Economic Feasibility of North Slope Propane Production and Distribution to Select Alaska Communities

Final Technical Summary

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Abstract

Could propane from Alaska's North Slope reduce energy costs for electric utilities and residential space heating, water heating, and cooking demands? We explored the hypothesis that propane is a viable alternative for fourteen selected communities along the Yukon and Kuskokwim Rivers, coastal Alaska, and Fairbanks. Our analysis forecasts propane and fuel prices at the wholesale and retail levels by incorporating current transportation margins with recent analysis on Alaska fuel price projections. Annual savings to households associated with converting to propane from fuel oil can be up to $1,700 at $60 per barrel (bbl) of crude oil, and amount to $5,300 at $140 per barrel.[1] Fairbanks residents would benefit from switching to propane for all applications at crude oil prices of $60/bbl. Interesting to note is that switching to propane for domestic water heating makes more sense at lower oil prices than conversions for home space heating. Three of the fourteen communities are projected to benefit from switching to propane for home heating at crude oil prices greater than $80 per barrel, and four communities at crude oil prices of more than $110/bbl. On the other hand, nine communities would benefit from conversion to propane for water heating as crude oil prices reach $50 and above. The realized household savings are also sensitive to assumptions surrounding the operating cost of the production facility and barge transportation delivery costs.

Suggested citation:

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[1] ANS West Coast

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Introduction

The cost of energy has long been a major contributor to the high cost of living in rural Alaska. Propane produced on Alaska's North Slope (ANS) could provide a viable option for displacing diesel in some select Alaska communities. While previous ISER work looked at a price comparison of propane versus fuel oil and naphta in Fairbanks, this analysis takes a closer look at the community savings for households and electric utilities and how these benefits would change given variable crude oil prices (Goldsmith and Szymoniak, 2009).

Experimental Methods

We constructed a spreadsheet model based on previous work by PND, Inc. (2005) improving user friendliness, appearance, and component linkages. Our analysis expands upon former work incorporating the following:

- most current fuel price and transportation data available
- fuel prices and propane prices dependent on crude oil prices
- documentation of model and assumptions
- sensitivity analysis of model results to crude oil prices, operating, capital, and transportation costs
- calculation of propane demand as well as diesel and electricity displacements dependent on estimated conversion rates
- assessment of household savings for home heating, water heating, and cooking
- efficiency gains from switching to more efficient technologies
- option to include carbon prices, if necessary

The following sections outline our assumptions in regards to capital costs, production and storage, transportation, household demand, and technology conversion rates.

Production and Storage

Based on the royalty value of ANS royalty oil and gas, royalty gas in $/1000 cubic feet (cft) is roughly 4.5% of the dollar per barrel ($/bbl) price of royalty oil (DNR, 2010).[2] We apply this relationship and calculate propane prices at the wellhead based on the wellhead price of ANS crