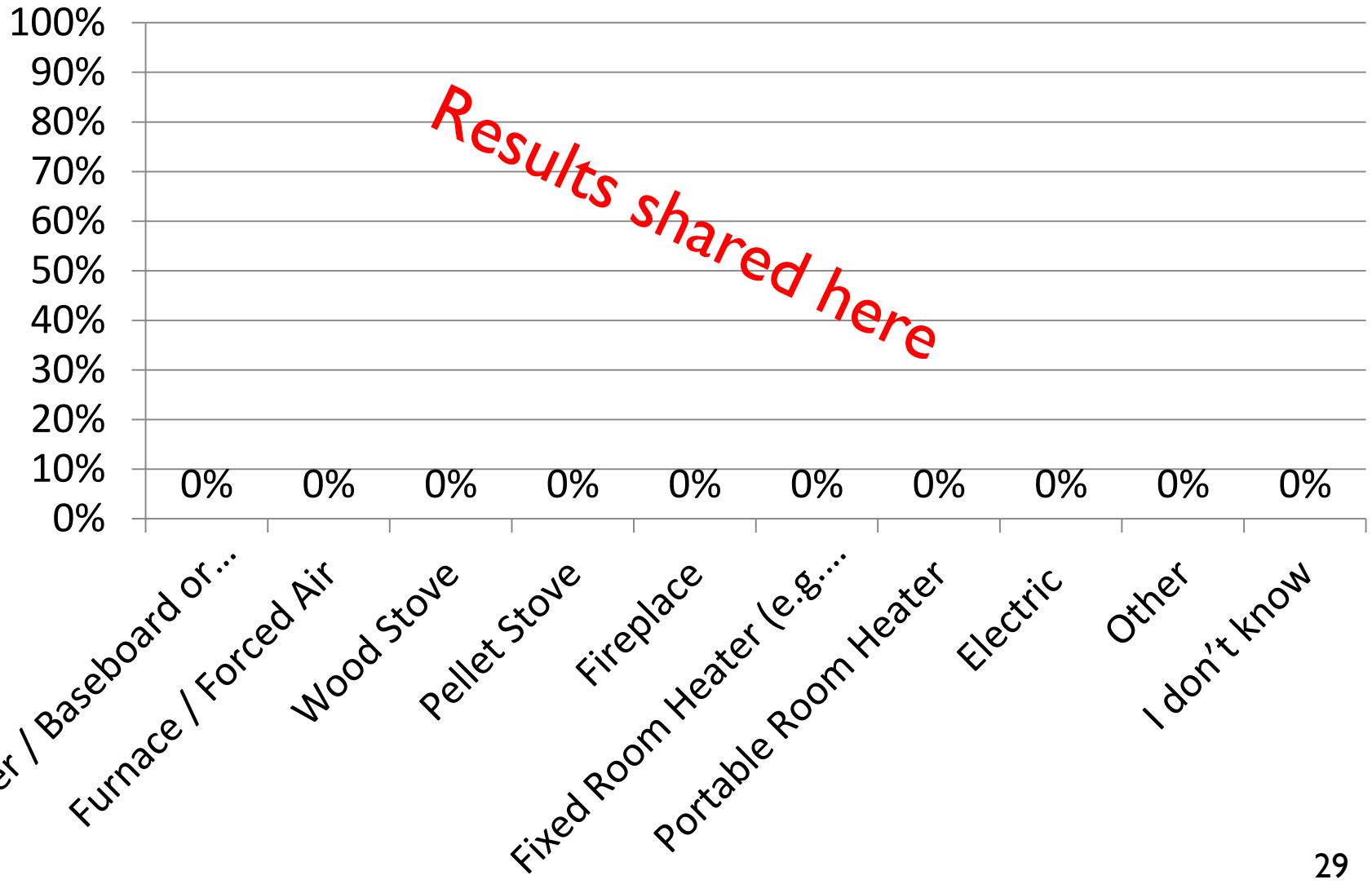


Q3/11 What is your primary heating system?

(primary residence)

1. Boiler / Baseboard or Radiant Heat
2. Furnace / Forced Air
3. Wood Stove
4. Pellet Stove
5. Fireplace
6. Fixed Room Heater (e.g. Toyo stove)
7. Portable Room Heater
8. Electric
9. Other
10. I don't know

What is your primary heating system?

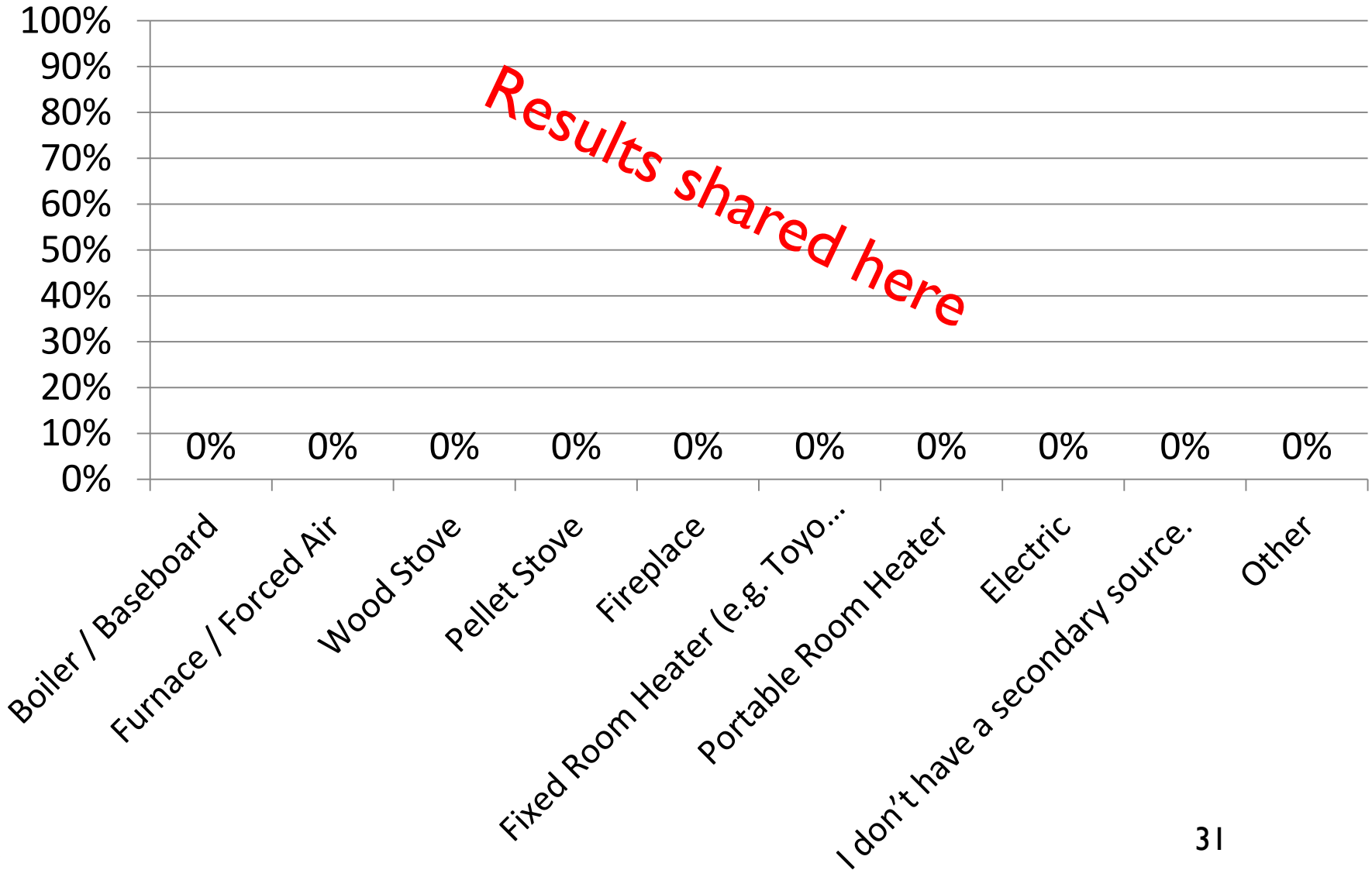


Q4/11 What is your secondary heating system?

(primary residence)

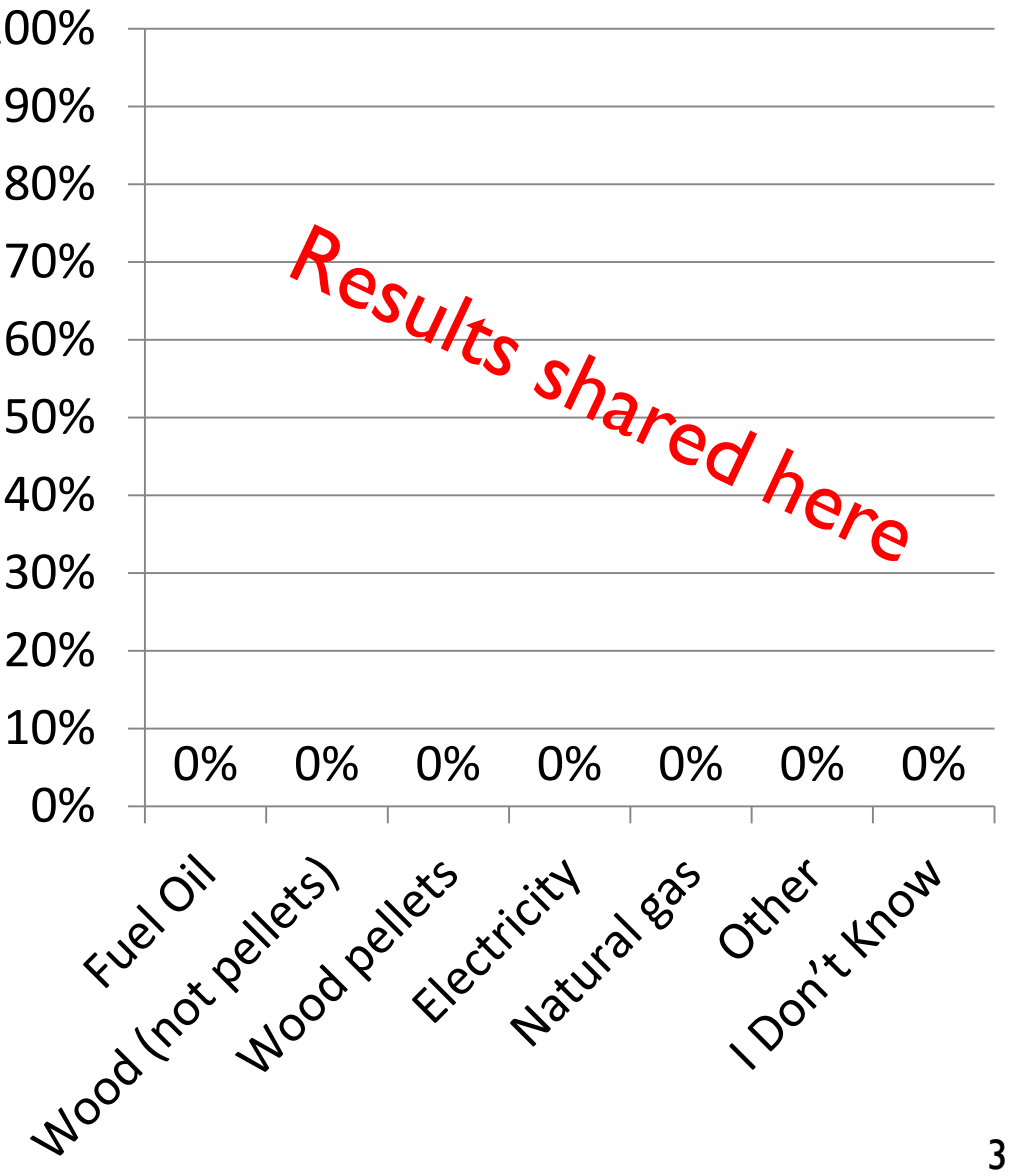
1. Boiler / Baseboard
2. Furnace / Forced Air
3. Wood Stove
4. Pellet Stove
5. Fireplace
6. Fixed Room Heater (e.g. Toyo stove)
7. Portable Room Heater
8. Electric
9. I don't have a secondary source.
10. Other

What is your secondary heating system?



Q5/11 What is your primary fuel heating source? (primary residence)

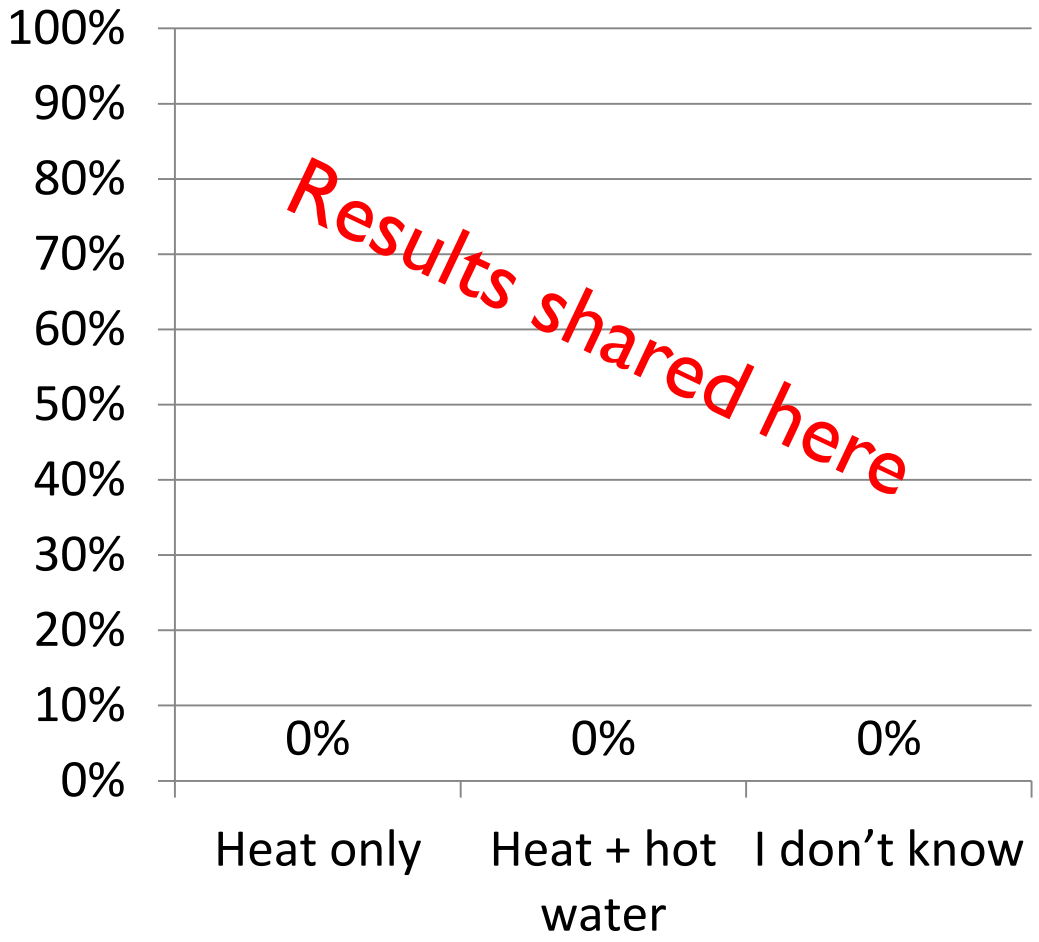
1. Fuel Oil
2. Wood (not pellets)
3. Wood pellets
4. Electricity
5. Natural gas
6. Other
7. I Don't Know



Q6/11 Does your primary heating system provide heat only, or does it also provide hot water for your home?

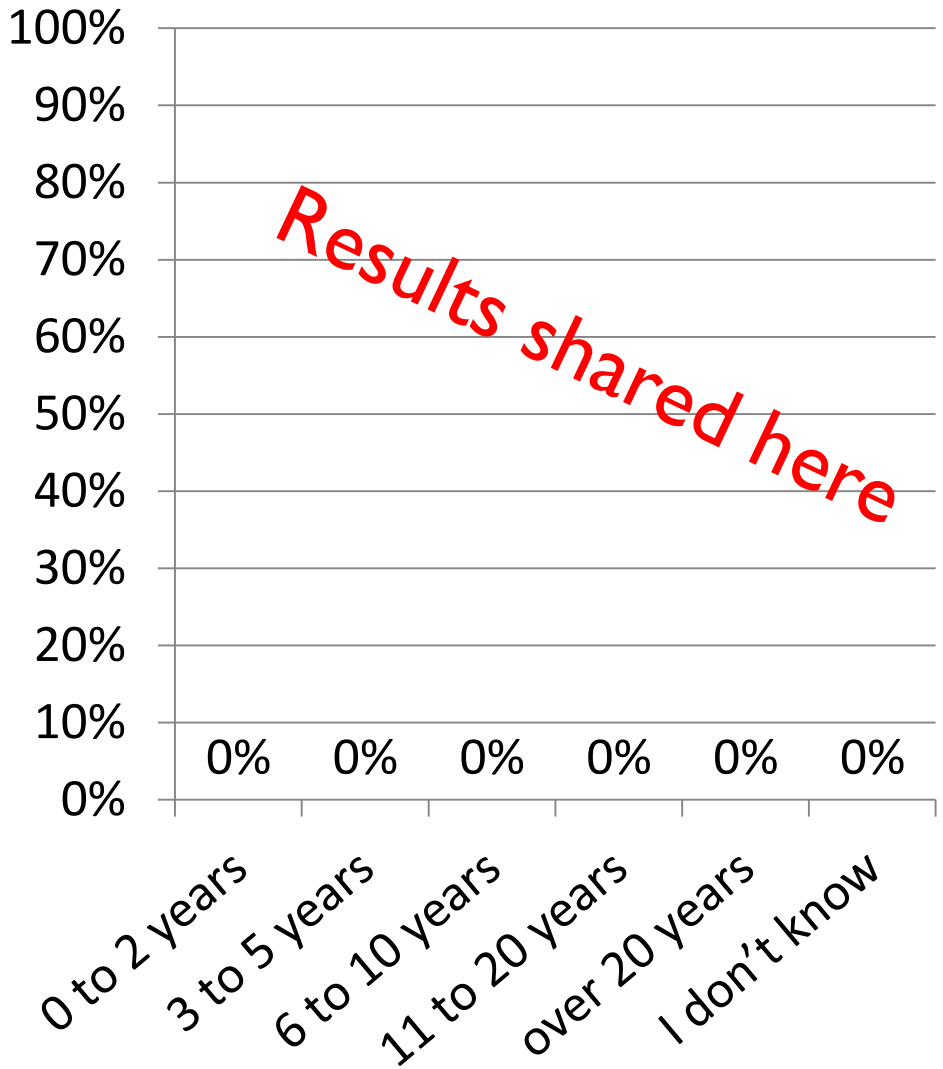
(primary residence)

1. Heat only
2. Heat + hot water
3. I don't know



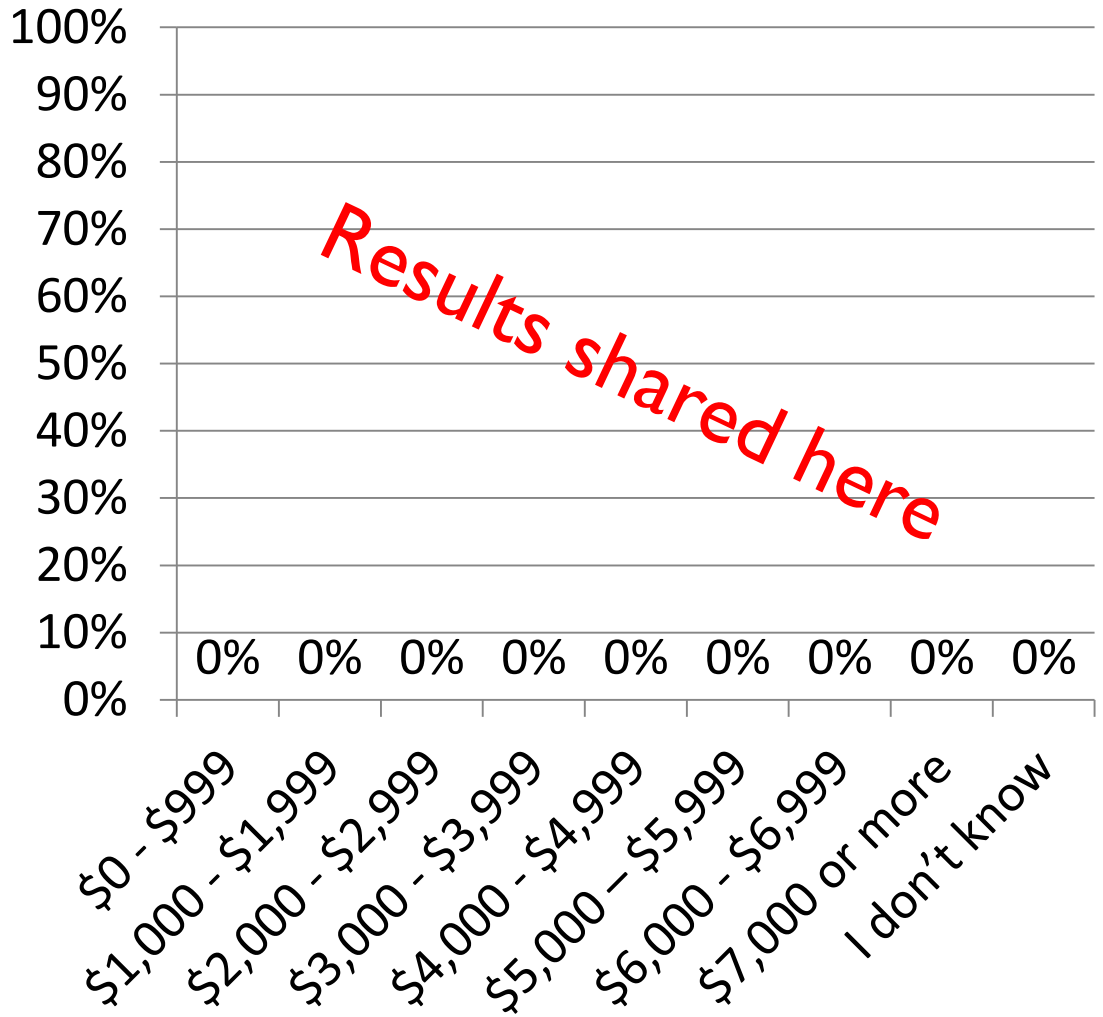
Q7/11 Approximately how old is your primary heating system? (primary residence)

1. 0 to 2 years
2. 3 to 5 years
3. 6 to 10 years
4. 11 to 20 years
5. over 20 years
6. I don't know



Q8/11 How much do you pay for your primary heating source per year? (primary residence, 3-yr avg.)

1. $0 - $999
2. $1,000 - $1,999
3. $2,000 - $2,999
4. $3,000 - $3,999
5. $4,000 - $4,999
6. $5,000 – $5,999
7. $6,000 - $6,999
8. $7,000 or more
9. I don't know



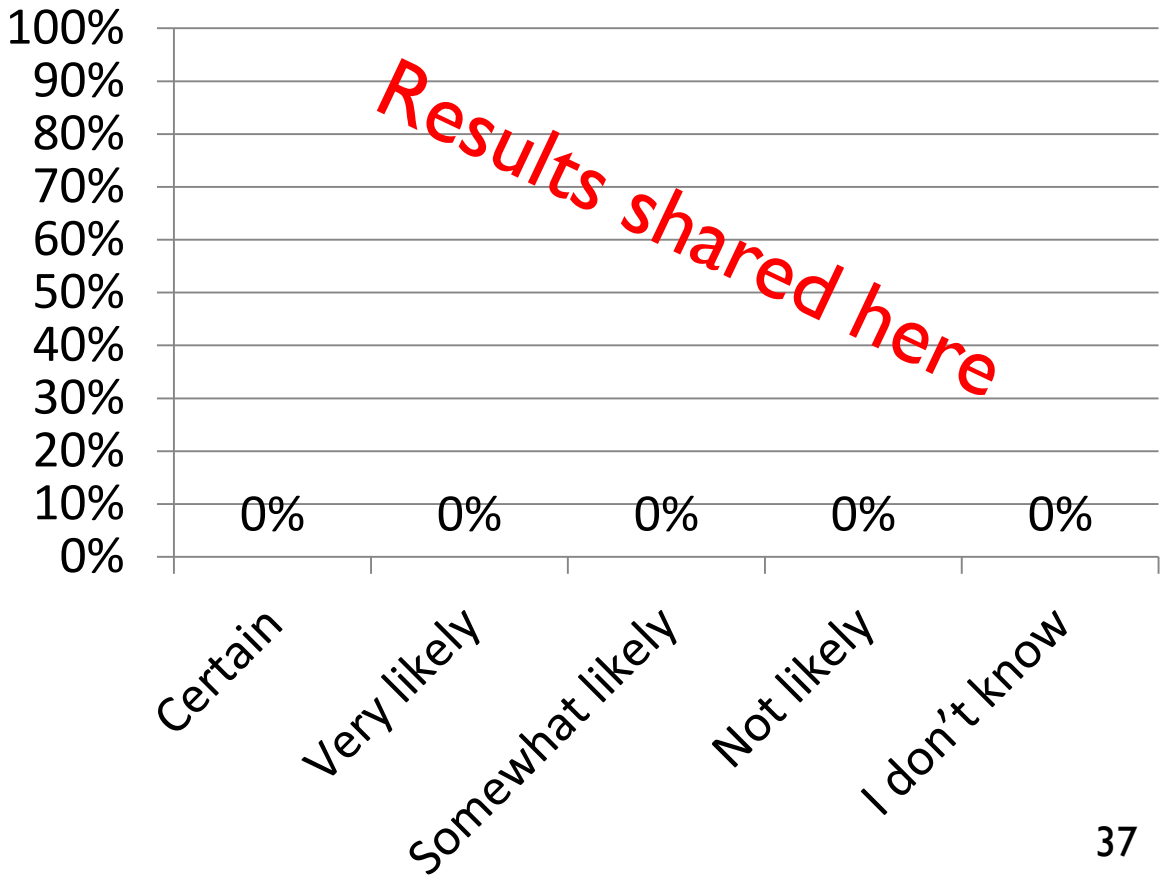
Q9/11 How much do you pay for your secondary heating source per year? (primary residence, 3-yr avg.)

1. $0 - $249
2. $250 - $499
3. $500 - $999
4. $1,000 - $1,999
5. $2,000 - $2,999
6. $3,000 – $3,999
7. $4,000 - $5,999
8. $6,000 or more
9. I don't know
10. I don't have a secondary heating source

Q10/11 Are you likely to convert to natural gas?

Given the information provided, how likely are you to convert your home to natural gas?

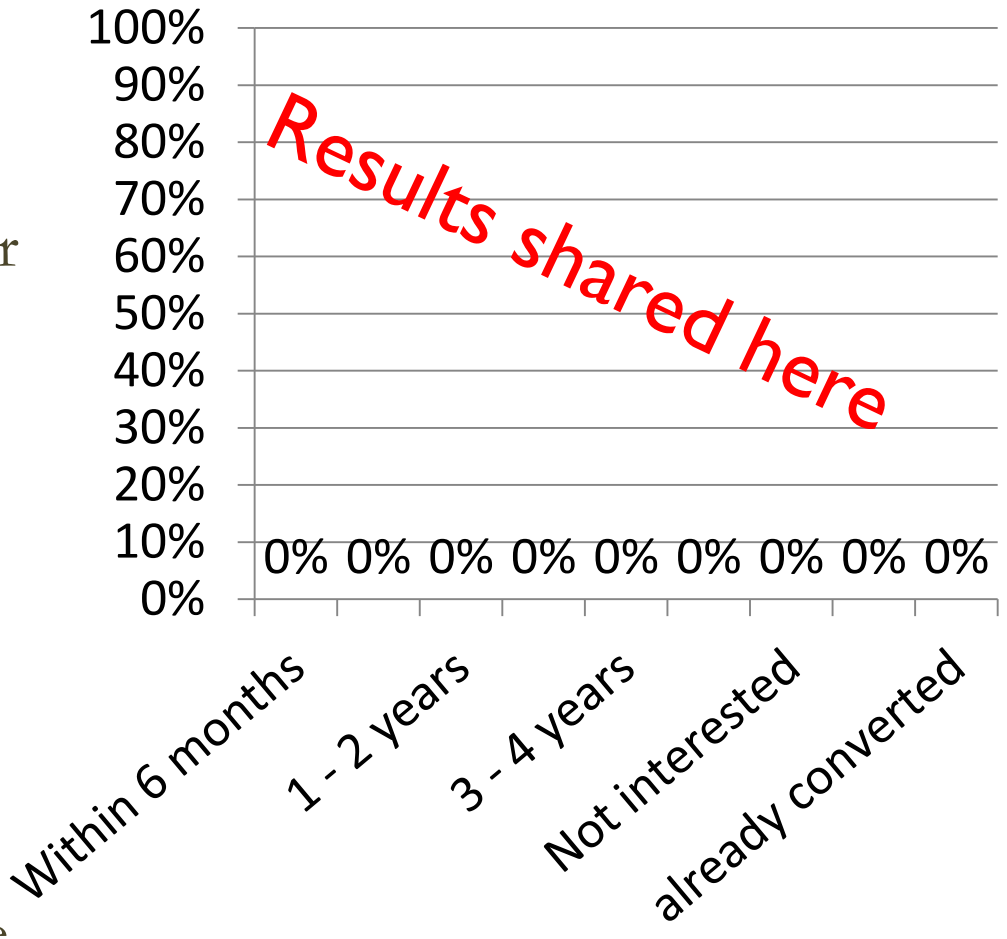
1. Certain
2. Very likely
3. Somewhat likely
4. Not likely
5. I don't know



Q11/11 How quickly would you convert?

Given the information provided, if natural gas was available, what time frame would you anticipate converting?

1. Within 6 months
2. Between 6 months and 1 year
3. Between 1 and 2 years
4. Between 2 and 3 years
5. Between 3 and 4 years
6. More than 4 years
7. Not interested in converting
8. I don't know
9. I already converted my home



Are you likely to convert?

Discussion

Why or why not?

What are the biggest obstacles to converting?

Tradeoffs:
Conversion Cost + Annual Savings

This section included a choice exercise using a series of slides with conversion costs and savings scenarios.

Information to Share, Part 3

Paying for Conversion:
What are some potential options?

Options to Pay for Conversion to Natural Gas

#	Option	Description	Examples
1	Pay cash	Take money out of savings	Household purchase
2	Private loan (market dictates interest rate)	• Bank loan or credit card • Loan from family or friends	AlaskaUSA Extra Credit Loan

3	Low interest loan tied to individual	• Homeowner borrows money at reduced interest rates
		• Examples include:
		  • Personal loan
		  • 2nd mortgage on your home
			AHFC Second Mortgage for Energy Conservation

4	Low interest loan tied to property	• Homeowner borrows money at reduced interest rates • Example includes: • Utility bill repayment	New York has a statewide program

5	Direct payments	• Offsets conversion costs
		• Examples include:
		  • Rebate to homeowner
		  • Direct to vendor
			AHFC Home Energy Rebate

6	Tax incentives	• Reduces future tax obligation • Typically reduces property taxes	Phase I of Wood Stove Changeout Program in Fairbanks

Pros + Cons

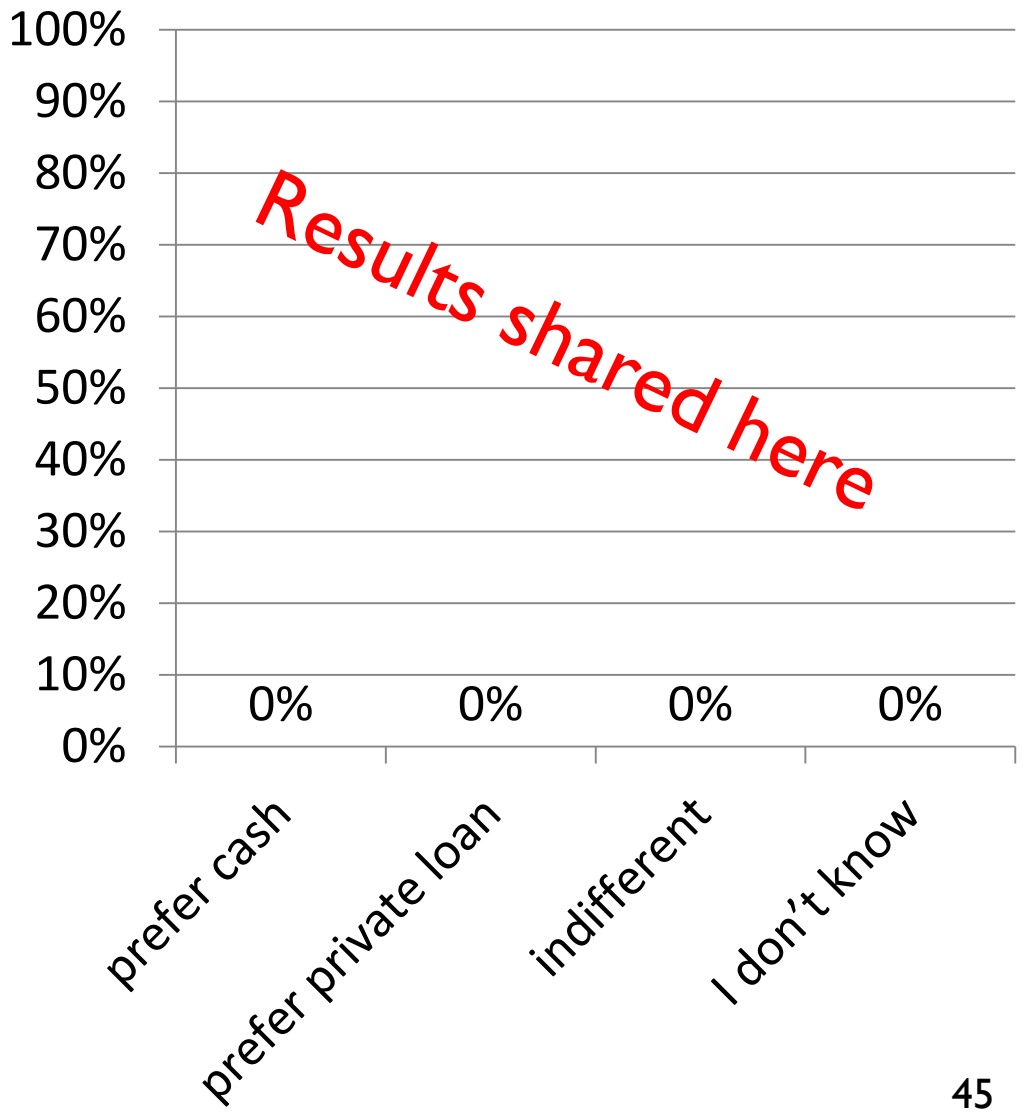
#	Option	Pros	Cons
1	Pay cash	Quick + easy No requirements on appliances or eligibility	Lack of funds. Need to save for other reasons
2	Take out a loan	Simple. Few requirements. Upfront costs covered.	Interest payments. Credit score can impact eligibility. Loan stays with you if you sell the house.
3	Low interest second mortgage	Interest expenses reduced. Upfront costs covered.	Lengthy process. Eligibility may be limited. Loan stays with you if you sell the house.
4	Low interest loan paid back on utility bill	Interest expenses reduced. Upfront costs covered. Loan stays with house if sold.	Process might be lengthy.
5	Direct Payments	Grant funds. No interest expense.	Funding provided after installation. Process can be lengthy.
6	Tax Incentives	Grant funds. No interest expense.	Complicated process. Funds provided in later tax years.

A Few More Questions for You + Discussion

Comparing Incentives: Cash to Private Loan

I would prefer…

1. **paying cash** over a **private loan**.
2. a **private loan** over **paying cash**.
3. I am indifferent.
4. I don't know.

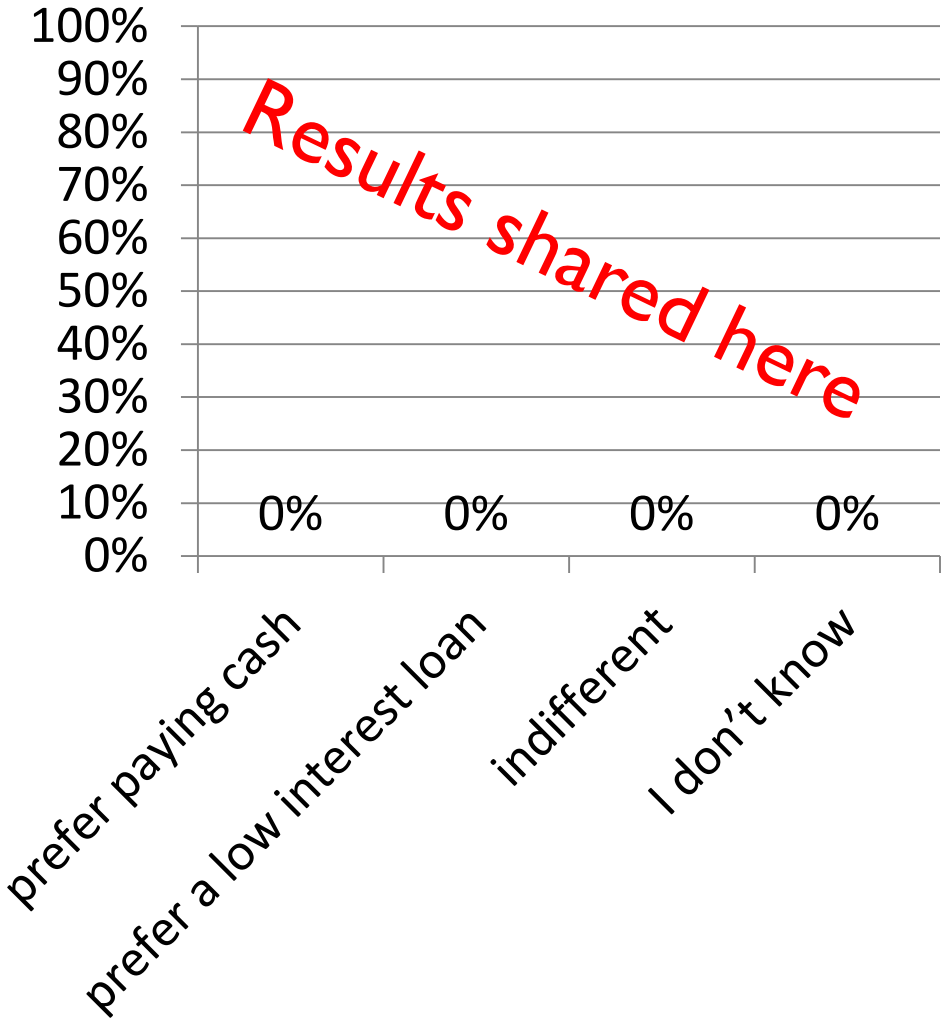


Question Slide 1 out of 5

Comparing Incentives: Cash to Low Interest Loan (Tied to Individual)

I would prefer…

1. **paying cash** over a **low interest loan** (individual).
2. a **low interest loan (individual)** over **paying cash**.
3. I am indifferent.
4. I don't know.

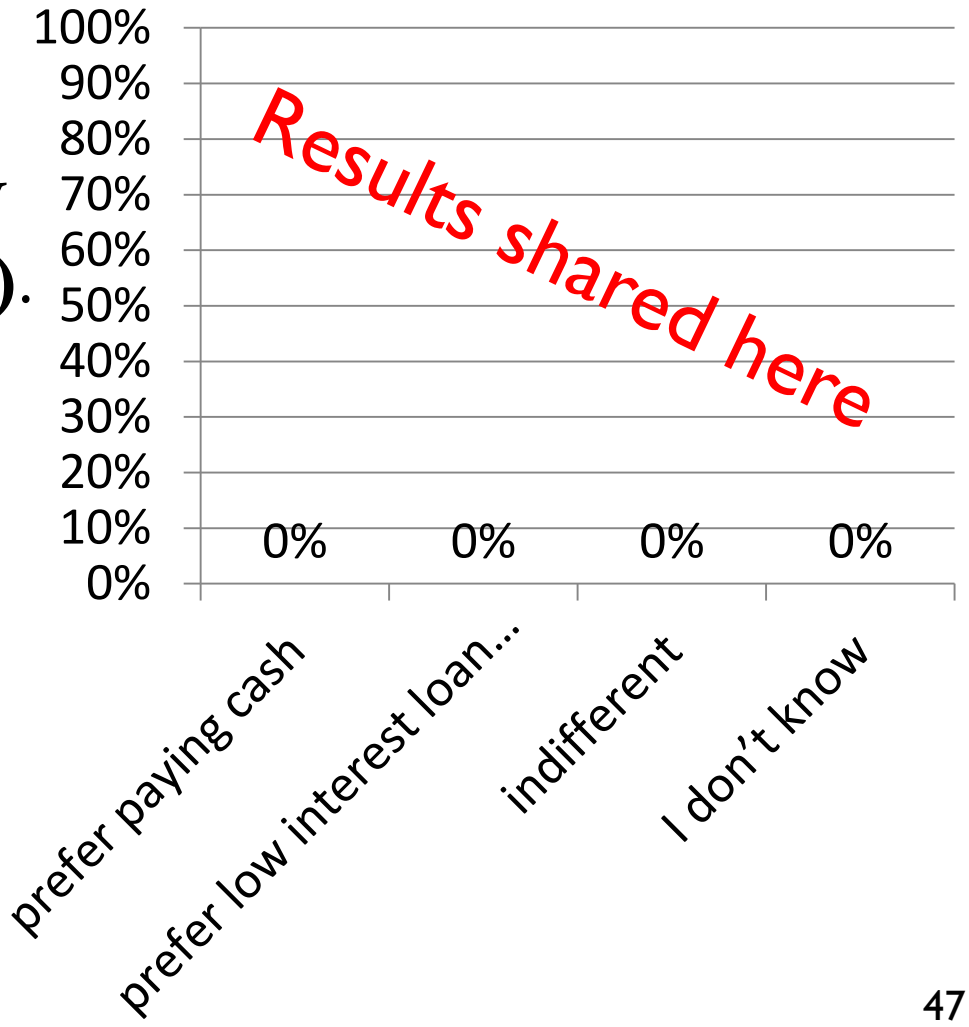


Question Slide 2 out of 5

Comparing Incentives: Cash to Low Interest Loan (Tied to Property)

I would prefer…

1. **paying cash** over a **low interest loan (property).**
2. a **low interest loan (property)** over **paying cash.**
3. I am indifferent.
4. I don't know.

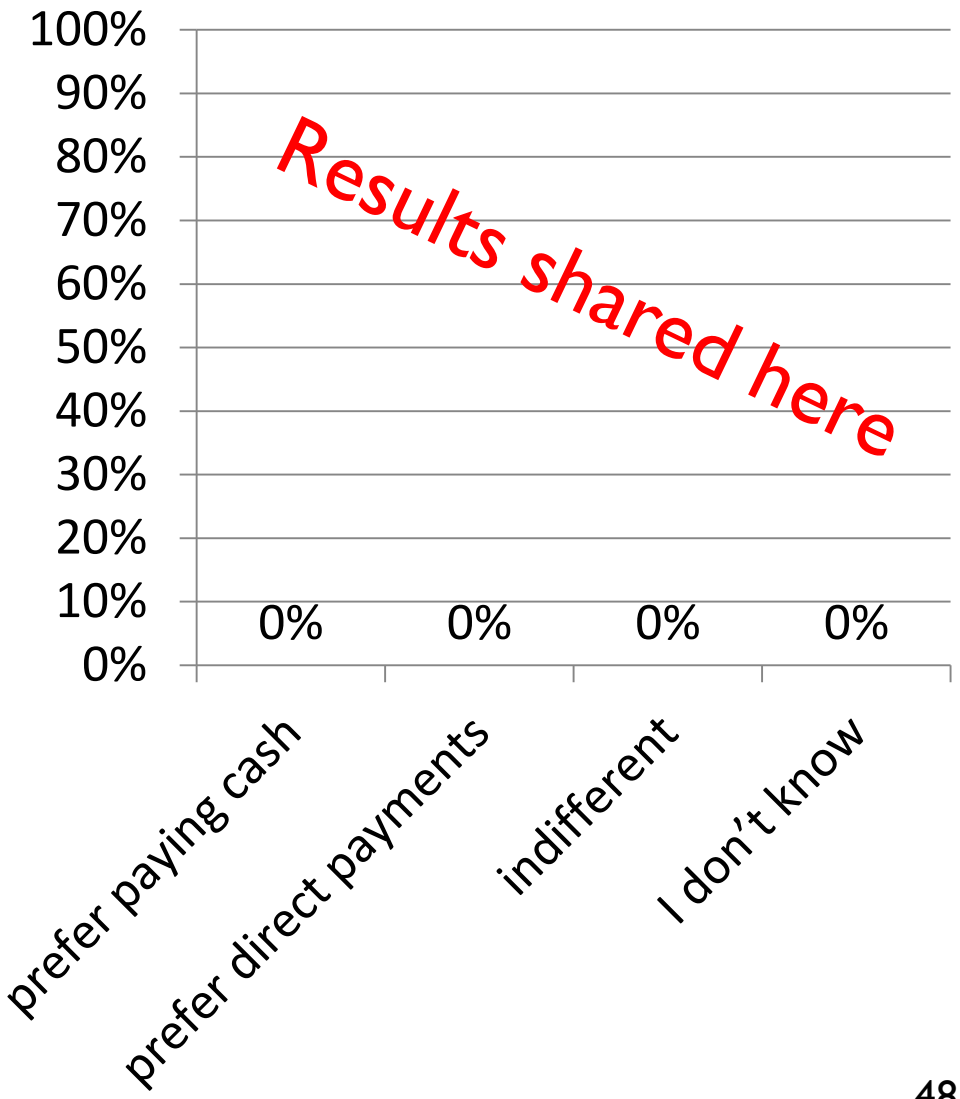


Question Slide 3 out of 5

Comparing Incentives: Cash to Direct Payments

I would prefer…

1. **paying cash** over **direct payments**.
2. **direct payments** over **paying cash**.
3. I am indifferent.
4. I don't know.

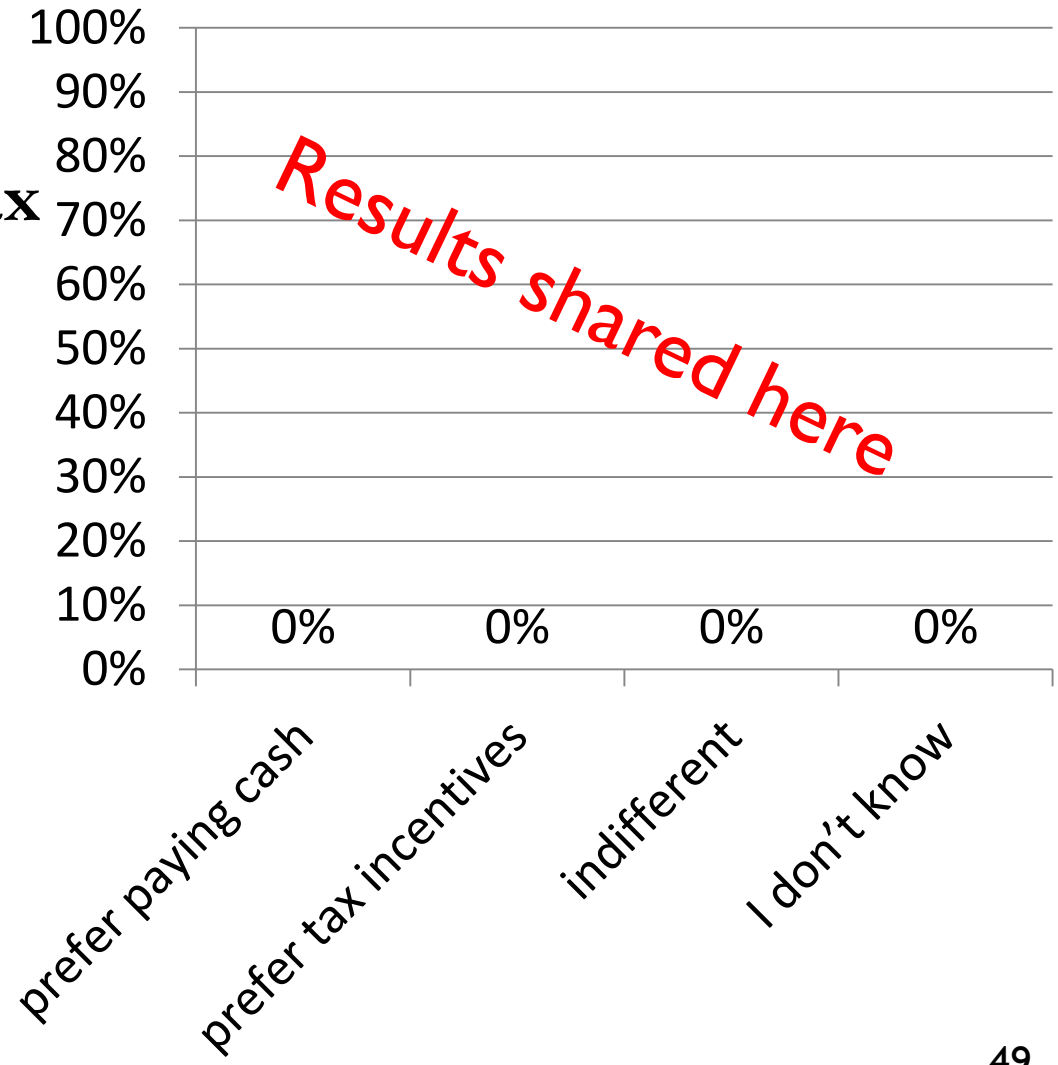


Question Slide 4 out of 5

Comparing Incentives: Cash to Tax Incentives

I would prefer…

1. **paying cash** over **tax incentives**.
2. **tax incentives** over **paying cash**.
3. I am indifferent.
4. I don't know.



Question Slide 5 out of 5

Payment Examples for $10,000 Conversion

#	Example	What do the numbers look like?
1	Pay cash + use credit card	• $5,000 cash payment by homeowner • $5,000 credit card debt with high interest
2	Utilize AHFC Energy Rebate	• $10,000 paid in advance by homeowner for conversion • $5,500 back from rebate*
3	Low interest loan paid back on utility bill	• $10,000 loan from utility at 3.5% interest for 10 years. • $99 per month on utility bill

* Assumes a 2 star improvement. Up to $10,000 returned in rebate after installation depending on energy efficiency rating after installation.

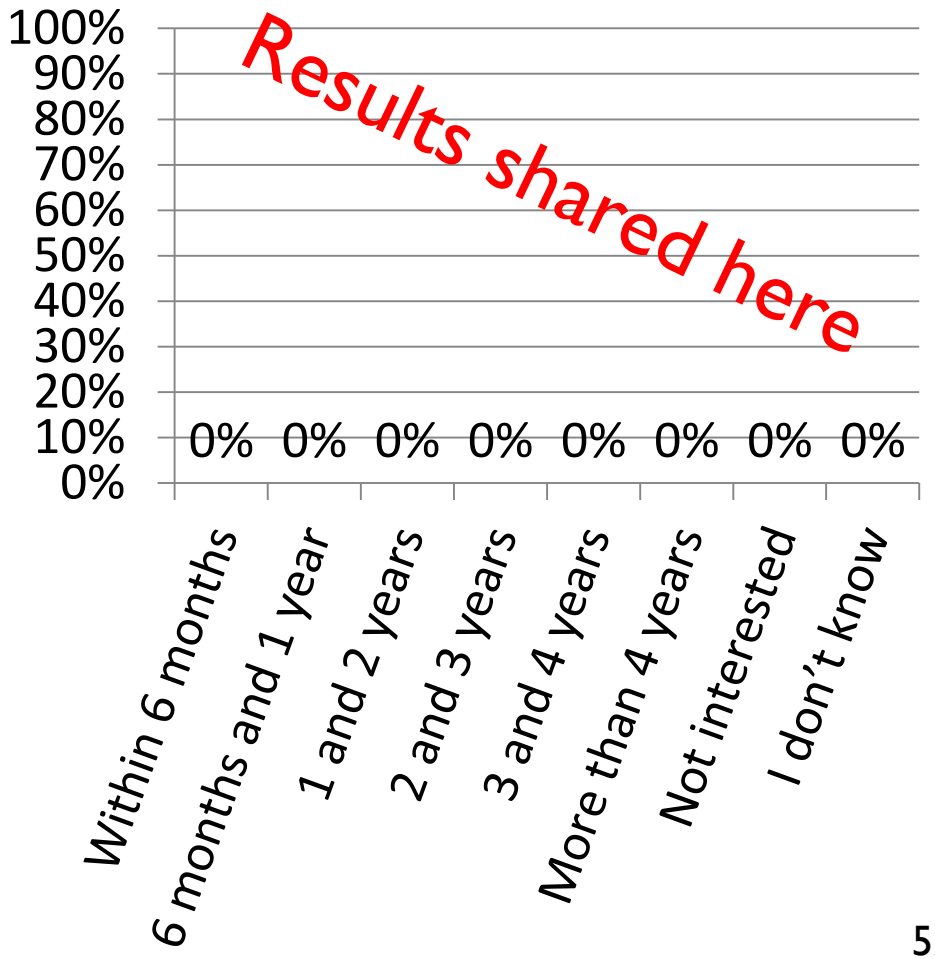
What are your thoughts about incentives?

- Will incentives encourage you to convert?
- Which incentives are the most desirable?
- What aspects of an incentive program are the most important to you?

How quickly would you convert?

If natural gas was available with an incentive program to help cover upfront costs of conversion, what timeframe would you anticipate converting?

1. Within 6 months
2. Between 6 months and 1 year
3. Between 1 and 2 years
4. Between 2 and 3 years
5. Between 3 and 4 years
6. More than 4 years
7. Not interested in converting
8. I don't know



Which of the following is most important to you in an incentive program?

Please rank your top 3.

1. Improving air quality in neighborhoods with poor air quality.
2. Assisting low income households with conversion costs.
3. Reliability and ease of use.
4. Getting the most people to convert.
5. Offering the cheapest conversion possible.
6. Offering the most annual savings possible.
7. Providing upfront funding.
8. Offering low interest rates.
9. Other.

Most important criteria - Results

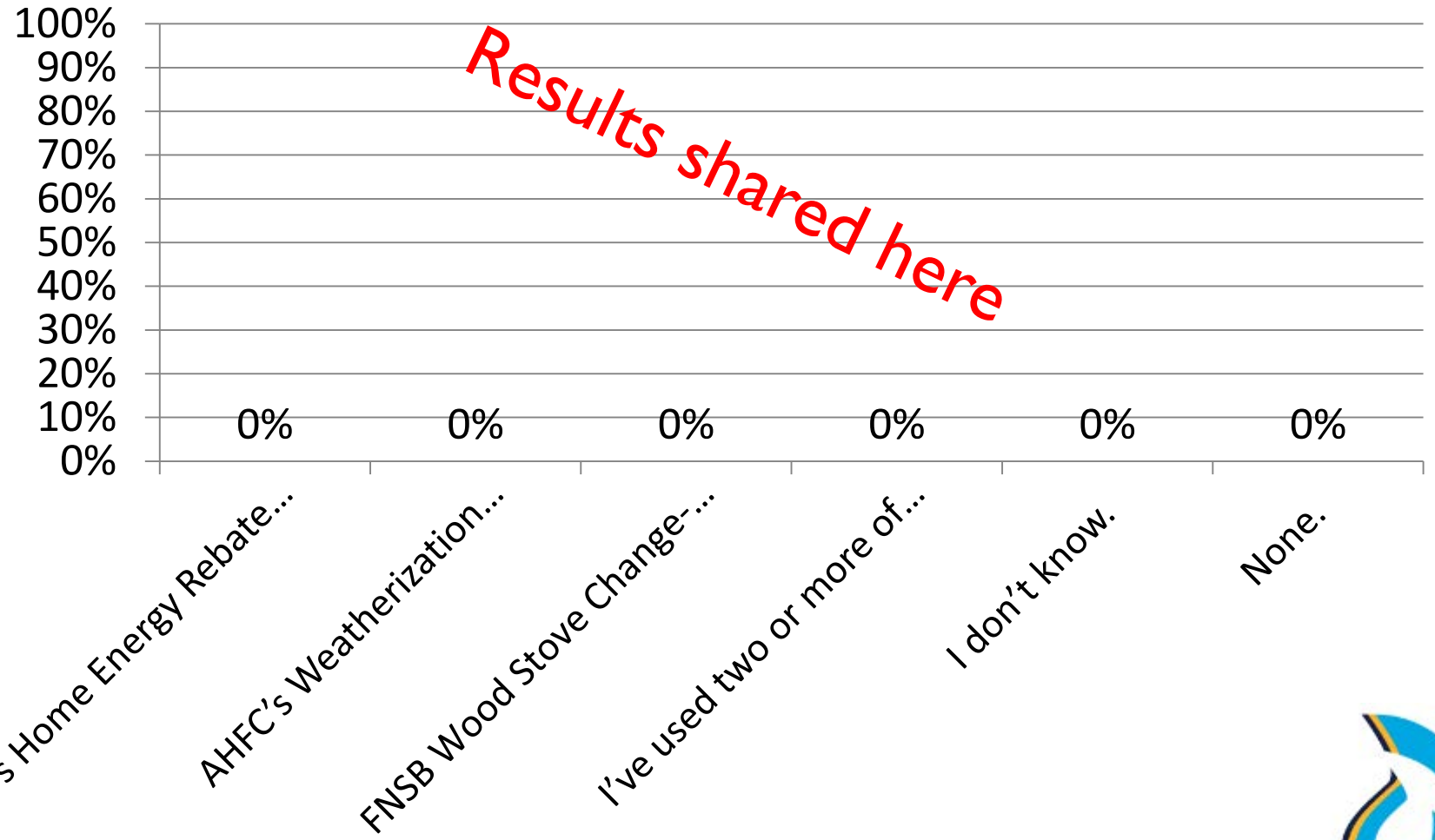
Sample Choice

Results shared here

Which of the following programs have you participated in for your current home?

1. AHFC's Home Energy Rebate Program
2. AHFC's Weatherization Program
3. FNSB Wood Stove Change-out Program
4. I've used two or more of these programs.
5. I don't know.
6. I have not used any of these programs.

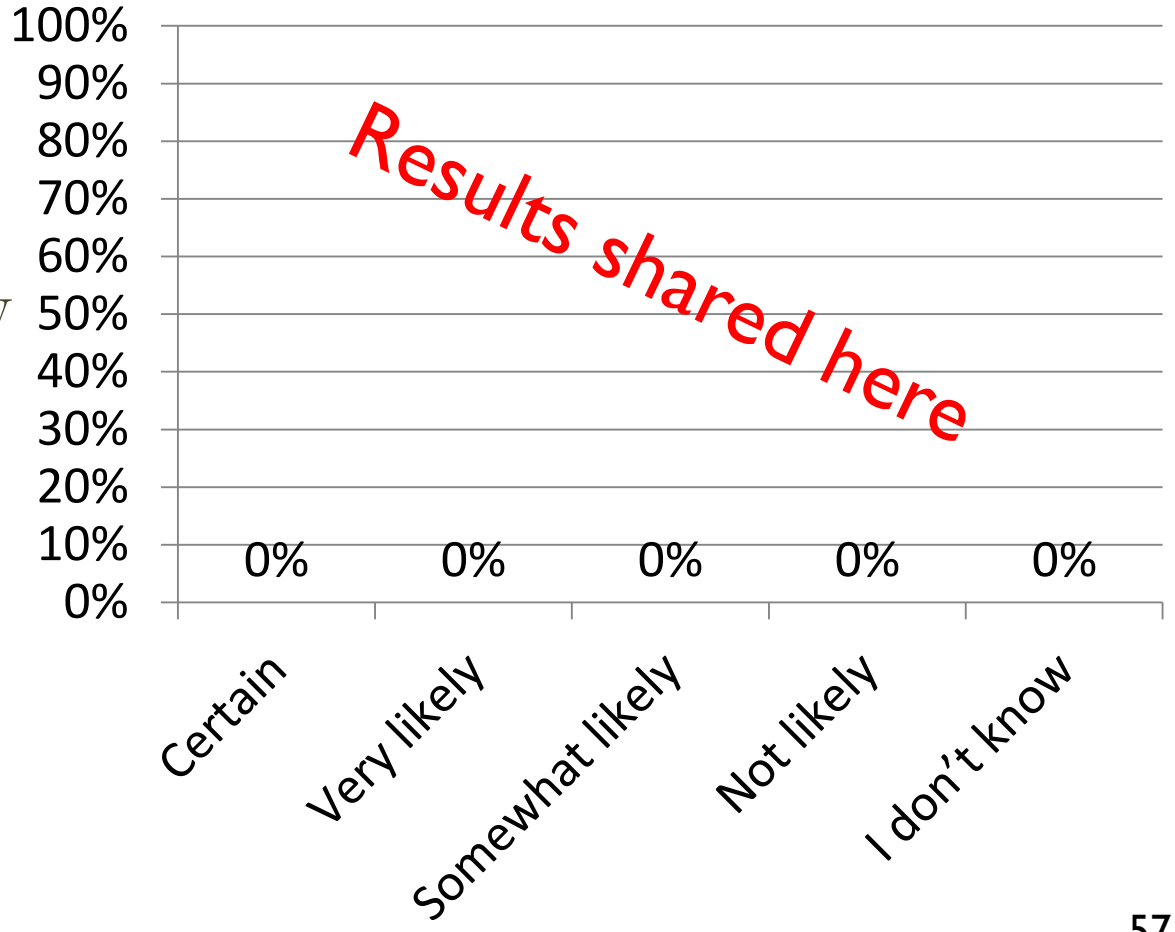
Which of the following programs have you participated in for your current home?



One final time - Are you likely to convert?

Given the information provided, how likely are you to convert your home to natural gas?

1. Certain
2. Very likely
3. Somewhat likely
4. Not likely
5. I don't know



Final Questions: Background Information

These responses are CONFIDENTIAL and will not appear on the screen.

What type of residence do you live in?

1. Single family residence
2. Duplex
3. Apartment
4. Condominium
5. Mobile home
6. Other
7. I don't know

What is the approximate size of your home (not including garage)?

1. Under 500 square feet
2. 501 to 1,000 square feet
3. 1,001 to 1,500 square feet
4. 1,501 to 2,000 square feet
5. 2,001 to 3,000 square feet
6. Over 3,000 square feet
7. I don't know

Do you have a heated garage?

1. Yes
2. No
3. Sometimes
4. I don't know
5. I don't have a garage

What is your zip code?

1. 99701
2. 99702
3. 99703
4. 99705
5. 99709
6. 99711
7. 99712
8. 99714
9. 99775
10. Other

Question 4 out of 9

How long have you lived in your current home?

1. Less than one year
2. One to five years
3. Five to ten years
4. Ten to 20 years
5. More than 20 years

How likely are you to move from your home sometime in the next 5 years?

1. Certain
2. Very likely
3. Somewhat likely
4. Not likely
5. I don't know

How old are you?

1. 18 to 24 years old
2. 25 to 35 years old
3. 36 to 45 years old
4. 46 to 55 years old
5. 56 to 65 years old
6. 66 to 75 years old
7. Over 75 years old

In which of the broad categories does your total household income fall?

1. $0 to $19,999
2. $20,000 to $39,999
3. $40,000 to $59,999
4. $60,000 to $79,999
5. $80,000 to $99,999
6. $100,000 to $149,999
7. $150,000 or more

What is your gender?

1. Male
2. Female

Wrap-up and Next Steps

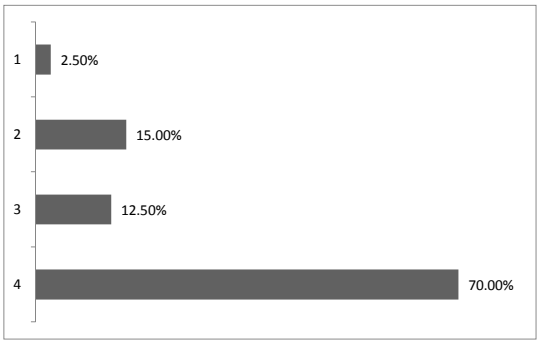
- How to sign up for project updates
- Questions or additional thoughts:

www.interiorenergyproject.com

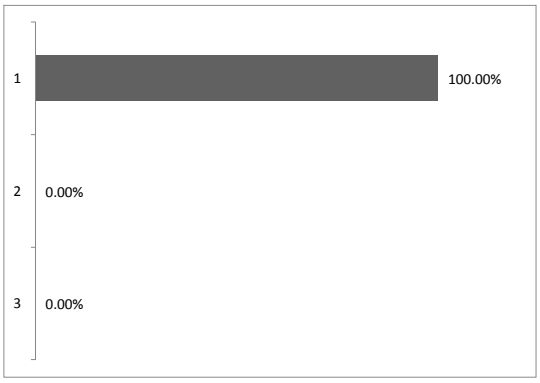
Appendix E: Audience Response Survey Results

Audience Response Questions and Responses (compiled from all 4 meetings)

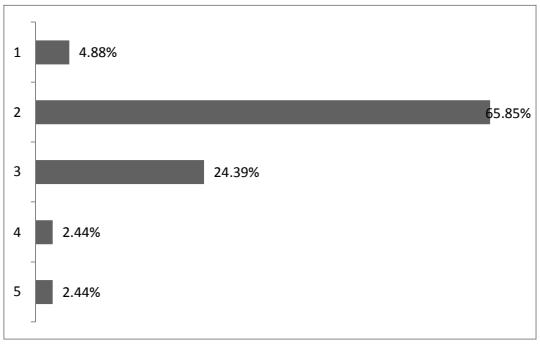
Question	Combined Responses	
Test question: How long have you lived in the Fairbanks North Star Borough?	**Count**	**%**
1. 0-5 years	1	2.50%
2. 6-10 years	6	15.00%
3. 11-20 years	5	12.50%
4. Over 20 years	28	70.00%
	40	**100.00%**



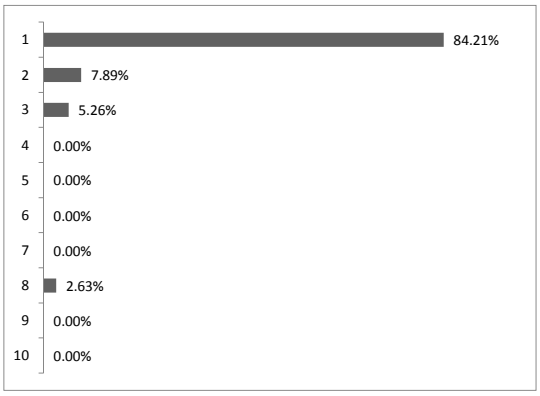
Do you own or rent the house you live in?	**Count**	**%**
1. Own	38	100.00%
2. Rent	0	0.00%
3. Other	0	0.00%
	38	**100.00%**



How many residential properties do you own in Fairbanks/North Star?	**Count**	**%**
1. None.	2	4.88%
2. One (my current home).	27	65.85%
3. Two to five properties.	10	24.39%
4. Six to ten properties.	1	2.44%
5. More than ten properties.	1	2.44%
	41	**100.00%**

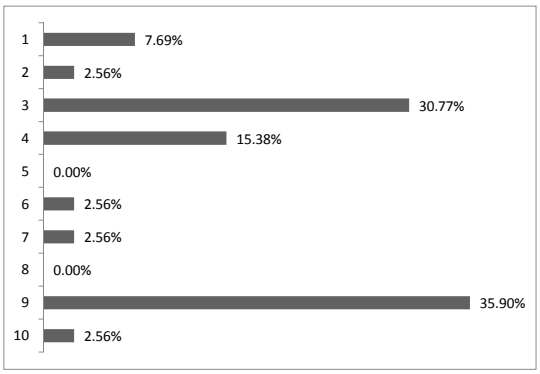


What is your primary heating system? (primary residence)	**Count**	**%**
1. Boiler / Baseboard or Radiant Heat	32	84.21%
2. Furnace / Forced Air	3	7.89%
3. Wood Stove	2	5.26%
4. Pellet Stove	0	0.00%
5. Fireplace	0	0.00%
6. Fixed Room Heater (e.g. Toyo stove)	0	0.00%
7. Portable Room Heater	0	0.00%
8. Electric	1	2.63%
9. Other	0	0.00%
10. I don't know	0	0.00%
	38	**100.00%**



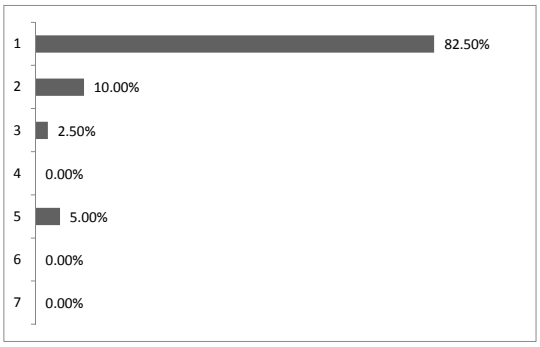
What is your secondary heating system? (primary residence)

	Count	%
1. Boiler / Baseboard	3	7.69%
2. Furnace / Forced Air	1	2.56%
3. Wood Stove	12	30.77%
4. Pellet Stove	6	15.38%
5. Fireplace	0	0.00%
6. Fixed Room Heater (e.g. Toyo stove)	1	2.56%
7. Portable Room Heater	1	2.56%
8. Electric	0	0.00%
9. I don't have a secondary source.	14	35.90%
10. Other	1	2.56%
	39	**100.00%**



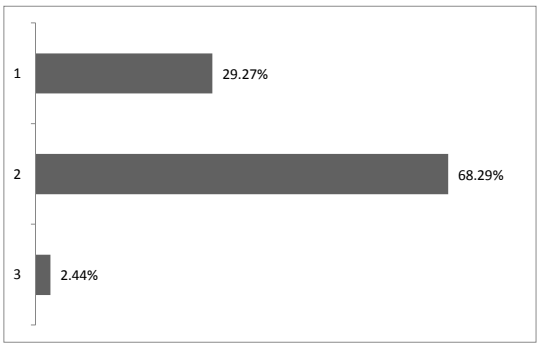
What is your primary fuel heating source? (primary residence)

	Count	%
1. Fuel Oil	33	82.50%
2. Wood (not pellets)	4	10.00%
3. Wood pellets	1	2.50%
4. Electricity	0	0.00%
5. Natural gas	2	5.00%
6. Other	0	0.00%
7. I Don't Know	0	0.00%
	40	**100.00%**



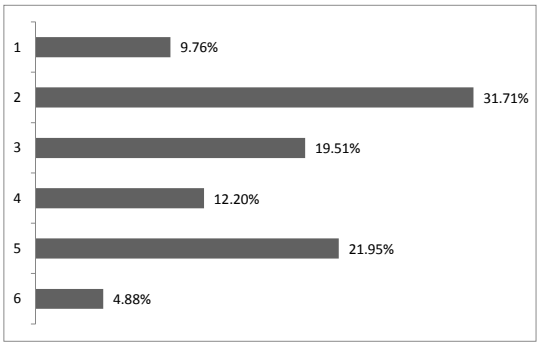
Does your primary heating system provide heat only, or does it also provide hot water for your home? (primary residence)

	Count	%
1. Heat only	12	29.27%
2. Heat + hot water	28	68.29%
3. I don't know	1	2.44%
	41	**100.00%**

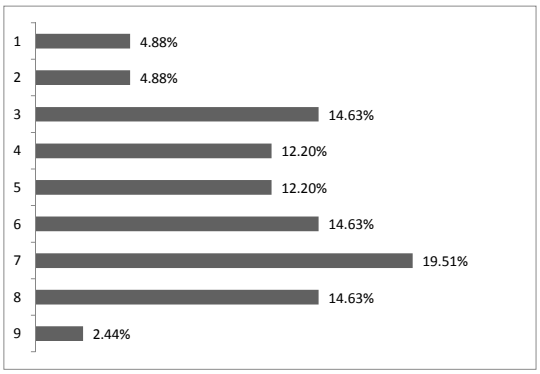


Approximately how old is your primary heating system? (primary residence)

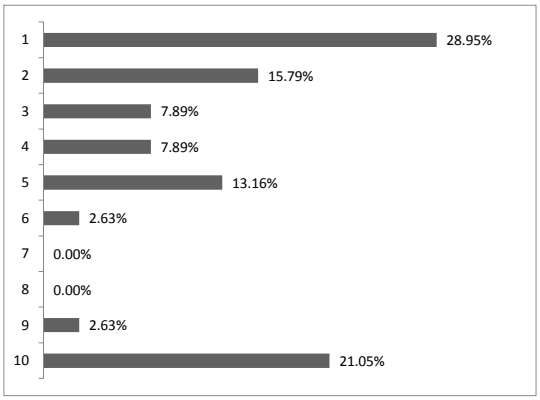
	Count	%
1. 0 to 2 years	4	9.76%
2. 3 to 5 years	13	31.71%
3. 6 to 10 years	8	19.51%
4. 11 to 20 years	5	12.20%
5. over 20 years	9	21.95%
6. I don't know	2	4.88%
	41	**100.00%**



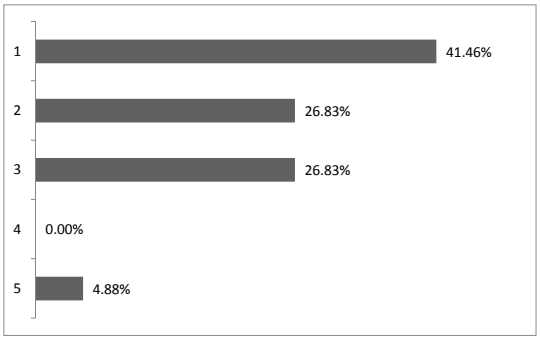
How much do you pay for your primary heating source per year? (primary residence, 3-yr avg.)	**Count**	**%**
1. $0 - $999	2	4.88%
2. $1,000 - $1,999	2	4.88%
3. $2,000 - $2,999	6	14.63%
4. $3,000 - $3,999	5	12.20%
5. $4,000 - $4,999	5	12.20%
6. $5,000 – $5,999	6	14.63%
7. $6,000 - $6,999	8	19.51%
8. $7,000 or more	6	14.63%
9. I don't know	1	2.44%
	41	**100.00%**



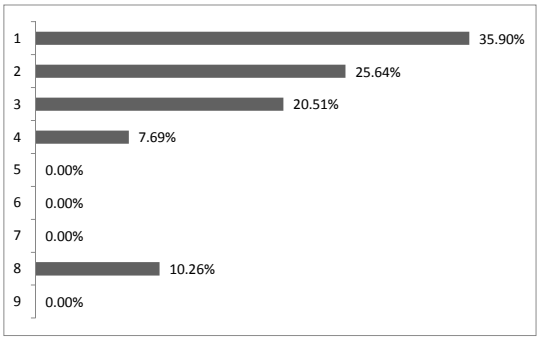
How much do you pay for your secondary heating source per year? (primary residence, 3-yr avg.)	**Count**	**%**
1. $0 - $249	11	28.95%
2. $250 - $499	6	15.79%
3. $500 - $999	3	7.89%
4. $1,000 - $1,999	3	7.89%
5. $2,000 - $2,999	5	13.16%
6. $3,000 – $3,999	1	2.63%
7. $4,000 - $5,999	0	0.00%
8. $6,000 or more	0	0.00%
9. I don't know	1	2.63%
10. I don't have a secondary heating source	8	21.05%
	38	**100.00%**



Are you likely to convert to natural gas?	**Count**	**%**
1. Certain	17	41.46%
2. Very likely	11	26.83%
3. Somewhat likely	11	26.83%
4. Not likely	0	0.00%
5. I don't know	2	4.88%
	41	**100.00%**



How quickly would you convert?	**Count**	**%**
1. Within 6 months	14	35.90%
2. Between 6 months and 1 year	10	25.64%
3. Between 1 and 2 years	8	20.51%
4. Between 2 and 3 years	3	7.69%
5. Between 3 and 4 years	0	0.00%
6. More than 4 years	0	0.00%
7. Not interested in converting	0	0.00%
8. I don't know	4	10.26%
9. I already converted my home	0	0.00%
	39	**100.00%**

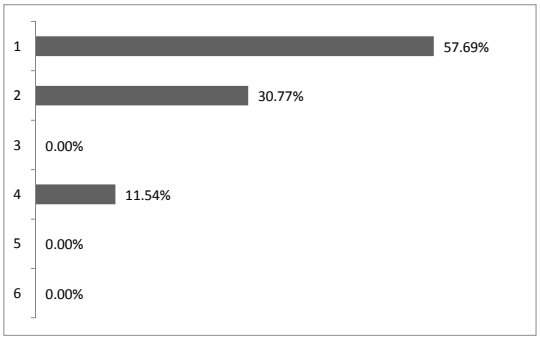


Conversion Cost/Savings Exercise Results

Which Option is the Most Appealing for Your Household?

Attributes	Option A	Option B
Conversion Cost	$4,000	$12,000
Annual Savings	$2,000	$2,500

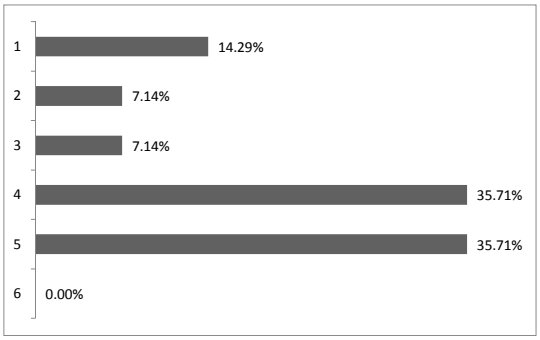
	Count	%
1. A is much better than B.	15	57.69%
2. A is better than B.	8	30.77%
3. Neither.	0	0.00%
4. B is better than A.	3	11.54%
5. B is much better than A.	0	0.00%
6. I am not interested in switching heating systems.	0	0.00%
	26	**100.00%**



Which Option is the Most Appealing for Your Household?

Attributes	Option A	Option B
Conversion Cost	$12,000	$4,000
Annual Savings	$2,000	$1,500

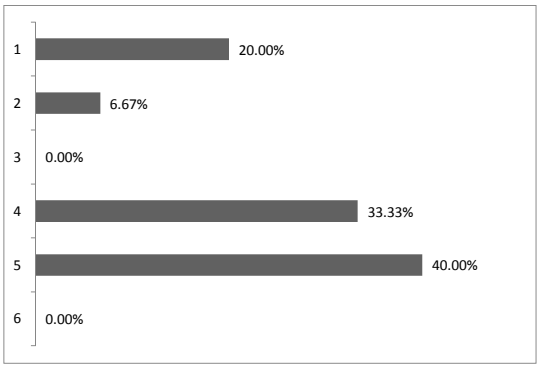
	Count	%
1. A is much better than B.	2	14.29%
2. A is better than B.	1	7.14%
3. Neither.	1	7.14%
4. B is better than A.	5	35.71%
5. B is much better than A.	5	35.71%
6. I am not interested in switching heating systems.	0	0.00%
	14	**100.00%**



Which Option is the Most Appealing for Your Household?

Attributes	Option A	Option B
Conversion Cost	$12,000	$4,000
Annual Savings	$3,000	$2,500

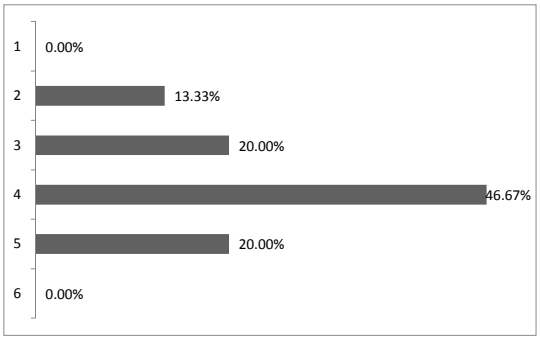
	Count	%
1. A is much better than B.	3	20.00%
2. A is better than B.	1	6.67%
3. Neither.	0	0.00%
4. B is better than A.	5	33.33%
5. B is much better than A.	6	40.00%
6. I am not interested in switching heating systems.	0	0.00%
	15	**100.00%**



Which Option is the Most Appealing for Your Household?

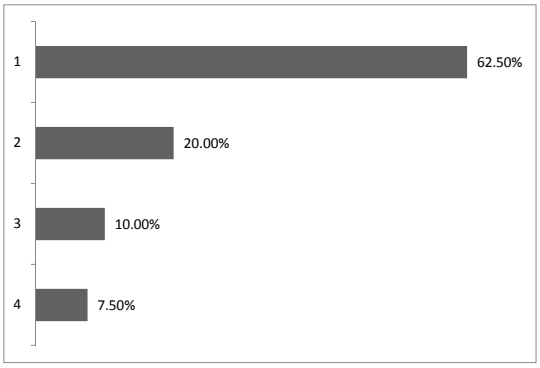
Attributes	Option A	Option B
Conversion Cost	$12,000	$16,000
Annual Savings	$500	$2,500

	Count	%
1. A is much better than B.	0	0.00%
2. A is better than B.	2	13.33%
3. Neither.	3	20.00%
4. B is better than A.	7	46.67%
5. B is much better than A.	3	20.00%
6. I am not interested in switching heating systems.	0	0.00%
	15	**100.00%**



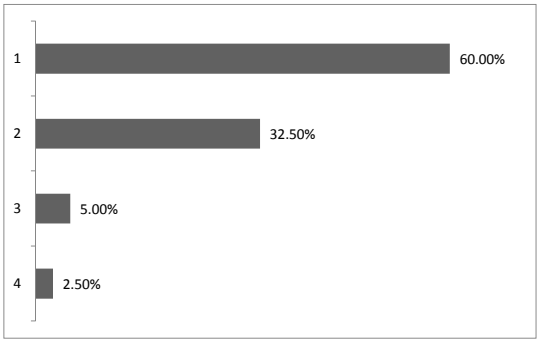
Comparing Incentives: Cash to Private Loan

I would prefer…	Count	%
1. paying cash over a private loan.	25	62.50%
2. a private loan over paying cash.	8	20.00%
3. I am indifferent.	4	10.00%
4. I don't know.	3	7.50%
	40	**100.00%**



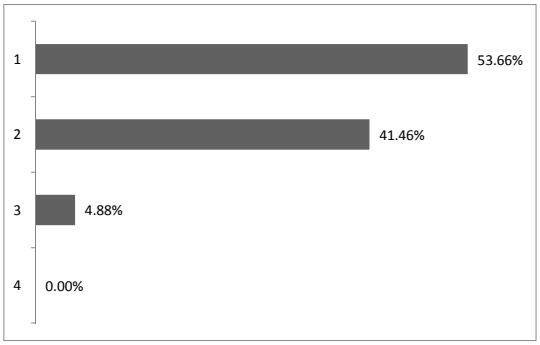
Comparing Incentives: Cash to Low Interest Loan (Tied to Individual)

I would prefer…	Count	%
1. paying cash over a low interest loan (individual).	24	60.00%
2. a low interest loan (individual) over paying cash.	13	32.50%
3. I am indifferent.	2	5.00%
4. I don't know.	1	2.50%
	40	**100.00%**



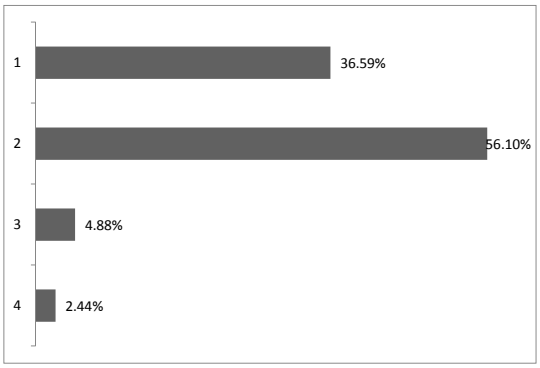
Comparing Incentives: Cash to Low Interest Loan (Tied to Property)

I would prefer…	Count	%
1. paying cash over a low interest loan (property).	22	53.66%
2. a low interest loan (property) over paying cash.	17	41.46%
3. I am indifferent.	2	4.88%
4. I don't know.	0	0.00%
	41	**100.00%**



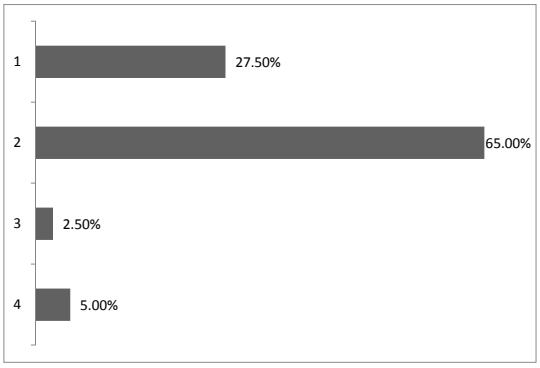
Comparing Incentives: Cash to Direct Payments

I would prefer…	Count	%
1. paying cash over direct payments.	15	36.59%
2. direct payments over paying cash.	23	56.10%
3. I am indifferent.	2	4.88%
4. I don't know.	1	2.44%
	41	**100.00%**

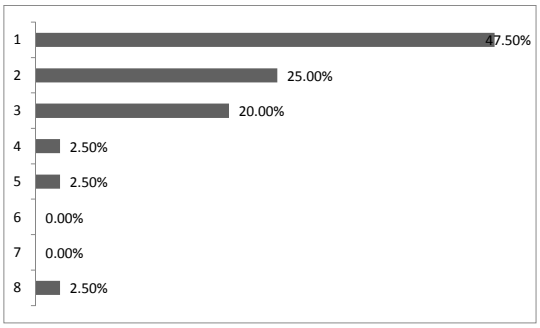


Comparing Incentives: Cash to Tax Incentives

I would prefer…	Count	%
1. paying cash over tax incentives.	11	27.50%
2. tax incentives over paying cash.	26	65.00%
3. I am indifferent.	1	2.50%
4. I don't know.	2	5.00%
	40	**100.00%**



How quickly would you convert?	Count	%
1. Within 6 months	19	47.50%
2. Between 6 months and 1 year	10	25.00%
3. Between 1 and 2 years	8	20.00%
4. Between 2 and 3 years	1	2.50%
5. Between 3 and 4 years	1	2.50%
6. More than 4 years	0	0.00%
7. Not interested in converting	0	0.00%
8. I don't know	1	2.50%
	40	**100.00%**



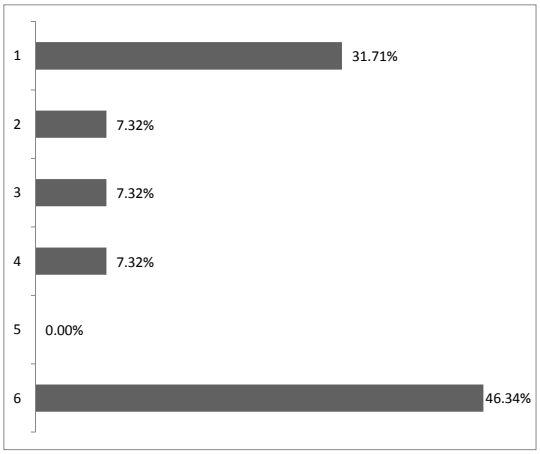
Which of the following is most important to you in an incentive program? Please rank your top 3.

1. Improving air quality in neighborhoods with poor air quality.
2. Assisting low income households with conversion costs.
3. Reliability and ease of use.
4. Getting the most people to convert.
5. Offering the cheapest conversion possible.
6. Offering the most annual savings possible.
7. Providing upfront funding.
8. Offering low interest rates.
9. Other.

	UNWEIGHTED				WEIGHTED				
Characteristic	#1 Choice	#2 Choice	#3 Choice	Total votes	#1 Choice x3	#2 Choice x2	#3 Choice x1	Weighted total	**% of total points**
Offering the cheapest conversion possible	5	15	6	26	15	30	6	51	**22%**
Offering the most annual savings possible	6	6	17	29	18	12	17	47	**20%**
Reliability and ease of use	7	5	2	14	21	10	2	33	**14%**
Providing upfront funding	8	3	3	14	24	6	3	33	**14%**
Improving air quality in neighborhoods with poor air quality	4	4	3	11	12	8	3	23	**10%**
Getting the most people to convert	3	4	0	7	9	8	0	17	**7%**
Assisting low income households w/conversion costs	3	1	2	6	9	2	2	13	**5%**
Offering low interest rates	3	1	1	5	9	2	1	12	**5%**
Other	2	1	0	3	6	2	0	8	**3%**
TOTAL	**41**	**40**	**34**	**115**	**123**	**80**	**34**	**237**	**100%**

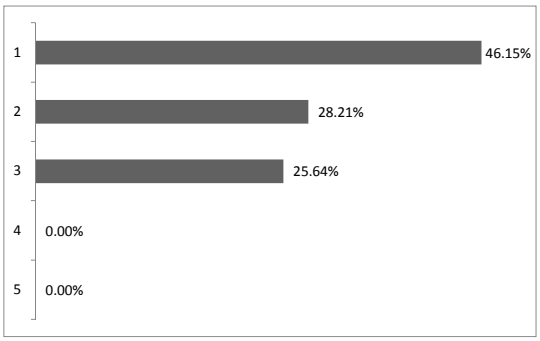
Which of the following programs have you participated in for your current home?

	Count	**%**
1. AHFC's Home Energy Rebate Program	13	31.71%
2. AHFC's Weatherization Program	3	7.32%
3. FNSB Wood Stove Change-out Program	3	7.32%
4. I've used two or more of these programs.	3	7.32%
5. I don't know.	0	0.00%
6. I have not used any of these programs.	19	46.34%
	41	**100.00%**



One final time - Are you likely to convert?

	Count	%
1. Certain	18	46.15%
2. Very likely	11	28.21%
3. Somewhat likely	10	25.64%
4. Not likely	0	0.00%
5. I don't know	0	0.00%
	39	**100.00%**

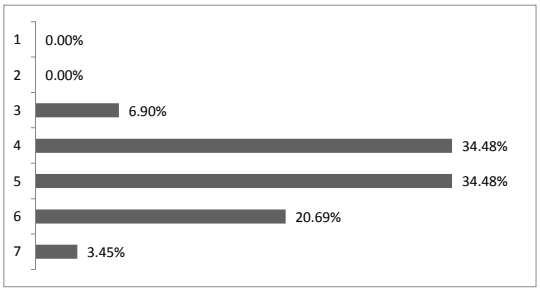


What type of residence do you live in?

	Count	%
1. Single family residence	27	93.10%
2. Duplex	1	3.45%
3. Apartment	0	0.00%
4. Condominium	0	0.00%
5. Mobile home	0	0.00%
6. Other	1	3.45%
7. I don't know	0	0.00%
	29	**100.00%**

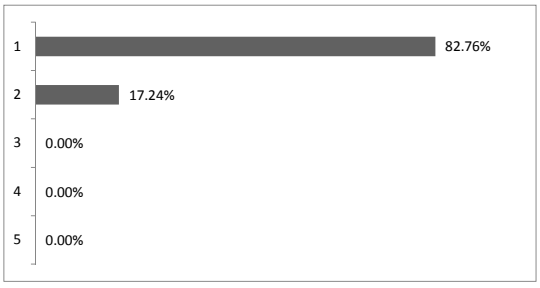
What is the approximate size of your home (not including garage)?

	Count	%
1. Under 500 square feet	0	0.00%
2. 501 to 1,000 square feet	0	0.00%
3. 1,001 to 1,500 square feet	2	6.90%
4. 1,501 to 2,000 square feet	10	34.48%
5. 2,001 to 3,000 square feet	10	34.48%
6. Over 3,000 square feet	6	20.69%
7. I don't know	1	3.45%
	29	**100.00%**



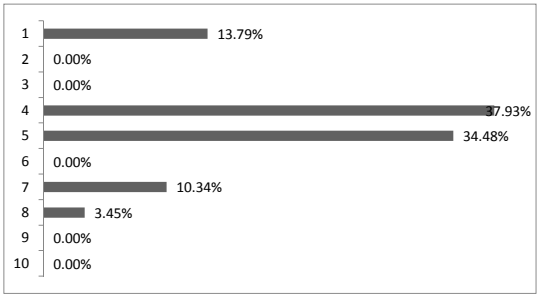
Do you have a heated garage?

	Count	%
1. Yes	24	82.76%
2. No	5	17.24%
3. Sometimes	0	0.00%
4. I don't know	0	0.00%
5. I don't have a garage	0	0.00%
	29	**100.00%**



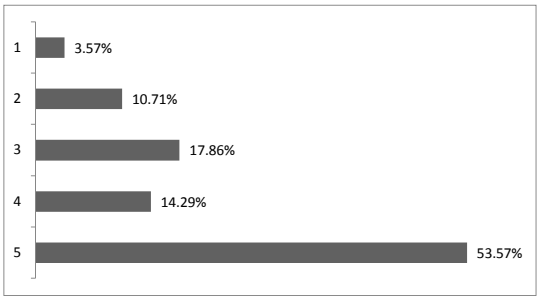
What is your zip code?

	Count	%
1. 99701	4	13.79%
2. 99702	0	0.00%
3. 99703	0	0.00%
4. 99705	11	37.93%
5. 99709	10	34.48%
6. 99711	0	0.00%
7. 99712	3	10.34%
8. 99714	1	3.45%
9. 99775	0	0.00%
10. Other	0	0.00%
	29	**100.00%**



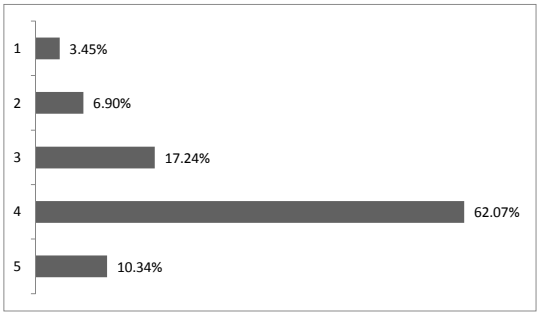
How long have you lived in your current home?

	Count	%
1. Less than one year	1	3.57%
2. One to five years	3	10.71%
3. Five to ten years	5	17.86%
4. Ten to 20 years	4	14.29%
5. More than 20 years	15	53.57%
	28	**100.00%**



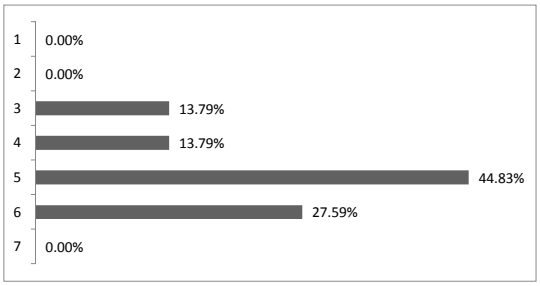
How likely are you to move from your home sometime in the next 5 years?

	Count	%
1. Certain	1	3.45%
2. Very likely	2	6.90%
3. Somewhat likely	5	17.24%
4. Not likely	18	62.07%
5. I don't know	3	10.34%
	29	**100.00%**



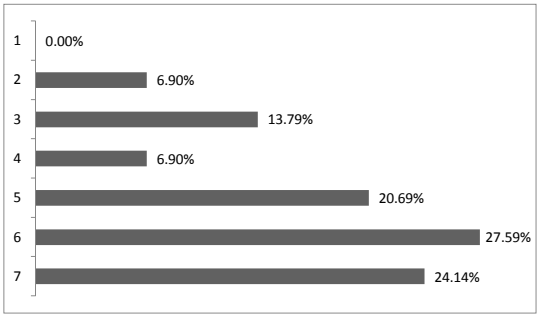
How old are you?

	Count	%
1. 18 to 24 years old	0	0.00%
2. 25 to 35 years old	0	0.00%
3. 36 to 45 years old	4	13.79%
4. 46 to 55 years old	4	13.79%
5. 56 to 65 years old	13	44.83%
6. 66 to 75 years old	8	27.59%
7. Over 75 years old	0	0.00%
	29	**100.00%**



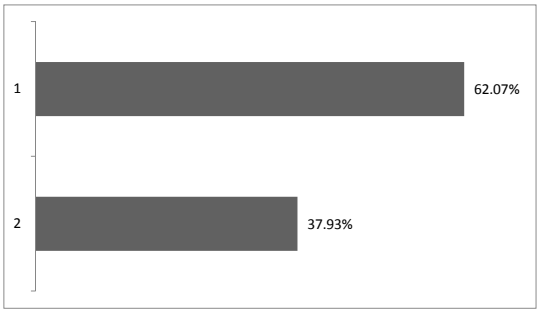
In which of the broad categories does your total household income fall?

	Count	%
1. $0 to $19,999	0	0.00%
2. $20,000 to $39,999	2	6.90%
3. $40,000 to $59,999	4	13.79%
4. $60,000 to $79,999	2	6.90%
5. $80,000 to $99,999	6	20.69%
6. $100,000 to $149,999	8	27.59%
7. $150,000 or more	7	24.14%
	29	**100.00%**



What is your gender?

	Count	%
1. Male	18	62.07%
2. Female	11	37.93%
	29	**100.00%**



Fairbanks Natural Gas Conversion Analysis

APPENDIX E

INCENTIVES WHITE PAPER

Appendix E Incentives White Paper

E.1 Executive Summary

The Interior Energy Project (IEP) would increase access to natural gas in Fairbanks North Star Borough (FNSB). Approximately 1,100 FNSB households currently have access to natural gas, while approximately 79 percent of Fairbanks households primarily use oil as a heating fuel and nearly six percent of households primarily use wood. As natural gas is a less expensive heating fuel than oil, and has significantly lower air emissions than either oil or wood, increased use of natural gas for heating would both reduce heating fuel costs and improve FNSB air quality (currently below federal standards for particulate matter) The IEP would increase access to natural gas, but would not necessarily increase use of natural gas for home heating. There are primarily **three potential barriers to converting FNSB residences to natural gas heating systems:**

1. High capital cost of conversion.
2. Short-term residents potentially not recouping investment, and
3. Inconvenience and time requirements.

To help homeowners overcome these barriers, this paper describes and reviews the three primary types of incentive programs that the IEP could recommend:

1. Loan programs (including on-bill financing);
2. Direct payment programs; and
3. Tax incentives (see Section 2).

There are pros and cons to each of these program types, with significant variation among national examples of these programs (see Section 4). Within each program, there are tradeoffs regarding program eligibility, ease of participation, assistance in financing of capital costs, timing of financial benefits, and risk of debt repayment (in the case of loans). As fuel switching may not qualify for incentives under existing energy efficiency programs available to FNSB residents (see Section E.7), we recommend developing an incentive program specifically tailored to promote fuel switching.

Based on an assessment of over 25 energy efficiency and residential heating fuel conversion programs in Alaska and nationally (see Section E.7 and E.10), **we believe that the three barriers to natural gas conversion would best be overcome with a straightforward on-bill financing program** that is tied to the meter (i.e. is transferable to the home's next resident). In such a program, the capital costs of conversion are financed by a lender and are repaid by consumers through their monthly utility bill. **This type of program has several advantages**:

1. Lowers initial capital cost. The consumer does not have to pay significant upfront capital costs, and can reap immediate benefits in a reduced monthly total energy bill (natural gas bill plus repayment of conversion capital is less than oil cost).
2. Reduces relocation considerations. As the repayment of the loan is tied to the meter and not the homeowner, the consumer does not have to evaluate if he/she will relocate before recouping the initial investment cost.
3. Increases eligibility. Those with less than desirable credit would receive financing, provided that their utility bill payment history is acceptable to the lender.

Drawbacks to an on-bill program can include higher complexity to the consumer and potentially high loan values. Ease of program participation could be ensured with a one-step system that allows for one phone call to determine eligibility and get the fuel system conversion in motion. To reduce loan value, the program may need to be accompanied by a rebate if the initial capital cost is so high that it results in a monthly utility bill (fuel cost plus capital repayment) that is higher than current monthly energy costs.

E.2 Introduction

The development of an expanded natural gas distribution system in Fairbanks is a critical component of the Interior Energy Project (IEP). The IEP would finance a natural gas conditioning and liquefaction plant on the North Slope and also a Liquefied Natural Gas (LNG) storage, re-gasification, and distribution system to bring natural gas to FNSB households. The development of the IEP would provide two major benefits to Fairbanks North Star Borough (FNSB) residents: 1) residential and business heating cost savings, and 2) improved air quality.

Preliminary IEP natural gas cost estimates for providing gas to the "burner tip" in the FNSB is expected to range between $14.59 and $17.09 per Mcf[172], or roughly half the cost of heating with fuel oil.[173] Depending on a number of factors, including home/heating system efficiency, climate, and the number of days using the heating system, the lower heating fuel price for natural gas could very well translate into large savings for FNSB homeowners.[174]

Replacing wood and oil heating systems with natural gas will also improve FNSB air quality. The US Environmental Protection Agency (EPA) designated portions of the FNSB as a non-attainment area for fine particulate matter ($PM_{2.5}$) on December 14, 2009.[175] The deadline for the FNSB to meet EPA air quality standards and to achieve attainment is currently December 14, 2014.[176]

A major contributor to fine particulate pollution is the use of wood and heating oil as residential heating fuel.[177] Oil furnaces generate approximately 0.013 pounds (lbs) of $PM_{2.5}$/MMBtu of heat output, while certified wood stoves and uncertified wood stoves generate approximately 1.4 and 4.6 lbs. of $PM_{2.5}$/MMBtu. Conversely, natural gas generates approximately 0.0083 lbs. of $PM_{2.5}$/MMBtu of heat output, which is less than half the $PM_{2.5}$ generated by oil.[178]

A recent survey of Fairbank households found that approximately four percent of homes in Fairbanks are heated by natural gas.[179] Conversely, 79 percent of homes in Fairbanks primarily use heating oil for space heating. Currently, natural gas is available to only approximately 1,100 Fairbanks households.[180]

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[172] Therriault, Gene and Mark Davis, September 4, 2013, Interior Energy Project: Brining North Slope Natural Gas to Alaskans, Website (http://www.alaskaalliance.com/servlet/content/presentations.html) accessed October 1, 2013.

[173] Calculation assumes heating oil cost of $4 per gallon and that oil generates 134,000 Btu per gallon, while natural gas generates 1,000 Btu per cubic foot.

[174] Therriault, Gene and Mark Davis, September 4, 2013, Interior Energy Project: Brining North Slope Natural Gas to Alaskans, Website (http://www.alaskaalliance.com/servlet/content/presentations.html) accessed October 1, 2013.

[175] State of Alaska, Particulate Matter, Website (http://www.dec.state.ak.us/air/anpms/pm/pm_plan.htm) accessed September 12, 2013.

[176] Ibid.

[177] Davis, John, Misiuk, David, Colgan, Ryan, and Nathan Wiltse, February 23, 2009, Reducing PM2.5 Emissions from Residential Heating Sources in the Fairbanks North Star Borough, Website (http://cchrc.org/docs/reports/PM2.5_Final_2-23-09.pdf) accessed September 12, 2013.

[178] EPA, Consumers – Energy Efficiency and Wood –Burning Stoves and Fireplaces, Website (http://www.epa.gov/burnwise/energyefficiency.html)

[179] U.S. Census Bureau, 2007-2011, House Heating Fuel, American Community Survey 5-Year Estimates, Website (https://www.census.gov), accessed October 15, 2013.

Increasing household access to natural gas is a necessary step, but access alone may not result in households converting to natural gas as their primary heating fuel. While the cost of heating with natural gas in FNSB is expected to be approximately one-half the price[181] of heating oil, and natural gas can be much less labor intensive than heating with wood, the sizeable capital cost of purchasing and installing gas furnaces is potentially a major hurdle to conversion. To increase conversion rates and enable the FNSB to achieve $PM_{2.5}$ attainment goals, conversion incentive programs may be needed.

Throughout the United States there are a variety of incentive programs that encourage home fuel switching and energy efficiency. While there are several such programs available currently to FNSB residents, none of the existing programs focus on fuel conversion. The purpose of this paper is to identify and recommend potential incentive structures that could fill this gap.

Following a brief overview of conversion economics and incentives, this paper describes the programs currently available to FNSB residents. The paper then describes and evaluates the range of incentive programs operating throughout the U.S. The aim is to provide an understanding of how each type of incentive program might be adapted for the FNSB context to increase household conversion to natural gas heating systems. The paper concludes with a recommendation for an incentive program for FNSB that should increase natural gas conversion.

E.3 Overview of Conversion Economics and Incentives

This section provides an overview of the costs and benefits of converting to a natural gas heating system based on case studies in Homer. This leads into a discussion of economic conditions for natural gas conversion in the FNSB, followed by discussion of the general barriers to program participation, several of which are economic. The remainder of this section describes in general terms the types of energy efficiency and fuel conversion programs currently offered in Alaska and elsewhere

E.3.1 Conversion Economics

This section provides an introduction to the economic factors affecting household conversion to natural gas, focusing on a case study in Homer and applicability of the Homer estimates to Fairbanks.

E.3.2 Homer Case Study

Table E-1 summarizes the economics of converting residential heating systems (primarily oil systems) to natural gas heating systems for eight case study homes in Homer, Alaska. The table highlights the monthly fuel cost savings of converting to natural gas, and weighs this against the initial, capital conversion costs of purchasing and installing a natural gas system. Homer property owners are required to pay a $3,283 assessment upfront or finance this amount at 4 percent interest over a ten year period, which is a $33 per month payment. As this cost is incurred by all property owners, regardless of whether they connect to the natural gas line, this is a 'sunk cost' that may not affect the economics of choosing to pay for the service line and appliances necessary to convert to natural gas.

Although capital costs can be substantial (for the case study homes in Homer, conversion costs ranged from $2,351 to $14,147), these investment costs can be recovered through monthly fuel savings in just a few years. As shown in the last row of **Table E.1**, for the case study homes and businesses in Homer, costs could be recovered in a time period of just one to five years, depending on the house.

[180] Fairbanks Natural Gas, LLC., FNG Announces LNG Storage, Website (http://www.fngas.com/) accessed September 12, 2013.

[181] Therriault, Gene and Mark Davis, September 4, 2013, Interior Energy Project: Brining North Slope Natural Gas to Alaskans, Website (http://www.alaskaalliance.com/servlet/content/presentations.html) accessed October 1, 2013.

Table E.1 Conversion Cost Repayment Schedule for Homes in Homer

	Home 1	Home 2	Home 3	Home 4	Home 5	Home 6	Home 7	House 8	Retail Shop	Office building
Existing System	Oil Boiler	Oil Boiler	Oil Space Heater	Oil Furnace	Propane Boiler	Oil Space Heater	Propane Boiler and Space Heater	Oil Furnace	Propane Space Heater	Oil Boiler
Type of Conversion	Replace burner	Replace boiler w/high-efficiency unit	Replace space heater	Furnace replaced w/high-efficiency unit	Convert existing propane system	Replace space heater	Convert boiler & space heater	Replace with high-efficiency furnace	Convert Existing Space Heater	Replace burner
Total Capital Costs (A)	$3,464	$14,147	$2,615	$6,326	$2,351	$4,158	$4,531	$6,099	$2,435	3726
Current annual heating cost (oil) (B)	$3,437	$4,388	$1,491	$2,544	$3,481	$2,010	$4,900	$2,983	$2,036	$6,039
Anticipated annual heating costs (natural gas) (C)	$1,173	$1,497	$509	$781	$746	$687	$1,674	$917	$388	$2,522
Annual fuel cost savings (D = B - C)	$2,264	$2,891	$982	$1,763	$2,735	$1,323	$3,226	$2,066	$1,648	$3,517
Average monthly fuel cost savings (E = D / 12)	$189	$241	$82	$147	$228	$110	$269	$172	$137	$293
Monthly conversion cost payments (assuming 10 year terms and 8% interest) F	$42	$172	$32	$77	$29	$50	$55	$74	$30	$45
Average monthly bill savings (G = E - F)	$147	$69	$50	$70	$199	$60	$214	$98	$108	$248
Simple payback calculation (A / D)	1.5	4.9	2.7	3.6	0.9	3.1	1.4	3.0	1.5	1.1

Source: Smith, Bill, October 15, 2012, Homer Case Studies, Website (http://www.cityofhomer-ak.gov/sites/default/files/fileattachments/case_studies_conversion_comparisons_updated_10-15.pdf) accessed September 12, 2013.

Source: Adapted from Smith, Bill, Homer Case Studies, Website (http://www.cityofhomer-ak.gov/sites/default/files/fileattachments/case_studies_conversion_comparisons_updated_10-15.pdf) accessed September 12, 2013.

Derived from data on annual heating costs and conversion capital costs estimated by Katie Koester, 2012, Homer Community and Economic Development Coordinator.

*Includes natural gas system in the house and service line and meter costs. The $3,285 assessment for the property has been excluded from the conversion cost.

E.3.3 FNSB Conversion Economics

A case study of FNSB homes has not been completed so it is not known if the economics of conversion in FNSB will be as favorable as in Homer. However, existing data do indicate that fuel costs would decline for FNSB residents converting from oil to natural gas heating systems, so access to natural gas could benefit the 79 percent of homeowners in Fairbanks who are currently using oil as their primary heating fuel.[182]

The cost of natural gas from the IEP for the FNSB is anticipated to range between $14.59 and $17.09 per Mcf[183], which is roughly half the current cost of fuel oil.[184] The data in **Table E-1** indicate that natural gas fuel costs in Homer are approximately one-third the cost of fuel oil, so the fuel cost savings from conversion are higher in Homer. However, Fairbanks has a colder climate than Homer, so total fuel use is likely much greater in Fairbanks. The net effect of these two factors on total fuel savings (reduced per unit savings, but more units consumed) is not known, nor is the comparability of fuel system conversion costs known. Thus, at this time we do not know if the payback period in Fairbanks would be comparable to that expected in Homer. The economics of natural gas conversion specific to Fairbanks will be studied in later phases of the IEP feasibility analysis. Regardless of payback period length, we expect that fuel savings in the long-run will outweigh initial capital cost of system conversion.

E.4 Barriers to Program Participation

While in the long-term it is financially beneficial for homeowners with oil heating systems to convert to natural gas, the relatively high capital cost of conversion can be a barrier to homeowners' ability to convert their systems. Median household income in FNSB is approximately $69,000, with 35 percent of households having incomes lower than $50,000. For these lower income households in particular, the high capital costs of conversion may pose a significant challenge to conversion. This is supported by recent research that found 46 percent of households who enrolled in the AHFC Home Energy Rebate Program, but have not completed the recommended updates, cite cost as the primary reason for not completing the program.[185]

In a related matter, if a homeowner expects to move in the near future, he or she may not be in the home long enough to personally recover the costs of conversion. This may be a particularly pertinent hurdle in Fairbanks. According to Census Bureau surveys, 34 percent of the population 18 and older are not in the same home as they were the previous year.

Finally, the inconvenience and time required to secure assistance can also be an impediment for many homeowners who may be deterred by what they perceive to be a complicated paperwork process to achieve conversion to natural gas as a fuel source.

This paper provides further analysis to suggest methods that will be useful in overcoming these three potential barriers to switching to natural gas as a primary source of fuel for space heating.

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[182] U.S. Census Bureau, 2007-2011, House Heating Fuel, American Community Survey 5-Year Estimates, Website (https://www.census.gov), accessed October 15, 2013.

[183] Therriault, Gene and Mark Davis, September 4, 2013, Interior Energy Project: Brining North Slope Natural Gas to Alaskans, Website (http://www.alaskaalliance.com/servlet/content/presentations.html) accessed October 1, 2013.

[184] Calculation assumes heating oil cost of $4 per gallon and that oil generates 134,000 Btu per gallon, while natural gas generates 1,000 Btu per cubic foot.

[185] Dodge, Dr. Kathryn, Wiltse, Nathan, and Virginia Valentine, Revised June 26, 2012, Home Energy Rebate Program Outcomes, Prepared by Cold Climate Housing Research Center for Alaska Housing Finance Corporation, Website (http://www.cchrc.org/docs/reports/HERP_final.pdf) accessed September 19, 2013.

E.5 Types of Incentive Programs

The three common types of incentive programs are:

1. Loans (subsidized and unsubsidized)
2. Direct payments to consumers, and
3. Tax incentives.

E.6 Loans

In addition to subsidized loan programs, there are private loan programs that are available to finance such as financing through lenders or heating system retailers.

E.6.1 Private Loans

Many banks offer loans to assist homeowners with the upfront costs of home improvement projects such as installing an energy efficiency improvement. In some instances banks work with retailers to offer special financing for purchases in the retail store. Private lenders provide consumers with a variety of financing options for home improvements, including unsecured loans, traditional mortgages, and secondary mortgages. Lending terms for private loans are based on market interest rates that are generally less favorable than subsidized loans.[186]

On-bill financing programs serve as a mechanism to collect payments for loans. Under an on-bill loan program, the utility, energy supplier, third-party financer, or a product vendor pays the upfront energy efficiency / fuel conversion equipment costs and the homeowner repays the costs of these upgrades through their monthly utility bill. There are two primary ways to administer on-bill financing: as a loan tied to the home's occupant or as a tariff that links the charge to the meter. These separate approaches have implications on the transferability of the loan. If the loan is tied to the customer then the loan will have to be repaid once the home is sold. If the loan is tied to the meter, the loan is transferred to the next owner. A recent review of on-bill financing programs found that the default rate is typically less than 2 percent.[187]

E.6.2 Subsidized Loans

Loans can be used by customers to finance the upfront cost of purchasing energy efficiency improvements. Numerous financing options are available for energy efficiency improvements through government or utility supported programs. There are two common types of subsidized loans:

1. Low interest loans,
2. Property-assessed clean energy loans, and

Low interest loans provide customers access to financing with lower than market rate interest which translates to lower monthly loan payments. Governments and utilities offer energy efficiency financing by employing a number of mechanisms to subsidize loans. These mechanisms include loan loss reserves, loan guarantees, interest rate buy downs, and by direct lending.[188] Loan loss reserves protect lenders from late payments and defaults, loan guarantees back the loan in the event of a default, interest rate buy

[186] Largely, subsidized loans offer better terms than are available through commercial banks. However, special financing terms for some banks provide zero percent interest over a 12-month period. See Section 3.4 for more detail on the AlaskaUSA Extra Credit Loan.

[187] Bell, Catherine J., Nadel, Steven, and Sara Hayes, December 2011, On-Bill Financing for Energy Efficiency Improvements: A Review of Current Program Challenges, Opportunities, and Best Practices, Website (http://www.puc.state.pa.us/Electric/pdf/Act129/OBF-ACEEE_OBF_EE_Improvements.pdf) accessed September 20, 2013.

[188] Palmer, Karen, Walls, Margaret and Todd Gerarden, April 2012, Borrowing to Save Energy: An Assessment of Energy-Efficiency Financing Programs, Website (http://www.rff.org/RFF/Documents/RFF-Rpt-Palmeretal%20EEFinancing.pdf) accessed September 20, 2013.

down programs employ a method of paying points on a loan to lower the rates charged to consumers, and direct lending involves providing funds directly to those consumers.

Property-assessed clean energy (PACE) programs link the value of energy efficiency equipment to the value of the home. Local governments provide low interest loans to property owners to help pay for the initial equipment costs. Repayment of the loan occurs through a property tax assessment for up to 20 years.[189] The programs are designed so that if the property owner moves prior to completion of loan repayment, the remaining balance is transferred to the person moving into the home.[190] However, residential PACE programs have been on hold since the Federal Housing Finance Agency (FHFA) directed Fannie Mae and Freddie Mac to take several actions with regard to PACE financing, which has effectively stalled any residential PACE loan programs from lending since July 2010.[191] For this purpose PACE loans are excluded from further analysis.

E.6.3 Direct Payments

There are two types of direct payment energy efficiency/fuel conversion programs: rebates and early retirement programs. Rebates are a financial incentive used to pay a portion of an energy efficiency improvement. Rebates are commonly used by utilities and other agencies to offset the costs for these improvements. For example, of the 1,390 financial incentive programs highlighted in the Database of State Incentives for Renewables and Efficiency (DSIRE) database, 76 percent are rebate programs.[192] Early retirement programs differ from rebate programs by paying for the entire cost of a new, replacement appliance rather than just a portion of these costs.

E.6.4 Tax Incentives

Tax incentive programs lower income taxes, sales taxes and property taxes paid by the consumer by providing a tax credit or a tax deduction. Due to low taxes within the FNSB, there are limited opportunities to provide incentives through tax abatement programs. The State of Alaska does not have a state income tax. Further, the City of Fairbanks and the Fairbanks North Star Borough do not collect sales tax, but do impose a property tax levy. The City of North Pole has a 4 percent sales tax and also has a 3.0 levy on property.[193] With the exception of a possible sales tax incentive in North Pole, the only type of tax incentive that could be implemented and used by area residents is a property tax incentive.

E.7 FNSB Incentives and Financial Assistance

This section provides information on programs and financial assistance for home heating conversion currently available to FNSB residents. Each program description includes information on eligibility, program goals, participation level, funding source, implications on conversion rates, and if the program supports fuel switching.

There are a number of energy efficiency incentive programs available to FNSB residents; however none of them are designed to incentivize fuel switching. These programs however, provide insights into the

[189] PaceNow, What is Pace, Website (http://pacenow.org/about-pace/what-is-pace/) accessed September 20, 2013.

[190] De la Rue du Can, Stephane, Shah Nihar, and Amol Phadke, Country Review of Energy-Efficiency Financial Incentives in the Residential Sector, Website (http://eetd.lbl.gov/sites/all/files/lbnl-5033e.pdf) accessed September 9, 2013.

[191] Palmer, Karen, Walls, Margaret and Todd Gerarden, April 2012, Borrowing to Save Energy: An Assessment of Energy-Efficiency Financing Programs, Website (http://www.rff.org/RFF/Documents/RFF-Rpt-Palmeretal%20EEFinancing.pdf) accessed September 20, 2013.

[192] De la Rue du Can, Stephane, Shah Nihar, and Amol Phadke, Country Review of Energy-Efficiency Financial Incentives in the Residential Sector, Website (http://eetd.lbl.gov/sites/all/files/lbnl-5033e.pdf) accessed September 9, 2013.

[193] City of North Pole, Website (http://www.northpolealaska.com/?page_id=84) accessed September 18, 2013.

design of existing programs as well as potential overlap and/or ability to coordinate program administration.

Many of the home energy efficiency incentive programs available within the FNSB are administered through the Alaska Housing Finance Corporation (AHFC). AHFC is a self-supporting public corporation that provides financing for multi-family complexes, single family homes, and other facilities throughout the state. AHFC energy programs include energy rebates, weatherization loans and grants, assistance with applying for federal tax credits, and heating assistance programs.[194] Another energy efficiency incentive program is available to FNSB residents through the Wood Stove Changeout Program administered by the Borough. Although not an incentive program, other financial assistance to FNSB residents for home improvements is available through private lenders and through retailers that establish agreements with lending institutions.

E.7.1 Loans

In addition to private loans from commercial lending institutions, there are three loan programs currently available to FNSB residents through AHFC that can help with the upfront costs of energy efficiency improvements. These include the AHFC Second Mortgage for Energy Conservation Program, the AHFC Energy Efficiency Revolving Loan Program, and the AHFC Energy Efficiency Interest Rate Reduction. Each of these loan programs may cover fuel switching if the audit recommends fuel switching as an energy improvement. However, none of these loan programs specifically support fuel switching.

AHFC Second Mortgage for Energy Conservation Program

The AHFC Second Mortgage for Energy Conservation Program was established in 2008 and since that time a total of 175 loans have been issued through the program.[195] Under this program AHFC lends money at their cost of funds plus 0.375 percent. Under this program AHFC is able to offer favorable interest rates to borrowers due to their credit rating and low operating expenses.[196] While being a valuable tool to assist homeowners with energy efficiency improvements, the program requires a considerable time commitment from the homeowner to file the necessary paperwork.[197] [198] Despite this, AHFC has recently eliminated several credit overlays for the program, which is anticipated to streamline the loan process.

[194] AHFC, Reducing Energy costs for Alaskans, Website (http://www.ahfc.us/efficiency/) accessed September 8, 2013.

[195] Waterman, Scott, AHFC Energy Programs Manager, Personal communication with Lee Elder, Cardno ENTRIX, September 17, 2013.

[196] Havelock, Eric, AHFC Acting Mortgage Director, Personal communication with Lee Elder, Cardno ENTRIX, October 28, 2013.

[197] Waterman, Scott, AHFC Energy Programs Manager, Personal communication with Lee Elder, Cardno ENTRIX, September 17, 2013.

[198] Buller, Mike, Deputy Executive Director AHFC, Personal communication with Lee Elder, Cardno ENTRIX, Shana Zuspan, Agnew::Beck, and Nick Szymoniak AIDEA, September 18, 2013.

Table E.2 AHFC Second Mortgage for Energy Conservation Program

Program Name	AHFC Second Mortgage for Energy Conservation Program
Program Area	State of Alaska
Program Goal	To provide financing for home energy improvements
Incentive for Fuel Switching?	Not specifically. Borrowers select from a list of energy upgrades from an audit of their homes. This program can be used to finance home improvements, which could include the purchase of a new heating system that uses a different fuel.
Program Type	State Loan Program
Funding	Funded through normal AHFC operations
Eligibility	> Owner-occupied properties are limited to single family (includes condos), duplex, triplex, and four-plex. Project must improve the energy efficiency of the structure. > Energy upgrades are eligible if included on a home energy audit performed by an AkWarm-certified Energy Rater. > All improvements must be completed within 365 days of loan closing (improvements not listed may not be included in the loan).
Program Features	15 year maximum term, monthly payment minimum is $100. Interest rate is 15 year Taxable Program or Rural Program, plus 0.375%
Program Outcomes	Since the program's inception in 2008, approximately 175 AHFC Second Mortgages have been issued for energy conservation projects

Sources: AHFC, Second Mortgage Program for Energy Conservation PDF, Website (http://www.ahfc.us/files/2213/5538/2684/energy2nd.pdf) accessed September 4, 2013.

AHFC, Second Mortgage Programs, Website (http://www.ahfc.us/buy/loan-programs/second-mortgage-programs/) accessed September 4, 2013.

AHFC, Second Mortgage Program for Energy Conservation PDF, Website (http://www.ahfc.us/files/2213/5538/2684/energy2nd.pdf) accessed September 4, 2013.Sims, Debbie, AHFC Underwriter, Personal communication with Scott Waterman, AHFC and Lee Elder, Cardno ENTRIX, September 16, 2013.

University of Alaska Fairbanks, Summer 2008, Alaska Building Science News, The Energy Conservation Special Edition, Vol. 13, Issue 4, Website (http://www.uaf.edu/files/ces/newsletters/ABSN/47_2008%20Summer.pdf) accessed September 21, 2013.

Ord, Jimmy, AHFC, Personal communication with Elizabeth Harrison, Cardno ENTRIX, September 30, 2013.

AHFC Energy Efficiency Revolving Loan Program

Senate Bill 220 authorized AHFC to issue bonds for up to $250 million to invest in energy efficiency improvements in public buildings in Alaska.[199] To participate in the resulting AHFC Energy Efficiency Revolving Loan Program, a public entity is required to obtain an energy audit of the facility in which the auditor would guarantee energy savings. AHFC then issues a loan to the public entity to pay for the audit and the energy efficiency improvements. Once improvements are made, the public entity then makes payments to AHFC with the savings resulting from the energy efficiency improvements.[200] Since the program's inception in 2010, only two public entities, the City of Kenai and the City of Seward, have submitted applications for the loan.

[199] Brehmer, Elwood, August 12, 2013, $250M Energy Program Still Untapped Three Years Later, Alaska Journal of Commerce, Website (http://www.alaskajournal.com/Alaska-Journal-of-Commerce/September-Issue-3-2013/250M-energy-program-still-untapped-three-years-later/) accessed September 21, 2013.

[200] Gutierrez, Alexandra, September 9, 2013, Schools Struggle with Heating Bills, But No Takers for Loan Program, Website (http://www.alaskapublic.org/2013/09/09/schools-struggle-with-heating-bills-but-no-takers-for-loan-program/) accessed September 21, 2013.

Table E.3 AHFC Energy Efficiency Revolving Loan Program

Program Name	AHFC Energy Efficiency Revolving Loan Program
Program Area	State of Alaska
Program Goal	This program is intended to finance energy efficiency improvements in public buildings such as school districts, universities, and municipal buildings.
Incentive for Fuel Switching?	Not specifically, but could if efficiency upgrade recommendations include heating system conversion.
Program Type	State Loan Program
Funding	Funded through normal AHFC operations. Granted $250 million in bonding authority in 2010. Cannot lend more than $250 million.
Eligibility	Eligible borrowers are: > Regional education attendance areas; > The University of Alaska; > The State of Alaska; and > Municipalities in the state. > Borrowers obtain an Investment Grade Audit as the basis for making cost-effective energy improvements, selecting from the list of energy efficiency measures identified. > All of the improvements must be completed within 365 days of loan closing.
Program Features	> 15 year term max or up to 12 month max draw period with 14 year max term, no max loan limit > Program rate is based on the available interest rate at the time of application > "At the end of the disbursement period, or no longer than 12 months from the date of loan closing, loan payments will then be amortized over the remaining term based on the terms of the Promissory Note and Financing Agreement."
Program Outcomes	Loan applications received from the City of Kenai and the City of Seward. No loans have been issued from this program.

Sources: AHFC, Energy Efficiency Revolving Loan Fund (AEERLP), Website (http://www.ahfc.us/efficiency/energy-programs/energy-efficiency-revolving-loan-fund-aeerlp/) accessed September 4, 2013.

AHFC, 2012 Annual Report, Website (http://www.ahfc.us/files/9213/5976/0436/12-AHFC-1199-Annual_report-final_files.pdf), page 20, accessed September 4, 2013.

AHFC, Alaska Energy Efficiency Revolving Loan Fund Program, Website (http://www.ahfc.us/files/8713/5483/8974/aeerlp_guides_101612.pdf) accessed September 4, 2013.

AHFC, Energy Efficiency Revolving Loan Fund (AEERLP), Website (http://www.ahfc.us/efficiency/energy-programs/energy-efficiency-revolving-loan-fund-aeerlp/) accessed September 4, 2013.

AHFC, Alaska Energy Efficiency Revolving Loan Fund Program, Website (http://www.ahfc.us/files/8713/5483/8974/aeerlp_guides_101612.pdf) accessed September 4, 2013

AHFC, AHFC Energy Programs Update, Website (http://www.jedc.org/sites/default/files/AHFC%20Energy%20Programs%20Update.pdf) accessed September 21, 2013.

Ord, Jimmy, AHFC, Personal communication with Elizabeth Harrison, Cardno ENTRIX, September 30, 2013.

AHFC Energy Efficiency Interest Rate Reduction

This program promotes energy efficiency through reduced rate loans to homebuyers or owners of qualifying properties. The lender is required to notify AHFC at the time the application is submitted that the borrower intends to participate in the Energy Efficiency Interest Rate Reduction. The borrower has

365 days within the closing of the loan to complete the improvements, obtain the final energy rates and submit the document to the loan servicer.[201]

Table E.4 AHFC Energy Efficiency Interest Rate Reduction

Program Name	AHFC Energy Efficiency Interest Rate Reduction
Program Area	Alaska Statewide
Program Type	State Subsidized Loan Program
Program Goal	The primary program goal is to promote the energy efficiency of existing and newly constructed homes. AHFC offers interest rate reductions to homebuyers for properties meeting certain criteria.
Incentive for Fuel Switching?	No, not specifically. This program is designed to promote energy efficiency not heating system conversion, but owners could receive a lower interest rate loan for energy efficiency improvements if energy ratings improve due to system conversion. The AHFC modifies the interest rate based on the number of points and steps of improvement. Fuel source conversions are not explicitly included or excluded.
Funding	Funded through normal AHFC operations
Eligibility	All properties that can be energy rated and are otherwise eligible for AHFC financing may qualify for this program through an approved lender.
Program Features	Interest rate reductions are offered when borrowers are (1) financing new or existing energy efficient homes or (2) purchasing and making energy improvements to an existing home. Interest rate reductions apply to the first $200,000 of the loan amount. A loan amount exceeding $200,000 receives a blended interest rate rounded up to the next 0.125 percent The percentage rate reduction depends upon whether the property has access to natural gas
Program Outcomes	No further information

Sources: AHFC, Energy Efficiency Interest Rate Reduction, Website (http://www.ahfc.us/efficiency/energy-programs/energy-efficiency-rate-reduction/) accessed September 4, 2013.

E.7.2 Direct Payments

There are three direct payment programs currently available to FNSB residents that can help to defray cost of energy efficiency improvements: the AHFC energy rebate program, the AHFC weatherization program, and the Fairbanks air quality improvement program (AQIP). None of these programs are specifically geared toward fuel switching. AQIP is focused on air quality improvements by encouraging the purchase or repair of inefficient wood burning systems, while both AHFC programs may be used for fuel conversion if such conversion results in energy efficiency improvements.

AHFC Home Energy Rebate Program

The AHFC Home Energy Rebate Program pays a rebate of up to $325 for an initial home energy rating audit. Further rebates for energy efficiency improvements are dependent on the amount of energy efficiency gained and the cost of the elected improvements. Homeowners select eligible energy improvements recommended from options suggested in the as-is audit. Rebates up to $10,000 are available for existing and new homes. Following installation of the energy improvement a post-audit is necessary. There are no income limitations to participation in the program, in contrast to the AHFC Weatherization Program.

[201] AHFC, Energy Efficiency Rate Reduction, Website (http://www.ahfc.us/efficiency/energy-programs/energy-efficiency-rate-reduction/) accessed September 4, 2013.

Currently, 4,604 homeowners in FNSB have completed an as-is energy audit, while 2,527 have completed a post-audit and have received a rebate.[202] AHFC Home Energy Rebate Program rules prevent homes from receiving a rebate more than once. As upgrades using the AHFC Energy Rebate have been completed on 2,537 housing units out of the total 42,740 housing units (6 percent of homes) in the FNSB, approximately 94 percent of homeowners remain eligible to participate in the AHFC Energy Rebate Program.[203]

Table E.5 AHFC Energy Rebate Program

Program Name	AHFC Energy Rebate Program
Program Area	Alaska Statewide
Program Type	State Rebate Program
Program Goal	The program goal is to incentivize homeowners to make energy rating improvements to their dwelling units. It is aimed at higher income home owners who are not eligible to participate in the Weatherization Assistance Program, due to income eligibility requirements.
Incentive for Fuel Switching?	Not specifically. Fuel switching is only supported through the program if it is recommended as an efficiency improvement.
Funding	Program is paid for by Alaska Legislature through the Home Energy Rating Rebate Grant (15 AAC 155.300 – 15 AAC 155.350). The program is dependent on legislative funding. Between 2008 – 2014: $237 million in appropriations
Eligibility	Homeowners who construct a new, energy efficient dwelling unit or improve energy efficiency of an existing unit. Home ownership verification and year-round occupancy of unit required.
Program Features	> AHFC reimburses up to $325 for an eligible as-Is energy rating and up to $175 for an eligible post-improvement rating > Improvement Rebate amounts: o New dwellings (New Home Rebate Program, part of the Home Energy Rebate Program): ▪ A 5 Star Plus dwelling may be eligible for a $7,000 rebate; and ▪ A 6 Star dwelling may be eligible for a $10,000 rebate o Existing dwelling: ▪ $10,000 for a five-step improvement; ▪ $8,500 for a four-step improvement; ▪ $7,000 for a three-step improvement; ▪ $5,500 for a two-step improvement; and ▪ $4,000 for a one-step improvement.
Program Outcomes	> Total as-is energy ratings paid as of FY 2012: 30,168 > Total rebates paid as of FY 2012: 16,701 > Total dollars received from Legislature as of FY 2012: $217.5 million > Average rebate: $6,382 > Program has lowered energy costs by 30% annually for participating homeowners

[202] Ord, Jimmy, Personal communication with Lee Elder, Cardno ENTRIX, September 18, 2013.

[203] U.S. Census Bureau, American Community Survey, Table DP04, Select Housing Characteristics, 2007-2011 American Community Survey 5-Year Estimates, Website (http://factfinder2.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t)

Sources: AHFC, 2012 Annual Report, Website (http://www.ahfc.us/files/9213/5976/0436/12-AHFC-1199-Annual_report-final_files.pdf), page 21, accessed September 4, 2013.

AHFC, Ch 155, Article 3, Website (http://www.ahfc.us/efficiency/learn-and-diy/research-information-center/ric-links-interest/regulations/ch-155-article-21/) accessed September 4, 2013.

AHFC, July 11, 2013, Home Energy Rebate Program Guidelines, Section 2004/09, Website (http://www.ahfc.us/files/1913/7401/5545/HER_program_guidelines.pdf) accessed September 4, 2013.

AHFC, July 11, 2013, New Home Rebate for Newly Constructed Homes Program Guidelines, Website (http://www.ahfc.us/files/2813/7367/3759/New_Home_Construction_Rebate_guidelines.pdf) accessed September 4, 2013.

Ord, Jimmy, AHFC, Personal communication with Elizabeth Harrison, Cardno ENTRIX, September 30, 2013.

AHFC Weatherization Program

The Alaska Weatherization Program has been in existence for approximately 30 years. It provides weatherization services and improves home energy efficiency at no cost to lower-income Alaska renters and homeowners.

Applicants are not eligible for the Weatherization Program if they earn more than 100 percent of the median area income for household size.[204] This program is generally used to improve the efficiency of homes through less expensive upgrades, such as air sealing and insulation rather than for furnaces or boilers.[205]

Table E.6 AHFC Weatherization Program

Program Name	AHFC Weatherization Program
Program Area	Alaska Statewide
Program Type	State Weatherization Program
Program Goal	The program goal is to provide weatherization services and improve energy efficiency of Alaska homes used by lower-income renters and homeowners
Incentive for Fuel Switching?	No, not specifically. In very limited cases, the weatherization service provider may change the dwelling's heating system fuel type (e.g. from wood heat to another fuel system).
Funding	U.S. Department of Energy ($1.5 million annually) and a legislative appropriation from the State of Alaska ($322 million from 2008 – 2014)
Eligibility	Alaska homeowners and renters who meet the specified income guidelines
Program Features	No charge for assistance—the weatherization provider will provide program services at no cost to qualified applicants
Program Outcomes	Average home energy efficiency savings of 28% for single-family homes and 18.5% for multi-family units. (As of March 5, 2012.) 10,500 households/homes have been weatherized (2008 to 2013) Total rebates paid as of FY 2012: 16,701

Sources: AHFC, August 6, 2012, Weatherization Assistance Program Outcomes, (http://www.ahfc.us/files/6313/5769/3840/wx_assistance_prog_outcomes.pdf) accessed September 4, 2013.

AHFC, April 1, 2013, Weatherization Operations Manual 2013, (http://www.ahfc.us/files/3513/6492/8425/wom2013.pdf), page 1-37, accessed September 4, 2013.

AHFC, 2012 Annual Report, (http://www.ahfc.us/files/9213/5976/0436/12-AHFC-1199-Annual_report-final_files.pdf), page 18, accessed September 4, 2013.

AHFC, FY 2013 100% Income Limits for Alaska, Website (http://www.ahfc.us/files/7613/6218/5306/FY2013_HUD_Income_Limits.2.14.13.pdf) accessed September 4, 2013.

[204] AHFC, FY 2013 Income Limits for Alaska, Website (http://www.ahfc.us/files/7613/6218/5306/FY2013_HUD_Income_Limits.2.14.13.pdf) accessed September 21, 2013.

[205] Anderson, John, AHFC, Personal communication with Lee Elder, Cardno ENTRIX, Shanna Zuspan, Agnew::Beck, and Nick Szymoniak, AIDEA, September 18, 2013.

AHFC, News Release, AHFC Weatherization Program Reaches Milestone: 10,500 Families Served, Website (http://www.ahfc.us/files/6913/6673/9855/AHFC_Weatherization_Release.pdf) accessed September 4, 2013.

Ord, Jimmy, AHFC, Personal communication with Elizabeth Harrison, Cardno ENTRIX, September 30, 2013.

FNSB Air Quality Improvement Program

AQIP began its first phase of the Voluntary Removal, Replacement, and Repair Program in June 2010. This program offers financial incentives to homeowners to reduce air pollution from solid fuel burning devices (SFBD, i.e. wood or coal stoves; wood- or coal-fired furnaces; wood- or coal-fired hydronic heaters; fireplace inserts). AQIP offered reimbursement, both a direct rebate and a tax credit, for removing a SFBD, replacing an unqualified SFBD, or repairing a qualified SFBD. Once all qualifications are met, the applicant submits appropriate documentation to receive a rebate check and any applicable property tax credit. With some modifications, this program continued until fall 2012 whereupon it entered a brief hiatus and was again implemented in January 2013 with modified features. These changes included the removal of the tax credit, expansion to the entire FNSB, and the requirement that the appliance to be repaired or replaced was installed prior to June 10, 2010. [206] [207]

In addition to the current AQIP, an enhanced pilot program accepted applications from May 1, 2013 through August 31, 2013 and provided greater incentives for the priority target areas of North Pole, Dale Road, and the City of Fairbanks. In this pilot program, qualifying applicants replacing specified outdoor hydronic heaters or older wood stoves with qualified cleaner devices are eligible to receive up to $10,000 or $3,500, respectively. If the replacement device used pellets, the property owner could be eligible to receive an additional cash payment of up to $1,000 for the purchase of the pellets. [208] In spite of the increased reimbursement incentives, the enhanced program had limited participation, with a total of 30 wood stoves/hydronic heaters and 8 boilers replaced.[209]

The AQIP also allows sellers of wood stoves to bill the Borough directly rather than the homeowner receiving a rebate at a later date. This change lowered the homeowner's upfront costs. Additionally, the current program is open to the entire borough, not just the air quality non-attainment area.

[206] Citizens Home Heating Initiative (Proposition 3) was passed in fall 2012 and states "The borough shall not, in any way, regulate, prohibit, curtail, nor issue fines or fees associated with, the sale, distribution, or operation of heating appliances or any type of combustible fuel." The passage of this initiative made it necessary to modify the requirements of the change out program.

[207] Buxton, Matt, November 9, 2012, "Assembly Oks reworked wood stove program," NewsMiner, Website (http://www.newsminer.com/article_6da53013-aad7-5aaa-941c-13bb84e890de.html), accessed September 21, 2013.

[208] FNSB, FNSB Enhanced SFBA Change Out Program PDF, (http://www.aqfairbanks.com/wp-content/uploads/EWSCOP-application-packet.pdf), accessed September 22, 2013.

[209] Buxton, Matt, August 26, 2013, "Limited success for Fairbanks borough's wood stove plan," NewsMiner, Website (http://www.newsminer.com/news/local_news/limited-success-for-fairbanks-borough-s-wood-stove-plan/article_1b0d93b0-0ed7-11e3-82b6-001a4bcf6878.html), accessed September 21, 2013.

Table E.7 FNSB Air Quality Improvement Program

Program Name	FNSB Air Quality Improvement Program
Program Area	Fairbanks North Star Borough
Program Goal	To improve the air quality of FNSB through retirement, repair removal of SFBD ((e.g. wood stoves, coal stoves, etc).
Incentive for Fuel Switching?	No, this program repairs or replaces SFBDs. Replacements must be EPA certified and either another solid fuel burning device or a hydronic heater. The program also incentives removal of a hydronic heater without replacement.
Program Type	> Phase I: Direct Subsidy – Rebate; Municipal Tax Credit Incentive > Phase II: Direct Subsidy - Rebate > Enhanced Pilot Program: Direct Subsidy - Rebate
Funding	**Phase I** $4 million. **Phase II** The program is funded through two state grants. The borough has about $1.2 million remaining from the initial funding grant and an additional $2.5 million general air quality grant. **Enhanced Program** $650,000 state grant
Eligibility	> Requirements common to all Phases and Enhanced Program > The program is limited to the legal homeowner of the residence > Property taxes must be up-to-date > Applicant must be willing to comply with the destruction requirement of the device as outlined in the ordinance > **Phase I** > Only those living within the boundaries of the non-attainment area are eligible for the program > Only solid fuel burning devices, as defined by the FNSB are eligible for the program. As per the Borough's definition, solid fuel burning devices include, but are not limited to: wood stoves, coal stoves, wood or pellet-fired hydronic heaters, wood-fired furnaces, coal-fired hydronic heaters, and coal-fired furnaces. > If the applicant has more than one SFBD, all SFBDs must be removed in order to qualify for the removal program. > **Phase II** > Properties throughout the Borough are eligible, including businesses and rental properties > Only solid fuel burning devices, as defined by the FNSB are eligible for the program. These devices include, but are not limited to: wood and coal stoves, wood- or coal-fired hydronic heaters, wood- or coal-fired furnaces, or fireplace inserts (i.e. a woodstove inserted into an existing fireplace). Non-solid fuel burning appliances are not eligible. Masonry heaters, pellet-burning devices, cook stoves, and fireplaces are excluded from the definition of a SFBD and are not eligible > Appliances for the replacement or repair program must have been installed prior to June 10, 2010 to be eligible > **Enhanced Program** > Only properties within the FNSB nonattainment area are eligible > Only properties located within the defined areas of the North Pole, Dale Road or City of Fairbanks are eligible

	> Only the replacements of solid fuel burning devices, as defined by the FNSB are eligible for the program. These devices include, but are not limited to: wood and coal stoves, wood- or coal-fired hydronic heaters, wood- or coal-fired furnaces, or fireplace inserts (i.e. a woodstove inserted into an existing fireplace). Non-solid fuel burning appliances are not eligible. Masonry heaters, pellet-burning devices, cook stoves, and fireplaces are excluded from the definition of a SFBD and are not eligible
Program Features	**Phase I** > For the removal of hydronic heaters, qualifying applicants are eligible for cash payments of up to $6,000 and municipal tax credits of $1,500 > For the removal of all other solid fuel burning devices, qualifying applicants are eligible for cash payments of up to $1,000 and municipal tax credits up to $1,500 > For the replacement of hydronic heaters, qualifying applicants are eligible for cash payments of up to $1,000 and municipal tax credits up to $1,500. > For the replacement of all other solid fuel burning appliances and any necessary chimney replacement, qualifying applicants are eligible for cash payments of $1,500 for the appliance replacement and $1,000 for a chimney replacement. **Phase II** > The amount reimbursed for replacements depends on the type of device installed: devices that have emissions rating less than or equal to 2.5 grams per hour are eligible for a higher rate of reimbursement than those that have higher emissions ratings. > For purchases of an EPA certified wood stove with emissions less than 2.5 grams per hour, the reimbursement amount is 75% of the total cost, including parts and labor, up to $3,000 or $2,500 (if the new EPA certified device is rated at greater than 2.5 grams per hour). > Hydronic heater replacements are eligible for a flat reimbursement of $3,000 (if the new EPA certified device is rated at less than or equal to 2.5 grams per hour), $2,500 (if the new EPA certified device is rated at greater than 2.5 grams per hour), or $2,000 (if the device is not replaced). No receipts are required for hydronic heater replacements. **Enhanced Program** > Replacements of either a non-EPA Certified SFBA OR an EPA Certified SFBA that has an emissions rate greater than 2.0 grams/hr with a qualified device is eligible for reimbursement up to $3,500 for purchase and installation of the appliance and a $500 cash payment if a pellet stove is purchased. > Replacements of outdoor hydronic heater with a qualified device is eligible for reimbursement up to $10,000 for purchase and installation of the appliance and a $1,000 cash payment if a pellet burning hydronic heater is purchased or $500 if a pellet stove is purchased.

Program Outcomes	The wood stove change-out program has replaced more than a 1,000 old stoves with newer, cleaner-burning devices. **Phase I and Phase II** > Phase I outcomes: > Replaced 707 wood stoves. > Removed an additional 190 wood stoves. > Removed 68 Outdoor Wood Boilers (OHH's > Removed 13 indoor wood boilers. > Phase II outcomes > Replaced 99 wood stoves > Removed 1 indoor wood boiler > Repaired 3 stoves **Enhanced Program** > 15 older wood stoves replaced in the Dale Road area > 10 hydronic heaters replaced in the North Pole area and 5 in the Dale/Fairbanks area > 8 boilers replaced in the North Pole area

Sources: EPA, Burnwise, Fairbanks, Alaska, Air Quality Improvement Program PDF, (http://www.epa.gov/burnwise/workshop2011/Fairbanks-AirQuality-DeHaven.pdf), accessed September 19, 2013.

Fairbanks North Star Borough Air Quality Division, Change Out Program, Website (http://www.aqfairbanks.com/wood-stoves/), accessed September 19, 2013.

Buxton, Matt, August 29, 2013, "EPA official touts teamwork, tech in helping improve Fairbanks air," NewsMiner, Website (http://www.newsminer.com/news/local_news/epa-official-touts-teamwork-tech-in-helping-improve-fairbanks-air/article_eb218388-1079-11e3-a9fc-001a4bcf6878.html), accessed September 19, 2013.

Richardson, Jeff, April 13, 2013, "Enhanced Stove Swap Approved," NewsMiner, Website (http://www.newsminer.com/news/local_news/enhanced-stove-swap-program-approved/article_cbe4805e-a410-11e2-98fc-001a4bcf6878.html), accessed September 21, 2013.

Buxton, Matt, August 26, 2013, "Limited success for Fairbanks borough's wood stove plan," NewsMiner, Website (http://www.newsminer.com/news/local_news/limited-success-for-fairbanks-borough-s-wood-stove-plan/article_1b0d93b0-0ed7-11e3-82b6-001a4bcf6878.html), accessed September 21, 2013.

Buxton, Matt, November 9, 2012, "Assembly Oks reworked wood stove program," NewsMiner, Website (http://www.newsminer.com/article_6da53013-aad7-5aaa-941c-13bb84e890de.html), accessed September 21, 2013.

Buxton, Matt, August 2, 2010, "Fairbanks borough begins its wood stove trade-in program," NewsMiner, Website (http://www.newsminer.com/news/local_news/fairbanks-borough-begins-its-wood-stove-trade-in-program/article_fb4a2898-d819-5cdc-9f68-b8e42cdda1f7.html), accessed September 21, 2013.

FNSB, Alaska, Ordinance No. 2010-28 (http://www.aqfairbanks.com/wp-content/uploads/Final-fairbanks-pm2.5-ordinance-2010-28.pdf)

FNSB, Alaska, Ordinance No. 2011-32 (http://co.fairbanks.ak.us/meetings/Ordinances/2011/2011-32.pdf)

FNSB, Alaska, Ordinance No. 2013-29 (http://co.fairbanks.ak.us/meetings/ordinances/2013/2013-29.pdf)

State of Alaska, Office of Management and Budget, Program Snapshot, Website (http://omb.alaska.gov/ombfiles/12_budget/CapBackup/proj55302.pdf) accessed September 21, 2013.

Thompson, Todd, FNSB Air Quality, Personal communication with Elizabeth Harrison, September 23, 2013.

E.7.3 Tax Incentives

Apart from the limited use of the tax incentive program in Phase I of the AQIP program (and no longer a component of that program), there are no tax abatement programs related to energy efficiency available to Alaska residents.

While not relevant to home heating system conversion or energy efficiency per se, the State of Alaska passed legislation allowing municipalities to exempt residential renewable energy systems from being subject to property tax. These systems include wind, hydro, and solar systems that use an alternative

source of fuel other than fossil or nuclear fuel. As such, this initiative does not include natural gas systems.[210]

Table E.8 Alaska Local Option - Property Tax Exemption for Renewable Energy Systems

Program Name	Alaska Local Option - Property Tax Exemption for Renewable Energy Systems
Program Area	Local municipalities within Alaska
Program Goal	Encourage the use and development of residential renewable energy systems which may reduce consumption of fossil fuels and reduce the emission of carbon dioxide and other pollutants.
Incentive for Fuel Switching?	Program design provides incentives to switch to renewable fuel sources such as wind, hydro, and solar for energy generation.
Program Type	Property Tax Exemption
Funding	Tax base of individual municipalities
Eligibility	> Homeowners with a residential renewable energy system that is used to develop means of energy production using energy sources other than fossil or nuclear fuel, including windmills and water and solar energy devices located in the municipality. > Exclusion or exemption may not exceed assessed value of $50,000 for any one residence, unless municipality adjusts the voter authorized exemption.
Program Features	> Local municipalities ultimately determine whether such energy systems will be tax exempt. > The maximum allowable assessed value and amount of tax exemption varies and is determined by each municipality, not to exceed the state approved amount of $50,000 assessed value.
Program Outcomes	Not Applicable

Sources: DSIRE: Alaska Local Option- Property Tax Exemption for Renewable Energy Systems, Website (http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=AK16F&re=0&ee=0), accessed September 20, 2013.

2012 Alaska Statutes, Sec. 29.45.050: Municipal Government: Optional exemptions and exclusions, Website (http://www.legis.state.ak.us/basis/statutes.asp#29.45.050), accessed September 20, 2013.

E.7.4 Private Loans

AlaskaUSA offers an Extra Credit Loan, which is an unsecured loan provided through a private bank rather than provided through a government entity that can be used to finance heating system purchases. AlaskaUSA and vendors have established agreements to share the risk of providing unsecured financing to customers. For example, VBS Heating in Homer, Alaska is charged four percent of the purchase price for any of their stove sales financed by AlaskaUSA.[211] AlaskaUSA finances the total purchase price for the customer and releases the funds to VBS Heating after the retailer pays four percent of the purchase price.

The Extra Credit Loan is an unsecured loan and monthly minimum payments are required. The Extra Credit Account offers a zero percent loan for up to 12 months for every person unless the applicant has no credit history. Eligibility for an Extra Credit Loan is based upon the applicant's credit score, payment

[210] DSIRE: Alaska Local Option- Property Tax Exemption for Renewable Energy Systems, Website (http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=AK16F&re=0&ee=0), accessed September 20, 2013.

[211] Cavasos, Connie, VBS Heating Homer, Personal communication with Lee Elder, September 16, 2013.

history, income, and other conditions. If borrowers do not pay back the full amount within 12 months, they will be charged 17.9 percent on the outstanding balance.[212]

Table E.9 AlaskaUSA Extra Credit Account

Program Name	AlaskaUSA Extra Credit Account
Program Area	Alaska Statewide
Program Goal	AlaskaUSA's goal is to provide financial services to members, affordably, conveniently, and professionally.
Incentive for Fuel Switching?	No, but the program can be used to finance the purchase of natural gas systems
Program Type	Unsecured Private Loan
Funding	Not Applicable
Eligibility	Only a select number of vendors participate in the AlaskaUSA Extra Credit Account. Within the Fairbanks area there are two heating supply stores that participate: Alaska Best Plumbing and Altrol heating and Cooling. Eligibility is based upon the applicant's credit score, payment history, income, and other factors.
Program Features	> The Extra Credit Account is a revolving credit line provided by local merchants through an arrangement with AlaskaUSA. Other program features include on-the-spot approval for a line of credit, an Extra Credit card for future purchases at the same business, no application fee, no annual fee, no down payment. > Minimum monthly payments are required and late payment fees of up to $5 and a returned payment fee of up to $20. > Program terms of 6 and 12 months available. > Annual Percentage Rate (APR) of 17.9 percent on outstanding balance once the interest free period has lapsed. > No interest charged until the end of the loan's term.
Program Outcomes	Unavailable

Sources: AlaskaUSA, Extra Credit Account Representative, Personal communication with Lee Elder, Cardno ENTRIX, September 9, 2013.

AlaskaUSA, 2013, Extra Credit, Website (https://www.alaskausa.org/loans/extra_credit.asp#terms) accessed September 21, 2013.

Cavasos, Connie, VBS Heating Homer, Personal communication with Lee Elder, September 16, 2013.

E.8 Incentive Comparison

The range of financial incentives for fuel switching vary in a number of key characteristics, each of which influences the ability of the incentive program to reduce barriers to natural gas conversion. These key characteristics include:

1. Ease of program participation, including time required to obtain the financial incentive and the effort required to understand program eligibility and required steps. Programs such as secondary mortgages and tax credits generally require a larger investment of participant time than a rebate program.
2. Timing of financial benefits. For example, a rebate can be received relatively quickly compared to a tax credit, which can take over a year for the participant to receive payment.

[212] AlaskaUSA, Extra Credit Application and Account Agreement, Website (https://www.alaskausa.org/downloads/ExtraCredit.pdf) accessed September 21, 2013.

3. Effect on program participant's ability to pay upfront capital cost requirements. For example, rebate programs typically require program participants to pay the upfront costs for the energy efficiency improvement prior to receiving cash back, while loan programs lower the upfront costs to the program participant.
4. Program eligibility. For example, for loans, is credit score a factor in determining program participation? Also, is income status a criterion for determining eligibility? These kinds of criteria limiting eligibility decrease potential program participation and effect on conversion rates.
5. Program transferability to new owners. Program transferability refers to whether the loan is transferable to the next resident to live in the home if the current homeowner relocates.

Table E-10 summarizes ten energy efficiency/fuel switching programs based on these key characteristics. The remainder of this section describes and compares program attributes in each of the key incentive categories.

Table E.10 Comparison of Incentive Program Features

Program	Customer Time Requirements	Program Complexity from Customer Perspective	Timing of Benefit (start to finish)	Assist with Upfront Costs	Relaxed Lending Requirements	Loan Transferability
On-bill Financing (NYSERDA On-bill Program)	Medium	Low - Medium	-	Yes	Yes	Yes
State Loan Program (AHFC Second Mortgage for Energy Conservation Program)	High	High	30 - 45 days	Yes	Yes	No
Subsidized Unsecured Loan (Michigan Saves Home Energy Loan Program)	Low	Low	Immediate	Yes	No	NA
Audit-Based Rebate Program (AHFC Energy Rebate Program)	Medium	Low - Medium	Weeks to Months	No	NA	NA
Low Income Direct Payment Program (Alaska Weatherization Program)	Medium	Low - Medium	Up to a Year	Yes	No	NA
County Rebate Program (FNSB AQIP Program - Phase II)	Low	Low	Approximately one week	Yes, retailers are able to submit for rebate and charge customer difference	NA	NA
Municipal Rebate Program (Kachemak City Rebate Program)	Low	Low	Less than a day	Yes, upfront cost of service line	NA	NA
Utility Rebate Program (National Grid Incentives for Natural Gas Heating)	Low	Low	6 - 8 weeks	No	NA	NA
Tax Abatement (AQIP Phase I)	Low - Medium	Low - Medium	Up to 2 Years	No	N/A	N/A
County Property Tax Credit Program (Montgomery County-Residential Energy Conservation Property Tax Credit)	Low – Medium	Low - Medium	Up to five years to receive payment	No	NA	NA

E.8.1 Loans

Loan programs can be a significant factor in motivating households to invest in high cost energy efficiency upgrades. For example, 29 percent of participants in the Pacific Gas and Electric CAL/NEVA program and the Northern States Power loan program would not have invested in energy efficiency upgrades without the zero percent loan programs.[213] However, the overall level of participation in state-sponsored and utility-sponsored financing programs is low. A recent survey of 15 energy efficiency loan programs found that subsidized loan programs capture between 0.10 and 24 percent of the total market, with an average participation rate of less than 1 percent.[214]

Key features that distinguish loan programs, and their associated participation rates, are the ease of obtaining a loan, the timing of loan availability, lending requirements that affect eligibility, and the transferability of the loan if the initial loan recipient moves to a new home. Further, from the policy makers perspective, principal and interest accrued on loans are repaid by the borrower, whereas; direct payments are simply a payment intended to lower the costs of goods and/or services.

The required participant time investment and the speed at which program participants can obtain financing under different types of loan programs varies drastically. For example, the Michigan Saves Home Energy Loan Program offers an unsecured loan for up to $20,000 that can be approved within minutes over the phone (see **Table E.11** below).[215] Conversely, the acquisition of a loan from the AHFC Second Mortgage for Energy Conservation Program can take considerably more time. The ease of access to capital is more than likely one of the primary reasons that the Michigan Saves program has issued approximately 3,000 loans since 2009, while the AHFC Second Mortgage for Energy Conservation Program has issued approximately 175 loans since 2008.

Table E.11 Michigan Saves Home Energy Loan Program

Program Name	Michigan Saves Home Energy Loan Program
Program Area	Michigan Statewide
Program Goal	Michigan Saves is a nonprofit dedicated to making energy improvements easier for all Michigan energy consumers
Incentive for Fuel Switching?	Fuel switching is not promoted and is allowed on a case-by-case basis when there exists an argument for improved efficiency
Program Type	State Subsidized Loan
Funding	> Established in 2009 through an $8 million grant from the Michigan Public Service Commission (MPSC) > Additional grants by state of Michigan and by the U.S. Department of Energy > Michigan Saves serves as guarantor for loans providing a loan loss reserve fund. Repeated use of funds is possible due to very low default rate.
Eligibility	Homeowners of owner occupied, single family (1-4 unit) homes with credit score above 640 (680 in some areas) and a debt-to-income ratio less than 50%.

[213] Stern, Paul, 1985, Energy Efficiency in Buildings: Behavior Issues, Website (http://www.nap.edu/catalog.php?record_id=10463) accessed September 13, 2013.

[214] Source: Adapted from Palmer, Karen, Walls, Margaret and Todd Gerarden, April 2012, Borrowing to Save Energy: An Assessment of Energy-Efficiency Financing Programs, Website (http://www.rff.org/RFF/Documents/RFF-Rpt-Palmeretal%20EEFinancing.pdf) accessed September 20, 2013.

[215] Michigan Saves, Home Energy Loan Program, Website (http://michigansaves.org/program/help#primary) accessed September 23, 2013.

Program Features	> Homeowner chooses among 300 Michigan Saves authorized contractors to get an estimate. Homeowner has an energy assessment or picks from a list of qualified energy improvements. > Homeowner completes the loan application. Authorized contractor will assist homeowner and homeowner will get a decision within minutes. > Once the loan is approved, chosen contractor will make the energy improvements. Contractor is paid directly by the lender after the work is done to homeowner's satisfaction. > Participating lenders offer an unsecured loan for amounts between $1,000 and $20,000, at a fixed annual percentage rate (APR) no higher than 7 %, with no prepayment penalty. Loan terms are one year for every $1,000 up to $4,999. For loans $5,000 and higher, 10-year terms are an option.
Program Outcomes	> About 3,000 homeowner projects complete totaling approximately $24 million in loans. > Approximately 75 percent of Michigan Saves homeowner loans are used for furnace change outs, however, fuel switching only permitted if argument made for efficiency improvements and not switching from natural gas to another fuel.

Sources: Michigan Saves, Website (http://michigansaves.org) accessed September 3, 2013.

O'Grady, Todd, Michigan Saves Program Coordinator, Personal communication with Adam Swadley, Cardno ENTRIX, September 5, 2013

Most loan programs reviewed for this paper required typical credit worthiness to qualify, with the exception of on-bill financing programs. In on–bill programs, a loan is provided by the utility or another entity to cover the upfront cost of an energy upgrade, and the loan is then repaid through the participant's utility bill. When on-bill financing is structured to follow the meter, it allows for financing to be extended to rentals and multifamily units, since the energy customer pays for the fuel switch upgrade rather than necessarily the unit owner. Additionally, on-bill financing can be structured to allow for customers with poor credit to have utility payment history taken into account when credit-worthiness is being considered, thereby increasing eligibility. For example, as provided in **Table E.12** below, the NYSERDA Home Performance with Energy Star On-Bill Loan Program has a two-tier lending approach to relax lending criteria for utility customers with poor credit, but with good utility bill payment history.

Table E.12 NYSERDA Home Performance with Energy Star On-bill Loan Program

Program Name	NYSERDA Home Performance with Energy Star On-Bill Loan Program
Program Area	New York Statewide
Program Goal	To increase the number of retrofits by extending financing to low and moderate income households by relaxing credit score requirements.
Incentive for Fuel Switching?	While not specifically designed as a program for switching out heating systems. This program does provide applicants the ability to receive benefits for fuel switching. This is ultimately based upon the savings to investment ratio and relies upon the audit report.
Program Type	On-Bill Financing
Funding	Funding provided through a revolving fund established by rate payer charge and was also Initially supported by funding through the Regional Greenhouse Gas Initiative (RGGI). Currently the program is receiving funding through a NYSERDA bond issue guaranteed by EPA State Revolving Funds (SRF).

Eligibility	To participate in the program applicants must be installing an eligible efficiency upgrade. Some of these upgrades are prequalified, while other upgrades require cost-effectiveness screening. In order to qualify for financing on eligible projects borrowers must meet minimum lending requirements. Under the on-bill financing program, the homeowner must be a customer of one of the following participating utilities: Central Hudson, Con Edison, Long Island Power Authority, National Grid (Upstate), New York State Electric and Gas, Orange and Rockland, or Rochester Gas and Electric.
Program Features	A maximum of $13,000 is available to each household and up to $25,000 if the project meets high cost-effectiveness standards. > Current rate of 3.49 percent > Term of 5, 10, or 15 years (may be limited by useful life of improvement) > Monthly loan payment included in utility bill > Annual loan payment is calculated to not exceed the anticipated saving on energy improvement > When the home is sold the seller has the option to transfer the outstanding portion of the loan to the new owner > Requires an On-Bill Recovery Program Declaration, which is not a lien on the property, but it is recorded in a similar way
Program Outcomes	As of July 2013, 976 On-Bill Loans have closed since April of 2012 when the program began. Of these total 976 loans, 100 Tier 2 loans have closed. Tier 2 loans are originated under alternative (relaxed) lending criteria.

Sources: DSIRE, Home Performance with Energy Star Financing, Website (http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NY88F&re=0&ee=0) accessed September 11, 2013.

Andrew, NYSERDA Call Center, Personal communication with Lee Elder, Cardno ENTRIX, September 5, 2013.

NYSERDA, NY Home Performance with ENERGY STAR Eligible Measures and Accessories, Website (http://www.energyfinancesolutions.com/assets/pdfs/consumer_eligible_measures.pdf) accessed September 5, 2013.

NYSERDA, NYSERDA 2012-2013 Annual Report: Meeting New York's Energy Challenges, Website (http://www.nyserda.ny.gov/Publications/NYSERDA-Annual-Reports-and-Financial-Statements.aspx) accessed September 4, 2013.

EPA, How the CWSRF Program Works, Website (http://water.epa.gov/grants_funding/cwsrf/basics.cfm) accessed September 3, 2013.

NYSERDA, August 13, 2013, NYSERDA Announces Residential Energy Efficiency Financing Bonds through Green Jobs-Green New York, Website (https://www.nyserda.ny.gov/About/Newsroom/2013-Announcements/2013-08-13-Residential-Energy-Efficiency-Financing-Bonds-through-GJGNY.aspx) accessed September 3, 2013.

Similarly, while traditional loans require the original loan recipient to fully repay the loan, on-bill loan financing enables the loan to remain with the household resident. The loan, in essence, is repaid by the current resident benefiting (in the form of reduced utility bills) from the energy efficiency upgrade. The NYSERDA on-bill loan program is structured in this manner. The transferability of on-bill loans is particularly important in areas where there are many short-term residents, who may not be a resident long enough to recoup investment costs in energy efficiency upgrades.

Although on-bill financing loan programs can increase participation through increasing eligibility, participant ease, and loan transferability, there are drawbacks for program administrators. On-bill financing may require utilities to modify their billing systems and may increase the risk of non-payment.[216]

E.8.2 Direct Payments

Direct payment rebate programs are the most common form of financial incentive for energy efficiency improvements. Rebates encourage the purchase of an energy efficient appliance, or an appliance that has other benefits such as reduced air emissions. Rebates are commonly used by utilities to encourage

[216] Bell, Catherine J., Nadel, Steven, and Sara Hayes, December 2011, On-bill Financing for Energy Efficiency Improvements: A Review of Current Program Challenges, Opportunities, and Best Practices, Website (http://www.puc.state.pa.us/Electric/pdf/Act129/OBF-ACEEE_OBF_EE_Improvements.pdf) accessed September 20, 2013.

the purchase of appliances necessary for fuel switching and thereby increase the number of customers a utility serves. Rebates differ widely in several of the key program characteristics outlined above; particularly their effect on upfront cost and participant time requirements.

The timing of rebate receipt determines the degree to which the rebate improves the participant's cash flow and their ability to pay capital costs. Rebates are often structured to reimburse program participants after they have made a capital investment, such as installing a new appliance. However, in some rebate programs, such as the FNSB AQIP Program - Phase II, customers receive a price discount from retailers at the time of purchase. Similarly, the Kachemak City Rebate Program provides a rebate relatively quickly for the purchase of a natural gas service line costs.

Reducing upfront capital costs is particularly beneficial to lower income households. Incentive programs that do not require a large upfront investment by homeowners are more appealing to low income households. In contrast, more affluent households can better take advantage of programs in which there is still a relatively large upfront cost.[217] For example, recent research conducted on the AHFC Energy Rebate Program, which does have a large initial cost, found a strong, direct relationship between income and participation in the program.[218]

Rebate programs also differ in their complexity and time requirements. Unsurprisingly, simpler programs requiring less time investment have greater participation.[219] One study of three U.S. subsidy programs and five foreign rebate programs found that the U.S rebates with a median subsidy of 77 percent had a median participation rate of four percent per year, while the five foreign subsidy programs with a *lower* subsidy (50 percent subsidy) had a *higher* participation rate of eight percent per year.[220] While the foreign subsidy programs had lower subsidies, they were simpler: they only required participants to submit proof of equipment purchase to the government to receive a rebate. Conversely, the three U.S. subsidy programs required homeowners to obtain a free energy audit and the subsidies were only given on those upgrades determined to be justified in the audit (similar to the AHFC Home Energy Rebate Program, in which only approximately 6 percent of FNSB housing units have received a rebate).[221]

Two domestic rebate programs with low time requirements and low complexity are the Kachemak City Rebate Program and the National Grid Incentives for Natural Gas Heating Rebate Program. As provided in **Table E-13** below, the Kachemak program requires very little investment of personal time and offers a rebate of $500 when city resident's sign up for a gas service line connection (total connection fee excluding rebate is approximately $1,290).[222] [223] Since the Kachemak City Rebate program implementation in the spring of 2013, approximately 78 percent of households within the natural gas distribution system service area have signed up for a gas line connection.[224] The National Grid Incentives for Natural Gas Heating Rebate Program (**Table E-14**) provides utility customers a rebate if the customer

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[217] Stern, Paul, 1985, Energy Efficiency in Buildings: Behavior Issues, Website (http://www.nap.edu/catalog.php?record_id=10463) accessed September 13, 2013.

[218] Dodge, Dr. Kathryn, Wiltse, Nathan, and Virginia Valentine, Revised June 26, 2012, Home Energy Rebate Program Outcomes, Prepared by Cold Climate Housing Research Center for Alaska Housing Finance Corporation, Website (http://www.cchrc.org/docs/reports/HERP_final.pdf) accessed September 19, 2013.

[219] Stern, Paul, 1985, Energy Efficiency in Buildings: Behavior Issues, Website (http://www.nap.edu/catalog.php?record_id=10463) accessed September 13, 2013.

[220] Ibid.

[221] Ibid.

[222] Jackinsky, McKibben, January 23, 2013, Kachemak City OKs Contract with ENSTAR, Homer News, Website (http://homernews.com/stories/012313/news_kacheCity.shtml) accessed September 21, 2013.

[223] Smith, Bill, Kenai Peninsula Borough Assembly Member, Personal communication with Lee Elder, September 15, 2013.

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

mails an application and a receipt for the eligible appliance to National Grid. Typically rebates are issued to the customer in six to eight weeks.[225]

Table E.13 Kachemak City Rebate Program

Program Name	Kachemak City Rebate Program
Program Area	Kachemak City, Alaska
Program Type	Municipal Rebate Program
Program Goal	The goal is to encourage city residents to sign up for natural gas service quickly.
Incentive for Fuel Switching?	Yes. Kachemak provided a $500 rebate for each home if they signed up for a connection to the new natural gas distribution system.
Funding	This rebate program is funded from two different sources. Primary program funding is provided through the mainline allowance pay back provided to the City by ENSTAR. A portion of the mainline was not constructed with City funds and a mainline allowance payback from ENSTAR was not available for approximately 60 homes along this portion of the mainline. In the interest of equitable treatment of City residents, Katchemack City supplemented the rebate program with approximately $30,000 to provide rebates to these residents.
Eligibility	Kachemak City residents are eligible for the rebate if they pay ENSTAR for the connection ($1,290 prior to July 1st). Once residents pay this connection fee they must submit proof to the City for the rebate.
Program Features	ENSTAR provides the developer (Kachemak City) a credit based upon the estimated annual load of the home. Rather than using this credit from ENSTAR to pay down debt, such is the case for Homer; Kachemak City has elected to use the freemain allowance to encourage residents to convert to natural gas.
Program Outcomes	A total of 243 homes are located in Kachemak City, of these homes 190 have signed up for a natural gas service line. This represents approximately 78 percent of the total homes in the community. While not completely attributable to the rebate program the Mayor of Kachemak City believes the rebate program had a significant impact on the number of people signing up for natural gas service lines. It should be noted, the purchase of a service line does not necessarily mean homeowners have installed gas appliances or have started using natural gas. As of September 2013, there are approximately 175 meters installed in the community, of which approximately 100 meters are running and providing gas to homes.

Source: Pierce, Charlie, ENSTAR, Southern Division Manager, Personal communication with Lee Elder, September 23, 2013.

Morse, Phil, Mayor of Kachemak City, Personal communication with Lee Elder, September 16, 2013.

Jackinsky, McKibben, January 23, 2013, Kachemak City OKs Contract with ENSTAR, Homer News, Website (http://homernews.com/stories/012313/news_kacheCity.shtml) accessed September 21, 2013.

Morse, Phil, Mayor of Kachemak City, Personal communication with Lee Elder, October 21, 2013.

[225] National Grid, FAQ, Website (https://smartenergy-zone.com/nationalgrid/FAQs.aspx) accessed September 24, 2013.

Table E.14 National Grid Incentives for Natural Gas Heating

Program Name	National Grid Incentives for Natural Gas Heating
Program Area	National Grid gas heating residential customers that install qualifying equipment in a Rhode Island home within a specified time frame
Program Type	Utility Rebate Program
Program Goal	Unknown
Incentive for Fuel Switching?	Yes. The National Grid incentive program helps to offset a portion of the cost of purchasing high-efficiency natural gas appliances.
Funding	No further information
Eligibility	Qualifying equipment are : > A high-efficiency natural gas heating boilers with an Annual Fuel Utilization Efficiency (AFUE) rating of 90% (or greater). > A high-efficiency natural gas heating (warm air) furnace with an AFUE rating of 95% (or greater) and an electronic commutated motor.
Program Features	Customers purchasing the qualifying boiler/furnace are accountable for the purchase price less any applicable rebate: Heating Boiler (hot water boiler) rebate amount: > AFUE Rating of 95% or greater: $1,500 > AFUE Rating of 90% or greater: $1,000 > Heating Furnace (warm air furnace) rebate amount: > AFUE Rating of 97% (or greater) and electronic commutated motor: $450 > AFUE Rating of 95% (or greater) and electronic commutated motor: $300
Program Outcomes	No further information

Sources: National Grid, Residential gas heating energy savings program, Website (https://www1.nationalgridus.com/Files/AddedPdf/POA/2013_RI_HEHE.pdf) accessed on September 6, 2013.

National Grid, High-Efficiency natural gas heating equipment (Furnaces or boilers), Website (https://www1.nationalgridus.com/HeatRI-RI-RES) accessed on September 6, 2013.

National Grid, Residential gas heating energy savings program, Website (https://www1.nationalgridus.com/Files/AddedPdf/POA/2013_RI_HEHE.pdf) accessed on September 6, 2013.

E.8.3 Tax Incentives

Tax abatement programs are not particularly common or useful in Alaska given the limited state and local taxes paid in the State. As noted in Section 2, property taxes are the only state and local taxes paid throughout the FNSB with exception of a sales tax in North Pole. The only program known to have implemented such an approach to encourage energy efficiency upgrades in Alaska was the Phase I of the FNSB AQIP Program. From an administrative perspective, tax abatement incentives can be cumbersome and significant time can pass before program participants receive a financial benefit. For example, Phase I of the AQIP required that the property tax credit be tracked over a two-year period. Due to the time requirements necessary for tracking the credit, FNSB issued an ordinance so participants could either 1) receive a cash/check reimbursement and a property tax credit or 2) take the entire rebate as a cash/check. Every program participant opted for the upfront reimbursement once this ordinance was passed.[226] While AQIP participants could wait up to two years to receive financial benefits, it can be up to

[226] Thompson, Todd, FNSB Air Quality, Personal communication with Elizabeth Harrison, September 23, 2013.

five years before benefits are transferred to participants in the Montgomery County- Residential Energy Conservation Property Tax Credit program in Maryland.

As highlighted in **Table E-10**, there are several potential disadvantages of tax abatement programs which are reflected in their limited use and lack of previous success in FNSB. A key disadvantage is the time delay of providing benefits to recipients. In addition to timing issues, program complexity can also limit consumer acceptance.

E.9 Recommendations

As described in previous sections, there are primarily three potential barriers to converting FNSB homes to natural gas heating systems:

1. Capital cost of conversion.
2. Short-term residents potentially not recouping investment, and
3. Inconvenience and time requirements.

To help homeowners overcome these barriers, this paper has described and reviewed the three primary types of incentive programs that could be developed: loan programs, direct payment programs and tax incentives. As discussed in Section 4, and summarized in **Table E-10**, there are pros and cons to each of these program types, with significant variation among national examples. There are particularly tradeoffs regarding program eligibility, ease of participation, assistance in financing of capital costs, and risk of debt repayment (in the case of loans).

As fuel switching may not qualify for incentives under existing energy efficiency programs (as described in Section E.7), we recommend development of an incentive program specifically tailored to promote fuel switching. Existing programs may incentivize fuel switching to some degree, but would likely be much less effective than a focused fuel switching program.

It appears that all three barriers may be able to be overcome with a straightforward on-bill pay financing incentive program that is tied to the meter, rather than the homeowner (i.e. is transferable to the home's next resident). In this type of program, the consumer does not have to pay significant upfront capital costs, and can reap immediate benefits in a reduced monthly total energy bill (energy plus capital repayment of conversion is less than oil cost) and does not have to evaluate if he/she will relocate before recouping the initial investment cost. Additionally, those with less than desirable credit could receive financing provided their utility bill payment history is acceptable to the lender. To ensure program participation in FNSB, such a program must be simple for participants. Similar to the Michigan Saves program, ease of program participation could be ensured with a one-step system that allows one phone call to determine eligibility and get the fuel system conversion in motion.

Furthermore, the interest rate on the loans obtained through an on-bill program will have implications on the monthly charges these borrowers will experience. **Table E-15** highlights the importance of the interest rate in determining monthly loan repayments. The higher the loan value is, the greater the implications for the size of the interest rate. For example, for a loan value of $1,000 with an interest rate of 8 percent requires the borrower to pay $12 per month, while a $13,000 loan with the same interest rate requires a monthly payment of $167. Finally, such an on-bill pay system may need to be accompanied by a rebate if the initial capital cost is so high that it results in a monthly utility bill that is higher than current energy costs.

Table E.15 Monthly Loan Payment for Varying Loan Amounts (assuming 10-year term)

	Loan Amount and Monthly Payments						
Interest Rate	$1,000	$3,000	$5,000	$7,000	$9,000	$11,000	$13,000
0%	$8	$25	$42	$58	$75	$92	$108
1%	$9	$26	$44	$62	$79	$97	$114
2%	$9	$28	$46	$65	$83	$102	$121
3%	$10	$29	$49	$68	$88	$107	$127
4%	$10	$31	$51	$72	$92	$113	$134
5%	$11	$32	$54	$76	$97	$119	$140
6%	$11	$34	$57	$79	$102	$125	$147
7%	$12	$36	$59	$83	$107	$131	$154
8%	$12	$37	$62	$87	$112	$137	$161

In summary, to incentivize fuel switching in FNSB, we recommend an on-bill financing program similar to the NYSERDA on-bill program. Such a program that ties the loan to the meter will reduce several barriers to fuel switching: facilitate financing of capital costs, reduce effects of out-migration through loan transferability, and increase financing eligibility as those with low credit would more likely qualify for financing based on utility bill payment history. Also, if home heating system capital costs are so high that monthly total energy costs (fuel plus capital repayment) exceed current fuel costs, the program may need to include an upfront rebate to reduce total loan value. It is also critical that the program is structured to minimize time requirements and complexity to the consumer.

E.10 Incentive Programs in the United

This section provides examples of subsidized loans programs, PACE programs, direct payment programs and tax incentive programs throughout the U.S.

E.10.1 Subsidized Loans

Low Interest Government Loan

Table E.16 Michigan Saves Business Energy Financing Program

Program Name	Michigan Saves Business Energy Financing Program
Program Area	Michigan Statewide
Program Goal	Michigan Saves is a nonprofit dedicated to making energy improvements easier for all Michigan energy consumers
Incentive for Fuel Switching?	Fuel switching is not promoted and is allowed on a case-by-case basis when there exists an argument for improved efficiency
Program Type	State Subsidized Loan
Funding	> Established in 2009 through an $8 million grant from the Michigan Public Service Commission (MPSC) > Additional grants by state of Michigan and by the U.S. Department of Energy > Michigan Saves serves as guarantor for loans providing a loan loss reserve fund. Repeated use of funds is possible due to very low default rate.

Eligibility	Buildings that are owned or occupied by businesses or nonprofit organizations located anywhere in the state of Michigan are eligible, subject to credit review by Ervin Leasing (third party lender).
Program Features	> Business chooses among 150 Michigan Saves authorized contractor to get an estimate on qualifying energy improvements. > Business completes an application with the help of chosen authorized contractor. Business will get a decision within 48 hours. > Once the financing is approved, chosen contractor makes the energy improvements. Contractor is paid by Ervin Leasing after the work is completed. > Fast financing up to $150,000 as low as 5.9% for up to 5 years. > As a special incentive for businesses in the food industry, Michigan Saves offers a 1.99% rate for a limited time, and if building's energy consumption is cut by 20%, eligible for $4,000 rebate.
Program Outcomes	> About $1.4 million in projects completed; average $25k per project > Approximately 20 percent of Michigan Saves business loans are used for furnace/HVAC change outs, however, fuel switching only permitted if argument made for efficiency improvements and not switching from natural gas to another fuel > Vast majority of business loans are used for LED lighting upgrades

Sources: Michigan Saves, Website (http://michigansaves.org) accessed September 3, 2013.

O'Grady, Todd, Michigan Saves Program Coordinator, Personal communication with Adam Swadley, Cardno ENTRIX, September 5, 2013

Table E.17 Michigan Saves Public Sector Energy Financing Program

Program Name	Michigan Saves Public Sector Energy Financing Program
Program Area	Michigan Statewide
Program Goal	Michigan Saves is a nonprofit dedicated to making energy improvements easier for all Michigan energy consumers
Incentive for Fuel Switching?	Fuel switching is not promoted and is allowed on a case-by-case basis when there exists an argument for improved efficiency
Program Type	State Subsidized Loan
Funding	> Established in 2009 through an $8 million grant from the Michigan Public Service Commission (MPSC) > Additional grants by state of Michigan and by the U.S. Department of Energy > Michigan Saves serves as guarantor for loans providing a loan loss reserve fund. Repeated use of funds is possible due to very low default rate.
Eligibility	Eligible facilities include local government buildings, schools, and other public entities

Program Features	> Public agency selects from 150 Michigan Saves authorized contractors to get an estimate on qualifying energy improvements. This can include an energy assessment by a certified auditor, or an improvement selected from a list of pre-screened improvements, such as lighting, HVAC, controls, and more. If the project needs to bid out, Michigan Saves can help by providing a full list of contractors that have already been screened for insurance, licenses, and finances. > Public agency completes the financing application. Installment purchase agreements available, ranging from $5,000 to $1 million. 2-5 year contracts. Lower of 1.99% or $500 per-loan fee to support QA and program operations. > Once the financing is approved and finalized, contractor makes the energy improvements. Contractor is paid directly by the participating lender after the work is completed. > Michigan Saves performs an independent quality assurance review after the project is completed.
Program Outcomes	Data not yet available—program began week of August 26, 2013

Sources: Michigan Saves, Website (http://michigansaves.org) accessed September 3, 2013.

O'Grady, Todd, Michigan Saves Program Coordinator, Personal communication with Adam Swadley, Cardno ENTRIX, September 5, 2013.

Table E.18 New Jersey Clean Energy Program (NJCEP): Home Performance with Energy Star (HPwES)

Program Name	New Jersey Clean Energy Program (NJCEP): Home Performance with Energy Star (HPwES)
Program Area	Must be serviced by utility in NJ
Program Goal	The HPwES Program offers "whole house" solutions to reduce energy costs and carbon footprint. The program offers financial incentives on energy efficient improvement packages.
Incentive for Fuel Switching?	Not specifically, but could if efficiency upgrade recommendations include a new natural gas system.
Program Type	Subsidized loan – low interest government loan; Direct Payments- rebates
Funding	New Jersey Societal Benefits Charge (public benefits fund); State Energy Program (SEP)
Eligibility	Any single family, townhouse, or small (2-4 unit) multifamily homeowner. A Home Energy Audit must be conducted first
Program Features	> Energy audit is conducted for the home. The cost of the home energy audit varies by contractor. > Homeowners qualify for financing through the home energy assessment and improvements program of up to $10,000, 10 year, 0% fixed APR and grants of up to $5,000, where a utility loan is unavailable. > NJNG customers have on-bill financing options through the NJNG SAVEGREEN on-bill financing program.
Program Outcomes	More than 13,000 projects have been completed since the program's inception in 2007.

Sources: New Jersey Clean Energy Project. Home Performance with ENERGY STAR Benefits and Incentives, Website (http://www.njcleanenergy.com/residential/programs/home-performance-energy-star/benefits-and-incentives) accessed September 5, 2013.

New Jersey Clean Energy Project. Societal Benefits Charge, website (http://www.njcleanenergy.com/main/about-njcep/societal-benefits-charge/societal-benefits-charge-sbc#Anchor-What-47857), accessed September 23,2013.

New Jersey Clean Energy Project. FAQ: How much does it cost to have a Home Performance assessment done?, website (http://www.njcleanenergy.com/residential/programs/home-performance-energy-star/frequently-asked-questions#auditcost), accessed September 23, 2013.

North Carolina State University, Database of State Incentives for Renewables & Efficiency (DSIRE), 2013. Home Performance with Energy Star Program, Website (http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NJ17F&re=0&ee=0) accessed September 11, 2013.

New Jersey Board of Public Utilities, May 29, 2013. NJ's Clean Energy Program Home Performance with Energy STAR Contractors Receive National Recognition, Press Release (http://www.njcleanenergy.com/files/file/Press%20Releases/Century%20Award%202012%20Release%2005%2029%2013%20sj.pdf) accessed September 9, 2013.

E.10.2 Property-Assessed Clean Energy Financing (PACE)

Table E.19 PACE - GreenFinanceSF (GFSF) – City of San Francisco

Program Name	PACE - GreenFinanceSF (GFSF) – City of San Francisco
Program Area	City/County of San Francisco
Program Goal	Stated purpose of the commercial program: > Provide commercial property owners in San Francisco access to a new form of financing for the installation of energy efficiency, renewable energy, and water conservation improvements – and to accelerate their installations. > Help commercial property owners reduce operating costs, improve occupant health and comfort, enhance building value, and mitigate environmental impact. > Provide financial institutions with very secure collateral to facilitate project financing at attractive rates.
Incentive for Fuel Switching?	No, not for residential fuel switching. The residential program is currently suspended. For commercial properties, potentially. Fuel switching is not excluded from the list of eligible measures.
Program Type	PACE Program
Funding	Funded through a mix of bonds/funds granted to the city through the federal American Recovery and Reinvestment Act (ARRA) Program budget: $150 million
Eligibility	Commercial PACE financing requirements include the following: > Location: The property must be located within the City and County of San Francisco, California. > Property-Based Debt: The property must not be in default, or have a history of default on the mortgage or non-payment of property taxes. It also must not have filed for bankruptcy recently, nor have significant pending legal action, nor any involuntary liens or judgments. > Debt Limit: The combined debt (including new project financing) cannot exceed the current value of the property; value is determined by using the current assessed value, or a recent appraisal by a City-approved appraiser. > Consent of Lien Holders: If the property has a mortgage or other private liens on the property, then these debt holders must consent in writing to the priority lien. > Audit Requirements: "GreenFinanceSF-Commercial requires a program-approved energy audit" > Performance Tracking: Property owners are to enroll in free or low-cost energy usage tracking services to help track how the project performs over time. Property owners are encouraged to do more detailed performance analysis to further ensure continued energy and cost savings

	> Verification and Quality Assurance: owners must participate in utility rebate or customized incentive programs (where available and applicable) that offer verification/inspection mechanisms, or submit to independent project review and site inspections at additional cost. > Generally, in order to be eligible for financing, property improvements must have a useful life of five years or longer, be attached to the real property or building and have the capacity to reduce energy or water usage, or generate clean power for the property. Measures not on the 'Eligible Measures List' may be considered on a case-by-case basis.
Program Features	> Minimum financing: $50,000. > Loans are repaid over a period of up to 20 years through property tax bills.
Program Outcomes	No further information

Sources: Energy Upgrade California, Property Assessed Clean Energy - Program Overview PDF, Website (https://commercial-pace.energyupgradeca.org/county/san_francisco/commercial_about).

Energy Upgrade California, "GreenFinanceSF Program Handbook" PDF, Website (https://commercial-pace.energyupgradeca.org/county/san_francisco/application_overview), page 3, accessed September 10, 2013.

Energy.gov, City of San Francisco – GreenFinanceSF, Website (http://energy.gov/savings/city-san-francisco-greenfinancesf), accessed September 16, 2013.

North Carolina State University, Database of State Incentives for Renewables & Efficiency (DSIRE), 2013, GreenFinanceSF, Website (http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA211F&re=1&ee=1) accessed September 20, 2013.

Table E.20 PACE – Sonoma County Energy Independence Program

Program Name	PACE – Sonoma County Energy Independence Program
Program Area	Sonoma County, California
Program Goal	"SCEIP will help property owners of improved real property make principled investments in the long-term health of the local, state, and national economy and global environment by providing a long-term financing mechanism for energy and water conservation improvements. SCEIP provides multiple benefits. By enabling property owners to take responsible energy and water conservation actions, SCEIP will reduce their utility bills. At the same time it boosts the local economy, the California power grid, national and global energy interests, and makes it possible for Sonoma County to fulfill energy and water conservation and climate protection commitments."
Incentive for Fuel Switching?	Yes. Eligible improvements include Natural Gas HVAC Furnaces (90 AFUE or greater)
Program Type	PACE Program
Funding	> SCEIP is financed by County Treasury funds > If financing is approved, the "county and the property owner enter into an assessment contract and implementation agreement, through which the county pays the final cost of the improvements. The county places an assessment lien on the property, and the property owner repays the county for the improvements as an assessment on his/her property tax bill over a 10 or 20 year period"

Eligibility	Any residential, commercial, agricultural or industrial property owner in Sonoma County, California may participate in the program provided the following requirements are satisfied: > Applicant(s) is/are legal owner of the property described in the Application (the "Property"). > Property is developed and located within Sonoma County. Mobile homes that are not affixed to real property and subject to secured property tax are not eligible. > Property owner is current on all property taxes. > Property owner is current on mortgage(s). For commercial property, lender has given consent to PACE Financing. > Property owner is not in bankruptcy and the property is not an asset in a bankruptcy.
Program Features	> Minimum financing amount is $2,500. > Financing is repaid through a special assessment on property tax bills. > Financing between $2,500 and $5,000 will be set for repayment in 10 years. Projects over $5,000 may be repaid over 10 or 20 years, at the property owner's discretion. > Projects of $60,000 up to $500,000 will require approval by the Program Administrator. > Projects valued at $500,000 and above will require specific approval by the Board of Supervisors.
Program Outcomes	> As of July 2012, this program has funded more than $57 million in projects > As of March 2013, projects for 1762 residential properties have been financed > From March 2009 to August 2013, there have been over 2,700 applicants to SCEIP (both residential and commercial).

Sources: Sonoma County Energy Independence Program, Program Report and Administrative Guidelines, (http://www.drivecms.com/uploads/sonomacountyenergy.org/Policy%20Documents/Program_Report_Admin_Guidelines.pdf), Page 1, accessed September 16, 2013.

U.S. Department of Energy Clean Energy Finance, "Commercial Property-Assessed Clean Energy (PACE) Financing," Website (http://www.cleanenergyfinancecenter.org/wp-content/uploads/ch12_commercial_pace_all.pdf)

Sonoma County Energy Independence Program, Frequently Asked Questions, Website (http://residential.sonomacountyenergy.org/lower.php?url=faqs-75) accessed September 16, 2013.

North Carolina State University, Database of State Incentives for Renewables & Efficiency (DSIRE), 2013, Sonoma County-Energy Independence Program, Website (http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA188F&re=1&ee=1), accessed September 16, 2013.

Sonoma County Energy Independence Program, SCEIP Newsletters, March 2013, Website (http://sonomacountyenergyindependenceprogram.createsend1.com/t/ViewEmail/r/376D9BB484FF55FC/3A4B775D0BB0A581C35B3650D253B2D9)

Sonoma County Energy Independence Program. SCEIP Monthly Report - August 2013, (https://www.drivecms.com/uploads/sonomacountyenergy.org/Reports/Monthly_Reports/Monthly%20Report_external_aug2013.pdf) , accessed September 16, 2013.

Table E.21 PACE – HERO Financing

Program Name	PACE – HERO Financing
Program Area	Participating California Jurisdictions
Program Goal	The stated purpose is "to provide relatively low interest rate financing to spark the local economy by creating jobs and reducing utility costs, and to reduce greenhouse gas emissions"
Incentive for Fuel Switching?	Yes. Natural gas furnaces are included in the list of eligible appliances.
Program Type	PACE Program
Funding	The July 2008 State of California Assembly Bill 811 authorized cities and counties to establish "voluntary contractual assessment programs as a new financing mechanism used to pay for energy efficiency and renewable energy products which are permanently attached to property"
Eligibility	> The residential property must be located within a participating California WRCOG jurisdiction: Banning, Calimesa, Canyon Lake, Corona, Eastvale, Hemet, Jurupa Valley, Lake Elsinore, Menifee, Moreno Valley, Murrieta, Norco, Perris, Riverside, San Jacinto, Temecula, Wildomar, or the Western portion of the unincorporated area of the County of Riverside > Generally, all permanently fixed energy efficiency, water efficiency and renewable energy products are eligible. > There are over 150,000 eligible products, and it includes High Efficiency Furnaces on the Energy Star Qualified list that are Natural Gas or Propane (≥90% AFUE).
Program Features	> WRCOG HERO Financing was launched in December 2011 for residential properties and is the largest and most successful Property Assessed Clean Energy Program in the nation > The minimum amount available through HERO Financing is $5,000. > The maximum amount available through HERO Financing is 15% of the market value of the property, not to exceed $200,000. Amounts greater than $200,000 require WRCOG Executive Committee approval.
Program Outcomes	As of January 29, 2013, more than 6,000 homeowners have been approved for HERO financing and $100 million has been approved for home energy projects

Sources: WRCOG HERO Financing, FAQ – Question #1, Website (http://wrcog.herofinancing.com/FAQs/#Q1), accessed September 10, 2013.

WRCOG HERO Financing, WRCOG HERO Program Handbook, Website (http://wrcog.herofinancing.com/Content/Documents/WRCOG_HEROProgramHandbook.pdf), accessed September 10, 2013.

WRCOG HERO Financing, Eligibility Criteria, Website (http://wrcog.herofinancing.com/HEROFinancing/EligibilityCriteria.aspx), accessed September 16, 2013.

WRCOG HERO Financing, FAQ – Question #23, Website (http://wrcog.herofinancing.com/FAQs/#Q23), accessed September 10, 2013.

WRCOG HERO Financing, Website (http://herofinancing.com/), accessed September 10, 2013.

Renovate America, Inc. "Wildly Successful Residential PACE Program in Riverside County Now Available to Communities throughout California", January 29, 2013, (http://www.renovateamerica.com/Content/Documents/Articles/HEROStatewideLaunchPR_2013_01_31.pdf), accessed September 16, 2013.

E.10.3 On-Bill Financing

Table E.22 NJNG SAVE GREEN On-bill Financing Program

Program Name	NJNG SAVE GREEN On-bill Financing Program
Program Area	State of New Jersey- NJNG Service Area.
Program Goal	Through the SAVEGREEN Project, New Jersey Natural Gas (NJNG) provides rebates that supplement the statewide WARMAdvantage Program. The program goal is to improve air quality and save consumer money on energy bills. New Jersey Natural Gas supplements assistance provided by New Jersey's Clean Energy Program (NJCEP).
Incentive for Fuel Switching?	Not explicitly, but efficiency requirements for financing are that of a WARMAdvantage High Efficiency Gas Furnace which is higher than requirement for oil furnace.
Program Type	Subsidized Loans – On-bill Financing
Funding	Energy efficiency cost recovery rider on consumer rates. Approved by New Jersey Board of Public Utilities.
Eligibility	Customers who upgrade to a WARMAdvantage qualified natural gas furnace or boiler through New Jersey's Clean Energy Program after completing the free home energy audit. (NJCEP)
Program Features	> Both loans below are paid through the customer's bill > High-Efficiency Equipment: Qualified NJNG customers can borrow $2,500 to $6,500, at a 0% APR fixed rate for 5 years with no fees, points or closing costs. Customers also receive $900 rebate from NJCEP. > Whole House Approach: Qualified NJNG customers can borrow $2,500 to $10,000, at a 0% APR fixed rate for 10 years** with no fees, points or closing costs. Customers may also be eligible for rebates up to $5,000 if measures are implemented by 6/14/2014.
Program Outcomes	Since the program's inception in 2009, the NJNG SAVEGREEN Project has helped over 24,000 customers upgrade to high-efficiency equipment

Sources: North Carolina State University, Database of State Incentives for Renewables & Efficiency (DSIRE), July 7, 2012. New Jersey Natural Gas - SAVEGREEN Residential Rebate Program, Website (http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NJ32F&re=0&ee=0) accessed September 11, 2013.

New Jersey Natural Gas Save Green Project, 2013. Website, (http://www.savegreenproject.com/featured-pages/o-apr-on-bill-repayment-program) accessed September 11, 2013.

New Jersey Natural Gas Save Green Project, June 21, 2013. News Release (http://www.savegreenproject.com/wp-content/uploads/2011/04/SAVEGREEN-_Ext_Approved.pdf) accessed September 5, 2013.

State of New Jersey Board of Public Utilities: In the Matter of the Petition of New Jersey Natural Gas Company for Approval of the Cost Recovery Associated with Energy Efficiency and Preliminary Regional Greenhouse Gas Initiative Programs. BPU Docket No. GR1106, available online (http://www.njng.com/regulatory/pdf/NJNG-2010-EE-Rate-Filing1.pdf), accessed September 23, 2013.

E.12 Direct Payments

E.12.1 Rebates

Table E.23 GasNetworks Commercial and Industrial High-Efficiency Heating Equipment Rebate Program

Program Name	GasNetworks Commercial and Industrial High-Efficiency Heating Equipment Rebate Program
Program Area	Massachusetts - must be serviced by a participating GasNetwork utility.
Program Type	Rebate Program
Program Goal	The program goal is "To work with our customers, stakeholders and industry professionals to promote energy efficient technologies, create common energy efficiency programs, educate consumers and promote contractor training and awareness of ever-changing natural gas technologies"
Incentive for Fuel Switching?	Yes. Fuel switching is generally permitted with GasNetworks rebates.
Funding	No further information
Eligibility	Commercial customers of participating GasNetworks utilities are eligible. Participating utilities in GasNetworks include: Columbia Gas of Massachusetts, Berkshire Gas, New England Gas Company, NSTAR Gas, Unitil, and NationalGrid (MA).
Program Features	> Program can be used to assist businesses with replacement of "old, inefficient heating equipment"-- only high efficiency natural gas furnaces and boilers are eligible for rebates in the program. > Rebates on eligible heating equipment for commercial customers range from $300 to $10,000, depending on the type, size, and efficiency of the equipment.
Program Outcomes	No further information

Sources: Mass Save, High-Efficiency Commercial Natural Gas Equipment Rebate, (http://www.gasnetworks.com/efficiency/pdf/GN_Commercial_Natural_Gas_Rebate_2013.pdf), accessed September 6, 2013

GasNetworks, About Us, Website (http://www.gasnetworks.com/about/index.asp) accessed September 6, 2013.

Mass Save Early Rebate Program Frequently Asked Questions, "What if my customer wants to switch to natural gas?" 2013, website (http://www.gasnetworks.com/pdf/Early_Boiler_Replacement_FAQs.pdf), accessed September 6, 2013.

Gas Networks, Commercial and Industrial High-Efficiency Heating Equipment Rebate Program, website (http://www.gasnetworks.com/efficiency/comm_heating.asp), accessed September 6, 2013.

Table E.24 GasNetworks Residential High-Efficiency Heating Equipment Rebate Program

Program Name	GasNetworks Residential High-Efficiency Heating Equipment Rebate Program
Program Area	New England area-must be serviced by a GasNetwork participating utility.
Program Type	Rebate Program
Program Goal	The program goal is "To work with our customers, stakeholders and industry professionals to promote energy efficient technologies, create common energy efficiency programs, educate consumers and promote contractor training and awareness of ever-changing natural gas technologies"
Incentive for Fuel Switching?	Potentially. Fuel switching is not specifically excluded.
Funding	No further information
Eligibility	Rebates are restricted to residential heating customers of participating GasNetworks utilities making a qualified purchase within the specified time frame. Participating GasNetworks members are: > Berkshire Gas > Blackstone Gas

	> Columbia Gas of Massachusetts > National Grid (MA only) > New England Gas > NSTAR Gas > Unitil (MA or NH)
Program Features	Customer is responsible for price of heating equipment less any applicable rebate for a qualified purchase. The qualifying equipment and available rebates are: > Furnace (equipped with an ECM motor or equivalent) with an AFUE of 97% or greater: $450 > Furnace (equipped with an ECM motor or equivalent) with an AFUE of 95% or greater: $300 > Boiler (Forced Hot Water System) with an AFUE of 95% or greater: $1,500 > Boiler (Forced Hot Water System) with an AFUE of 90% or greater: $1,000 > Condensing Boiler with On-Demand DHW with an AFUE of 90% or greater: $1,200 > Heat Recovery Ventilator: $500 > After-Market Boiler Reset Controls*: $225
Program Outcomes	No further information

Sources: Gas Networks, About Us, Website (http://www.gasnetworks.com/about/index.asp) accessed September 6, 2013.

Gas Networks, About Us, Website (http://www.gasnetworks.com/about/index.asp) accessed September 6, 2013.

Gas Networks, Massachusetts and New Hampshire Residential High-Efficiency Heating Equipment Rebate Program, Website (http://www.gasnetworks.com/efficiency/resid_heating.asp) accessed September 6, 2013.

E.12.2 Early Retirement Programs

Table E.25 Northern Indiana Wood Stove Changeout Program

Program Name	Northern Indiana Wood Stove Changeout Program
Program Area	Northern Indiana - 32 Northern Indiana counties serviced by NIPSCO
Program Type	Early Retirement Program
Program Goal	As part of the Northern Indiana Public Service Company Clean Air Act settlement, NIPSCO agreed to fund numerous environmental mitigation projects to address past emissions. To that end, the Northern Indiana Wood Stove Changeout program was developed. The program's goal is to minimize particulate air emissions and hazardous air pollution in northern Indiana while fulfilling NIPSCO's mitigation project requirements under the EPA settlement.
Incentive for Fuel Switching?	Yes. The Northern Indiana Wood Stove Changeout Program is one of many Environmental Mitigation Projects that are part of a consent decree among NIPSCO, the EPA, and the Indiana Department of Environmental Management (IDEM). NIPSCO is sponsoring and offered up to $5,000 for residential customers to replace and/or retrofit inefficient wood-burning stoves/boilers. All replacements must be made with a qualified appliance. Inefficient wood stoves/boilers are defined to be those that are either non-EPA certified or a non-qualified appliance (typically one manufactured over 8 years ago).

Funding	As part of the Northern Indiana Public Service Company Clean Air Act settlement, the Northern Indiana Public Service Co. (NIPSCO) agreed to spend $9.5 million on environmental mitigation projects to address past emissions: one of these environmental mitigation projects is the Northern Indiana Wood Stove Changeout Program. For the Northern Indiana Wood Stove Changeout Program, NIPSCO (an energy distribution company) is providing a total of $452,500 for the voucher programs. > General Vouchers: $332,500 > Income Qualified Vouchers: $120,000
Eligibility	Installation and/or retrofits must occur in of the 32 northern Indiana Counties serviced by NIPSCO, the sponsor of the Northern Indiana Wood Stove Changeout Program. In order to receive the voucher, the wood stove or outdoor wood-burning boiler being retrofitted and/or replaced must be a non-EPA certified or non-qualified appliance. The program does not apply to fireplaces.
Program Features	Qualifying replacement appliances are: > EPA-certified energy efficient wood-stoves, or cleaner burning and more energy-efficient hearth appliances (wood pellet, gas, or propane stove) > EPA Phase 2 hydronic heaters that burn biomass wood pellets and have continuous feed fuel (or retrofit kit) > Natural gas boiler of 90% or higher AFUE > Natural gas furnace of 92% or higher AFUE > Energy Star qualified Geothermal Heat Pump **Voucher Types** General Residential Voucher: > Provides residential customers with an instant in-store credit toward the purchase of qualified appliances. > Instant credit ranges from $1,000 to $5,000 > Income Qualified Residential Voucher: > For low income individuals (at or below 150% of the poverty level) or those on specified programs > provides up to $4,000 per home for the replacement of an inefficient wood-burning stove/boiler
Program Outcomes	No further information

Sources: EPA, Northern Indiana Public Service Company Clean Air Act Settlement, Website (http://www.epa.gov/compliance/resources/cases/civil/caa/nipsco.html) accessed on September 5, 2013.

NIPSCO, Northern Indiana Wood Stove Changeout Program PDF, (http://www.nipsco.com/Libraries/Our_Services/Northern_Indiana_Wood_Burning_Stove_Changeout_Program_Fact_Sheet.sflb.ashx) accessed September 5, 2013.

Table E.26 City of Pendleton, OR Wood Stove Replacement Program

Program Name	City of Pendleton, OR Wood Stove Replacement Program
Program Area	City of Pendleton, OR urban growth boundary
Program Goal	Goal is to save residents money thorough increased fuel efficiency and to improve air quality through the reduction of wood smoke.
Incentive for Fuel Switching?	None, although fuel switching is available as long as replacement system is City approved
Program Type	Government Subsidized loan, Direct Subsidy (Early Retirement Program)
Funding	HUD/ Community Development Block Grants, Funds from repaid loans, Oregon Department of Environmental Quality
Eligibility	Residents living within the City of Pendleton Urban Growth Boundary are eligible to participate in the program.
Program Features	> The program provides interest-free loans of up to $3,500 to replace an old, uncertified wood stove or wood stove insert with a new, approved heating system. Lien on homeowner's property is filed with county. Loans are repaid over 5 years with monthly payments. > Low income seniors are eligible for grants to replace faulty heating systems, including wood stoves; other low income residents are eligible for loans for 20 years at 1% interest to change out wood stoves (Phase II).
Program Outcomes	> As of July 2010, 144 stoves had been replaced. > 93 (approx. 65% of) replacements took place between 2000-2002 in Phase I of the program. > 115 of 144 stoves replaced (about 80%) were replaced with gas stoves.

Sources: The City of Pendleton, OR: Wood Stove Replacement Program, 2013, website (http://www.pendleton.or.us/public-works/environmental/wood-stove-replacement-program), accessed September 10, 2013.

City of Pendleton, OR Wood Stove Replacement Program (Summary for EPA), 2010, available online (http://www.epa.gov/burnwise/pdfs/PendWoodStoveReplacementSumforEPA.pdf), accessed September 10, 2013.

City of Pendleton: Air Quality Programs (Oregon Dept. of Environmental Quality Presentation), July 30,2010, available online (http://www.deq.state.or.us/aq/planning/docs/cityPendletonPresent.pdf), accessed September 10, 2013.

Hoehna, Klaus, City of Pendleton Regulatory Specialist, Email communication with Adam Swadley, Cardno ENTRIX, September 12, 2013

Table E.27 Sacramento Metropolitan Air Quality Management District: Wood Stove and Wood Fireplace Change-Out Incentive Program

Program Name	Sacramento Metropolitan Air Quality Management District: Wood Stove and Wood Fireplace Change-Out Incentive Program
Program Area	Sacramento County, CA
Program Goal	Goal to reduce wood smoke pollution by helping Sacramento County residents replace older, more polluting units with cleaner-burning, USEPA certified or equivalent units.
Incentive for Fuel Switching?	For non-low income, voucher/rebate amount is greater when change out involves switching from wood to another fuel
Program Type	Direct Subsidy (Rebates), Direct Subsidy (Early Retirement Program)
Funding	> Solutions for the Environment and Economic Development (SEED) funding through Sacramento AQMD > SEED is a bank of emission reduction credits that are leased to local businesses for a fee. Revenues from leasing the credits are used to replenish the bank with new credits (e.g., pollution reduction through wood smoke reduction). > SEED funding typically awarded through RFP process, however, alternate approaches allowed when AQMD board determines need to fund certain programs. This approach has provided funding to the Wood Stove/Fireplace program every year since its inception. > California Environmental Quality Act mitigation fees
Eligibility	For non-low income > Residence in Sacramento County > Replacing existing uncertified wood stove, insert, or open hearth fireplace > 50% of AQMD's funding must go to Environmental Justice areas. > For low income > Either a low-income resident or landlord for a low-income residence in Sacramento County > Replacing existing uncertified wood stove, insert, or open hearth fireplace > Satisfy low-income eligibility criteria.
Program Features	This is a voucher program which can be used toward replacement of old wood stoves and fireplaces with gas stoves or fireplace insert. > For non-low income, the voucher amounts range from $150 to $450, depending on the equipment removed and replacement equipment. > For low income, the voucher amount may be up to $1,500 for the purchase and installation of a qualifying replacement to qualifying low income homeowners or landlords of low income rental properties.
Program Outcomes	> 3,355 total change-outs since program inception (As of June 21, 2010. Includes voucher and low-income programs, however, 3,183 (95%) of change-outs originated from voucher program). > 2,728 (81%) of change-outs involved conversion to natural gas

Sources: Sacramento Metropolitan Air Quality Management District: Wood Stoves and Wood Fireplace Change Out Incentive Program, 2011, website (http://www.airquality.org/woodstove/), accessed September 9, 2013.

Sacramento Metropolitan Air Quality Management District: Memo to Board of Directors (Subject: Adopt a resolution authorizing incentive funding levels and continued use of funding from the Solutions for the Environment and Economic Development (SEED) Program for the Wood Stove/Fireplace Change out Incentive Program for Fiscal Year 2010/2011), July 22, 2010. Available online (http://www.airquality.org/bod/2010/JulWoodStoveBrdLtr.pdf), accessed September 9, 2013.

E.12.4 Tax Incentives

Table E.28 Florida Property Tax Exclusion for Residential Renewable Energy Property

Program Name	Florida Property Tax Exclusion for Residential Renewable Energy Property
Program Area	Florida Statewide
Program Goal	Encourage the installation of residential photovoltaic systems, wind energy systems, solar water heaters, and geothermal heat pumps
Incentive for Fuel Switching?	Program design provides incentives to switch to renewable energy sources such as residential photovoltaic systems, wind energy systems, solar water heaters, and geothermal heat pumps.
Program Type	Property Tax Exemption
Funding	Tax base of individual municipalities
Eligibility	> Homeowners installing any of the following equipment as part of a solar, wind, or geothermal system on or after January 1, 2013: o Solar energy collectors, photovoltaic modules, and inverters. o Storage tanks and other storage systems, excluding swimming pools used as storage tanks. o Rockbeds. o Thermostats and other control devices. o Heat exchange devices. o Pumps and fans. o Roof ponds. o Freestanding thermal containers. o Pipes, ducts, refrigerant handling systems, and other equipment used to interconnect such systems; however, such equipment does not include conventional backup systems of any type o Windmills and wind turbines. o Wind-driven generators. o Power conditioning and storage devices that use wind energy to generate electricity or mechanical forms of energy. o Pipes and other equipment used to transmit hot geothermal water to a dwelling or structure from a geothermal deposit. > Up to 100% of the added property value resulting from installation of equipment is eligible for property tax exemption.
Program Features	> In 2013, the State of Florida enacted legislation which provides property tax exemptions on residential photovoltaic systems, wind energy systems, solar water heaters, and geothermal heat pumps installed on or after January 1, 2013. > Up to 100 % of any increase in property value resulting from installation of eligible equipment will not be considered for property tax assessment purposes > The exemption applies to property tax assessments beginning January 1, 2014
Program Outcomes	

Sources: DSIRE: Florida Property Tax Exclusion for Residential Renewable Energy Property, Website (http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=FL141F), accessed September 20, 2013.
Laws of Florida: Ch. 2013-77", Website (http://laws.flrules.org/2013/77) accessed September 20, 2013.

Table E.29 New York Energy Conservation Improvements Property Tax Exemption

Program Name	New York Energy Conservation Improvements Property Tax Exemption
Program Area	New York Statewide
Program Goal	Encourage the installation of residential renewable energy technologies and technologies to improve residential energy efficiency.
Incentive for Fuel Switching?	Program design provides incentives to switch to renewable energy sources such as Solar Water Heat, Photovoltaics, Wind, Biomass, and Geothermal Heat Pumps.
Program Type	Property Tax Exemption
Funding	Tax base of individual municipalities
Eligibility	> 1-4 family homes owned by private individuals or organizations are eligible > Eligible improvements include: caulking and weather stripping of all exterior doors and windows; furnace efficiency modifications; furnace and boiler retrofits; furnace and boiler replacements, provided that such replacements meet minimum efficiency standards; heat pumps that meet minimum efficiency standards; clock thermostats; ceiling, attic, wall, foundation, air duct, heating pipe, and floor insulation; hot water heater insulation; storm and thermal windows and doors; solar and wind systems; load management devices and energy use meters, together with associated wiring. Also eligible are any improvements qualifying for any conservation-related state or federal tax credit or deduction.
Program Features	> In 1977, the State of New York enacted legislation which provides property tax exemptions on increased residential property value resulting from installation of eligible energy efficiency or renewable technologies > Up to 100 % of any increase in property value resulting from installation of eligible equipment will not be considered for property tax assessment purposes; however, the tax exemption does not apply to special assessments > The exemption applies directly to a variety of equipment and measures, but the statute also states that any conservation-related state or federal tax credit or deduction is also exempt from property tax assessment.
Program Outcomes	No further information

Source: DSIRE: New York Energy Conservation Improvements Property Tax Exemption, Website (http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NY27F), accessed September 20, 2013.

"The New York State Department of Taxation and Finance: Property Tax and Assessment Administration. Assessor's Manual Section 4.01 –RPTL Section 487-a: Energy Conservation Improvements to Certain Residential Premises", Website (http://www.tax.ny.gov/research/property/assess/manuals/vol4/pt1/sec4_01/sec487_a.htm), accessed September 20,2013.

Table E.30 Montgomery County- Residential Energy Conservation Property Tax Credit

Program Name	Montgomery County- Residential Energy Conservation Property Tax Credit
Program Area	Montgomery County, MD
Program Goal	Encourage installation and use of solar or geothermal devices (renewable energy devices) and eligible energy conservation devices.
Incentive for Fuel Switching?	Incentives encourage use of renewable technologies for energy generation and use of other energy conservation devices, but no explicit incentive for fuel switching.
Program Type	Property Tax Credit
Funding	> Funded by Montgomery County, MD tax base > Initial annual funding in levy year 2008 was $250,000 for each credit program. > In levy year 2009, amount was lowered to $100,000 for energy conservation device credits, and increased to $400,000 for renewable energy devices credits.
Eligibility	Owners of owner-occupied residential property. Eligible devices include: > Caulking and weatherstripping doors and windows; furnace efficiency modifications; programmable thermostat; ceiling, attic, wall, or floor insulation; water heater insulation; storm windows or doors, multiglazed windows or doors, and heat-absorbed or heat reflective glazed window or door materials; any device which controls demand of appliances and aids load management; and any other conservation device, renewable energy technology, and specific home improvement that is determined necessary to assure that energy conservation measures are effective. > Must meet safety and performance standards set by a nationally recognized testing laboratory for that kind of device. Approved Renewable Energy Devices and Energy Conservation Devices must have been installed within 12 months before the property owner submits an application to the Director of Finance.
Program Features	Montgomery County Code, Chapter 52, Article I, Section 52-18R was effective July 1, 2008, allowing a property tax credit for renewable energy devices and energy conservation devices. The credit is limited to the lesser of: > 50% of the eligible costs of the system, or > $5,000 for a device to heat or cool a structure; $5,000 for a device to generate electricity in a structure; $1,500 for a device to provide hot water in a structure. Property Tax Credit – Renewable Energy (Energy Conservation Devices) In any fiscal year, the total amount of credit allowed under this section for all conservation devices is limited to $250 per property.
Program Outcomes	Montgomery County has recently suspended applications for the renewable energy property tax credit, which experienced an extremely high level of demand that greatly outstripped the available funds (capped at $400,000 annually) resulting in a backlog of at least 5 years between the time of application to time of payment.

Sources: DSIRE: Montgomery County - Residential Energy Conservation Property Tax Credit", Website (http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=MD29F), accessed September 20, 2013.
Montgomery County, MD Department of Finance: Property Tax Credit and Exemption Information, Property Tax Credit - Renewable Energy, Website (http://www.montgomerycountymd.gov/finance/taxes/tax_credit_exempt.html#p20x), accessed September 20,2013
Application Form: Property Tax Credit - Renewable Energy, Website (http://www.montgomerycountymd.gov/Finance/Resources/Files/data/taxes/renewable_energy_tax_credit_application.pdf), accessed September 20,2013.

Montgomery County, Financial Incentives, Website (http://www6.montgomerycountymd.gov/dectmpl.asp?url=/Content/dep/energy/EnergyIncentives.asp) accessed September 23, 2013.

Fairbanks Natural Gas Conversion Analysis

APPENDIX F

CONVERSION RATE WITH INCENTIVES

Appendix F Conversion Rates with Incentives

Increasing household access to natural gas is a necessary step, however, it is anticipated that 25 percent of study area residential households will not convert to natural gas without incentives. It is anticipated that the use of well-designed incentive programs, particularly on-bill pay and rebates, will encourage a significant portion of study area residents to convert their heating systems to natural gas. This appendix presents methods and findings on how incentive programs might increase conversion rates and enable the FNSB to better achieve $PM_{2.5}$ attainment goals.

Research on the effects of incentive programs upon conversion began by identifying the economics of conversion, the barriers to incentive program participation, the structure of incentive programs, the programs currently available to FNSB residents and other incentive programs throughout the nation. The findings from this research were compiled as a white paper which is provided in Appendix E.

Findings from this research indicate that there are three primary barriers preventing natural gas conversions in the FNSB:

1. High capital cost of conversion.
2. Short-term residents potentially not recouping investment, and
3. Inconvenience and time requirements.

These three barriers to natural gas conversion may best be overcome with a straightforward on-bill financing program that is tied to the meter (i.e. is transferable to the home's next resident). In such a program, the capital costs of conversion are financed by private or public lending institutions and are repaid by consumers through their monthly utility bill. This type of program has several advantages:

1. Lowers initial capital cost. The consumer does not have to pay significant upfront capital costs, and can reap immediate benefits in a reduced monthly total energy bill (natural gas bill plus repayment of conversion capital is less than oil cost).
2. Reduces relocation considerations. As the repayment of the loan is tied to the meter and not the homeowner, the consumer does not have to evaluate if he/she will relocate before recouping the initial investment cost.
3. Increases eligibility. Those with less than desirable credit would receive financing, provided that their utility bill payment history is acceptable to the lender.

The three barriers to natural gas conversion may also be overcome with the help of a rebate program. Rebates lower the capital cost of conversion, which can also help to reduce the time required to recoup the investment. Rebates can also be designed to be simple and quick to receive. This section evaluates how an on-bill program and a rebate program would increase the conversion rates identified in Chapter 5.

F.1 On-bill Program

On-bill financing programs are loan programs that are repaid through the monthly energy bill. Under an on-bill loan program, the utility, energy supplier, third-party financer, or a product vendor pays the upfront energy efficiency/fuel conversion equipment costs and the customer repays the costs of these upgrades through their monthly utility bill. There are two primary ways to administer on-bill financing: as a loan tied to the home's occupant or as a tariff that links the charge to the meter. These approaches have implications on the transferability of the loan. If the loan is tied to the customer then the loan will have to be repaid once the home is sold. If the loan is tied to the meter, the loan is transferred to the next owner. Loans tied to the meter thus reduce the barrier of recouping the investment since the current property

owner is always paying both the capital loan payment and recouping the fuel savings (i.e., thus, if the monthly loan repayment value is less than the monthly fuel cost savings, homeowners will benefit financially from converting regardless of how long they own the property). Due to this advantage of loans tied to the meter, particularly in light of Fairbanks relatively mobile population, this research assumes that the loan will be tied to the meter, so that if the current owner moves the cost of conversion will continue to be paid by the subsequent homeowner.

F.1.1 On-bill Willingness to Convert

The IGU predictive model indicates that conversion rates are very high when the capital cost payments are low. In an on-bill pay system, particularly one tied to the meter, there are essential no upfront conversion costs. If the loan repayment value is less than the monthly cost savings, then there are net savings in the initial month of conversion, and every month thereafter. Therefore, we expect that the conversion rates under an on-bill payment system to be at least as high as under the lowest capital cost scenario ($2,000) analyzed by the IGU predictive model.

An on-bill program removes a major consideration of those requiring a loan; the repayment of the remaining loan amount in the event of a move. The use of an on-bill program alters the psychology of a homeowner that would otherwise provide a large upfront financial outlay when they convert to natural gas. The implementation of an on-bill program coupled with a good education program should encourage study area residents to convert to natural gas more so than without an on-bill program. If homeowner's monthly utility bills are lower, when including periodic loan repayment values, study area residents are expected to exhibit a higher willingness to convert to natural gas than estimated in Chapter 5.

Table F.1 IGU Model Results and Estimated On-Bill Pay Conversion Rates

Annual Savings	Conversion Rate
$5,000	95%
$4,500	95%
$4,000	95%
$3,500	95%
$3,000	95%
$2,500	95%
$2,000	95%
$1,500	95%
$1,000	95%
$900	92%
$700	85%
$600	81%
$500	78%

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

This analysis assumes that only those households that are most likely to install a furnace or boiler are eligible for the on-bill program. In other words, households in the study area that currently have a boiler or furnace and are expected to covert by purchasing a boiler or furnace would be eligible for the on-bill program. This will increase the effectiveness of this program because households that are expected to

convert through a burner switch or a space heater already exhibit a high willingness to covert to natural gas.

The rates from **Table F.1** were applied to the estimated net annual savings from converting to natural gas for each system type. The resulting willingness to convert estimates for homeowners with an on-bill program is provided in **Table F.2** below. The WTC estimates assume an 8.0 percent rate and a 10-year term.

Table F.2 Willingness to Convert under On-bill Program

System Type	Capital Cost Conversion	Annualized Cost, 10 Year, 8% interest Loan	Annual Fuel Savings	Annual Net Savings	Estimated WTC with On-bill
Oil/No Secondary					
Baseboard (new boiler	$9,100	$1,356	$2,300	$900	92%
Furnace	$6,400	$954	$2,200	$1,200	95%
Oil/Wood					
Baseboard (new boiler)	$9,100	$1,356	$1,900	$500	78%
Furnace	$6,400	$954	$2,500	$1,500	95%
Wood/Oil					
Baseboard (new boiler)	$9,100	$1,356	$1,500	$100	64%
Furnace	$6,400	$954	$1,900	$900	92%
Oil/Other					
Baseboard (new boiler)	$9,100	$1,356	$1,900	$500	78%
Furnace	$6,400	$954	$2,500	$1,500	95%
Other/Oil					
Baseboard (new boiler)*	$9,100	$1,356	$900	($500)	33%
Furnace	$6,400	$954	$3,600	$2,600	95%

*Assumes that homeowners with these particular systems have the same willingness to convert as determined for the baseline model

Willingness to convert estimates provided above was derived using the $2,000 conversion cost willingness to convert estimates as determined by the IGU predictive model. The $2,000 conversion cost level is the lowest conversion cost level estimated by the IGU predictive model and total annual costs provided above are less than $2,000.

An on-bill program is expected to be very effective at incentivizing landlords to convert single-family rental properties. Under the on-bill program the cost of the heating system will be repaid by the renter through their utility bill, so the beneficiary of the conversion that reaps the fuel cost savings also pays the capital cost of the conversion. Furthermore, based upon communication with NYSERDA on-bill program specialist, even with the on-bill pay program, the conversion can also be used reduce the landlord's federal tax liability.[227] This is expected to increase the willingness to convert for this subset of homes.

Additionally, an on-bill program will also likely incentivize military homeowners to participate in converting their home to natural gas. This is because they will benefit from lower heating expenditures regardless of the timing of relocation. If the military homeowner moves, repayment of the heating system would then be

[227] NYSERDA On-bill Recovery Financing Program Call Center, personal communication with Lee Elder, January 6, 2014.

the responsibility of the following homeowner. Again, if fuel cost savings exceed capital cost repayment, then the homeowner starts benefitting from conversion on their first utility bill.

Table F.3 below illustrates the expected willingness to convert with an on-bill incentive program. In addition to the boiler or furnace eligibility requirement, this analysis also assumes that not all on-bill program applicants will be eligible for program participation. The on-bill program is a loan program and as such participants must meet specific lending criteria. However, in the absence of an existing on-bill program in Alaska this analysis assumes that the number of FNSB families in poverty (5 percent of families) will not be eligible for participation in an on-bill program, and will not have the funds to otherwise convert, resulting in a zero conversion rate for these households. These low income families could receive assistance from another state or federal assistance program to help cover the cost of conversion, but as noted elsewhere, other programs are not designed for natural gas conversion and eligibility for conversion is not certain. As provided below, it is anticipated that 82 percent of single-family residential properties within the study area will be willing to convert under an on-bill program, assuming that 95 percent of the study area population meets eligibility requirements.

Table F.3 On-bill Program Impacts on Single-Family Residential WTC

	Eligible for On-bill	Not Meeting Eligibility Requirements	Total
Households	19,070	1,004	20,080
Percent of Households	95%	5%	100%
Households WTC	16,530	0	16,530
Percent WTC	87%	0%	82%
Baseline WTC			75%
On-bill impact on WTC*			+7%

*Totals may not sum due to rounding

F.1.2 On-bill Rate of Conversion

The rate of conversion is anticipated to be greater under an on-bill program. This is attributable to focus group responses that indicated that the availability of an incentive program would encourage participants to increase their rate of conversion by ten percent. Therefore, this analysis assumes that the cumulative rates of conversion for single-family residential properties provided in **Table 5.7** increase to 70 percent in year one, 85 percent in year two and reaches 100 percent by year three. Further, the cumulative rate of conversion for single-family rentals increases to 55 percent in year one, 70 percent in year two, 85 percent in year three and reaches 100 percent by year four. Rates of conversion in year 0 (the construction year) remains 15 percent under an on-bill program since the rate of conversion during this timeframe is influenced by limitation imposed by the construction process. **Tables F.4** illustrates the estimated number of conversions by phase when an on-bill program is available to study area residents.

Table F.4 On-bill Number of Conversions by Phase, Customer Type and Year

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
Phase 1 (Construction Year 0)													
Single-Family (minus single-family rentals)	620	2,870	3,490	4,100	4,100	4,100	4,100	4,100	4,100	4,100	4,100	4,100	4,100
Single-Family Rentals	110	390	490	600	700	700	700	700	700	700	700	700	700
Multi-Family Residential	60	260	310	350	370	370	370	370	370	370	370	370	370
Commercial	110	530	650	760	760	760	760	760	760	760	760	760	760
Industrial	0	10	20	20	20	20	20	20	20	20	20	20	20
Subtotal	900	4,060	4,960	5,830	5,950	5,950	5,950	5,950	5,950	5,950	5,950	5,950	5,950
Phase 2 (Construction Year 1)													
Single-Family (minus single-family rentals)		410	1,900	2,310	2,720	2,720	2,720	2,720	2,720	2,720	2,720	2,720	2,720
Single-Family Rentals		70	260	330	400	470	470	470	470	470	470	470	470
Multi-Family Residential		10	40	50	60	60	60	60	60	60	60	60	60
Commercial		10	70	80	100	100	100	100	100	100	100	100	100
Industrial		0	0	0	0	0	0	0	0	0	0	0	0
Subtotal		500	2,270	2,770	3,280	3,350	3,350	3,350	3,350	3,350	3,350	3,350	3,350
Phase 3 (Construction Year 2)													
Single-Family (minus single-family rentals)			290	1,350	1,640	1,930	1,930	1,930	1,930	1,930	1,930	1,930	1,930
Single-Family Rentals			50	180	230	280	330	330	330	330	330	330	330

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
Multi-Family Residential			10	30	30	40	40	40	40	40	40	40	40
Commercial			20	70	90	100	100	100	100	100	100	100	100
Industrial			0	0	0	0	0	0	0	0	0	0	0
Subtotal			370	1,630	1,990	2,350	2,400	2,400	2,400	2,400	2,400	2,400	2,400
Phase 4 (Construction Year 3)													
Single-Family (minus single-family rentals)				250	1,180	1,440	1,690	1,690	1,690	1,690	1,690	1,690	1,690
Single-Family Rentals				40	160	200	250	290	290	290	290	290	290
Multi-Family Residential				30	140	160	180	190	190	190	190	190	190
Commercial				20	100	120	150	150	150	150	150	150	150
Industrial				0	0	0	0	0	0	0	0	0	0
Subtotal				340	1,580	1,920	2,270	2,320	2,320	2,320	2,320	2,320	2,320
Phase 5 (Construction Year 4)													
Single-Family (minus single-family rentals)					300	1,390	1,690	1,990	1,990	1,990	1,990	1,990	1,990
Single-Family Rentals					50	190	240	290	340	340	340	340	340
Multi-Family Residential					0	20	20	20	20	20	20	20	20
Commercial					10	40	50	60	60	60	60	60	60
Industrial					0	0	0	0	0	0	0	0	0
Subtotal					360	1,640	2,000	2,360	2,410	2,410	2,410	2,410	2,410

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
Phase 6 (Construction Year 5)													
Single-Family (minus single-family rentals)						250	1,170	1,430	1,680	1,680	1,680	1,680	1,680
Single-Family Rentals						40	160	200	240	290	290	290	290
Multi-Family Residential						10	30	30	40	40	40	40	40
Commercial						0	20	20	20	20	20	20	20
Industrial						0	0	0	0	0	0	0	0
Subtotal						300	1,380	1,680	1,980	2,030	2,030	2,030	2,030
Total	900	4,560	7,600	10,570	13,160	15,510	17,350	18,060	18,410	18,460	18,460	18,460	18,460

F.2 Direct Payments/Rebates

Rebates are a financial incentive that would reduce the upfront capital cost of natural gas conversion. Rebates are commonly used by utilities and other agencies to offset the costs of energy-related improvements. For example, of the 1,390 financial incentive programs highlighted in the Database of State Incentives for Renewables and Efficiency (DSIRE) database, 76 percent are rebate programs. This analysis evaluates how a range of rebate amounts will affect willingness to convert within the study area. This analysis assumes that rebates are available for high-efficiency boilers, medium-efficiency boilers, and furnaces. Rebates are not expected for those customers most likely to switch burners or purchase a natural gas space heater since willingness to convert for these conversions are already high.

The willingness to convert for different rebate levels is highlighted in **Table F.5**. This calculation assumes that rebate program eligibility is restricted to those that currently have an oil furnace or boiler heating system and wish to purchase a new natural gas furnace or boiler. Total rebate costs are presented in **Table 6.6**, assuming that all single-family residential properties with a boiler or furnace are eligible to receive a rebate. These costs may overestimate total rebate program costs given these eligibility requirements as some homeowners may not submit rebate information or elect to not obtain the rebate.

Table F.5 Rebate Program Effects upon Willingness to Convert and Cost

	Rebate Amount								
	No Rebate	$500	$1,000	$1,500	$2,000	$2,500	$3,000	$3,500	$4,000
Willingness to Convert	75%	76%	77%	79%	80%	81%	83%	85%	85%
Participants	NA	4,660	4,880	5,120	5,380	5,670	5,990	6,280	6,430
Payment total ($million)	NA	$2.3	$4.9	$7.7	$10.8	$14.2	$18.0	$22.0	$25.7

Fairbanks Natural Gas Conversion Analysis

APPENDIX

G

INCENTIVE PROGRAM BENEFITS

Appendix G Incentive Program Benefits

This section estimates the program cost for the rebate program and the on-bill loan program. Rebate program costs were calculated by estimating the per year costs based on the eligible number of households converting each year, multiplied by the rebate amount of $1,500. This results in an estimated present value of the program cost of $7.3 million.

This analysis assumes that the on-bill program will be financed by private institutions at 8.0 percent over a 10-year term. Therefore, the program is not expected to require public financing and public on-bill program costs are assumed to equal zero (although there may be some administrative costs of the program borne by a public entity). This analysis does not consider the potential costs and/or revenues associated with the on-bill program for institutions providing financing.

Total lending initiated in each year is estimated as the cost of conversion (estimated as the average of conversion costs for boilers ($9,100) and furnaces ($6,400)) multiplied by the number of eligible households converting. We estimate that a maximum of $51.8 million in loans will be required if all eligible households that convert use the program.

G.1 On-Bill Conversion

A total of 16,530 single-family residential households are expected to convert with an on-bill program. Final natural gas demand within the study area with an on-bill program is estimated at 6.6 Bcf by the end of Year 12, of which 2.5 Bcf is from single-family residential customers. This is 258,000 Mcf more than natural gas use in that year than projected to occur without incentives.

On-bill conversion is expected to particularly increase demand in the initial years following project construction, with single family residential demand with an on-bill program anticipated to be approximately 32 percent higher than without incentives in Years 1, 2, and 3. This indicates that an on-bill program will be effective at increasing the demand for natural gas quickly following project development.

Table G.1 On-Bill Pay Program: Natural Gas Demand for All Study Area Customers (Mcf)

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
Single-family residential	112,130	574,480	995,360	1,408,560	1,764,920	2,107,460	2,373,200	2,479,190	2,531,410	2,539,090	2,539,090	2,539,090	2,539,090
Multi-family residential	60,000	270,000	360,000	460,000	600,000	650,000	700,000	710,000	720,000	720,000	720,000	720,000	720,000
Small commercial	56,160	262,080	318,240	374,400	374,400	374,400	374,400	374,400	374,400	374,400	374,400	374,400	374,400
Medium commercial	310,200	1,447,600	1,757,800	2,068,000	2,068,000	2,068,000	2,068,000	2,068,000	2,068,000	2,068,000	2,068,000	2,068,000	2,068,000
Large/Commercial/ Industrial	138,000	644,000	782,000	920,000	920,000	920,000	920,000	920,000	920,000	920,000	920,000	920,000	920,000
Total	676,490	3,198,160	4,213,400	5,230,960	5,727,320	6,119,860	6,435,600	6,551,590	6,613,810	6,621,490	6,621,490	6,621,490	6,621,490
Portion of total demand attained each year	10%	48%	64%	79%	86%	92%	97%	99%	100%	100%	100%	100%	100%
Portion of final single-family demand attained each year	4%	23%	39%	55%	70%	83%	93%	98%	100%	100%	100%	100%	100%
Difference from No Incentive Scenario (Mcf)	17,100	141,550	239,620	325,480	384,670	420,990	427,280	386,950	353,180	323,150	292,980	270,360	258,290
% Difference from No Incentive single-family residential	18%	33%	32%	30%	28%	25%	22%	18%	16%	15%	13%	12%	11%

This analysis assumes that to be eligible for the on-bill program households must currently have an older boiler or furnace that requires purchasing a new boiler or furnace for conversion. We estimate that a total of 6,700 single-family homeowners will participate in the on-bill program. These homeowners will require a total of $51.4 million in loans to fund the upfront cost of conversion.

Table G.2 Annual On-bill Program Participation and Costs

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Total
Participants	290	1,250	1,160	1,120	900	910	690	260	120	6,700
Loaned Amount ($million)	$2.2	$9.7	$9.0	$8.7	$7.0	$7.0	$5.3	$2.0	$0.9	$51.8
Public Cost of Funds (0.0%)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

Table G.3 On-bill Program Savings for Residential, Multi-family and Commercial Properties ($ millions)

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
Single-family residential	$1.7	$8.9	$15.4	$21.8	$27.3	$32.7	$36.8	$38.4	$39.2	$39.3	$39.3	$39.3	$39.3
Multi-family	$0.9	$4.1	$5.4	$6.9	$9.0	$9.8	$10.5	$10.7	$10.8	$10.8	$10.8	$10.8	$10.8
Commercial	$7.6	$35.3	$42.9	$50.4	$50.4	$50.4	$50.4	$50.4	$50.4	$50.4	$50.4	$50.4	$50.4
Total Savings	$10.2	$48.3	$63.7	$79.2	$86.8	$92.8	$97.7	$99.5	$100.5	$100.6	$100.6	$100.6	$100.6
On-bill Program Public Cost	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Annual Net Benefit	$10.2	$48.3	$63.7	$79.2	$86.8	$92.8	$97.7	$99.5	$100.5	$100.6	$100.6	$100.6	$100.6

This analysis finds that total natural gas demand within the study area with a $1,500 rebate program is 6.5 Bcf by the end of Year 12. As illustrated below, a $1,500 rebate program increases the single-family residential demand for natural gas within the study area over the No Incentives Scenario. Single-family residential customers are anticipated to use 2.4 Bcf of natural gas by the end of Year 12. This is 116,050 Mcf more than the baseline estimate of natural gas demand in that same year. The $1,500 rebate program increases total single-family residential natural gas demand by approximately 5 percent each year.

Table G.4 Rebate Program: Natural Gas Demand for All Study Area Customers (Mcf)

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
Single-family residential	101,240	454,820	794,800	1,146,880	1,470,240	1,799,640	2,067,100	2,216,690	2,307,350	2,345,130	2,372,320	2,388,950	2,398,010
Multi-family residential	60,000	270,000	360,000	460,000	600,000	650,000	700,000	710,000	720,000	720,000	720,000	720,000	720,000
Small commercial	56,160	262,080	318,240	374,400	374,400	374,400	374,400	374,400	374,400	374,400	374,400	374,400	374,400
Medium commercial	310,200	1,447,600	1,757,800	2,068,000	2,068,000	2,068,000	2,068,000	2,068,000	2,068,000	2,068,000	2,068,000	2,068,000	2,068,000
Large/Commercial /Industrial	138,000	644,000	782,000	920,000	920,000	920,000	920,000	920,000	920,000	920,000	920,000	920,000	920,000
Total	665,600	3,078,500	4,012,840	4,969,280	5,432,640	5,812,040	6,129,500	6,289,090	6,389,750	6,427,530	6,454,720	6,471,350	6,480,410
Proportion of final demand attained each year	10%	48%	62%	77%	84%	90%	95%	97%	99%	99%	100%	100%	100%
Portion of total single-family demand attained each year	4%	19%	33%	48%	61%	75%	86%	92%	96%	98%	99%	100%	100%
Difference from No Incentive Scenario (Mcf)	6,220	21,960	39,180	63,970	76,630	92,320	101,870	108,180	114,380	112,950	116,000	116,040	116,050
% Difference from No Incentive single-family residential	7%	5%	5%	6%	5%	5%	5%	5%	5%	5%	5%	5%	5%

Table G.5 $1,500 Rebate Program Annual Savings, Cost and Net Benefit ($ millions)

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
Single-family residential	$1.6	$7.1	$12.3	$17.8	$22.8	$27.9	$32.1	$34.4	$35.8	$36.4	$36.8	$37.1	$37.2
Multi-family	$0.9	$4.1	$5.4	$6.9	$9.0	$9.8	$10.5	$10.7	$10.8	$10.8	$10.8	$10.8	$10.8
Commercial	$7.6	$35.3	$42.9	$50.4	$50.4	$50.4	$50.4	$50.4	$50.4	$50.4	$50.4	$50.4	$50.4
Total Savings	$10.0	$46.4	$60.6	$75.1	$82.3	$88.1	$93.0	$95.5	$97.0	$97.6	$98.1	$98.3	$98.5
Rebate Program Cost ($1,500 Rebate)	-$1.2	-$3.5	-$1.2	-$1.2	-$0.2	-$0.2	-$0.2	-$0.2					
Annual Net Benefit	$8.9	$43.0	$59.5	$74.0	$82.1	$87.9	$92.8	$95.3	$97.0	$97.6	$98.1	$98.3	$98.5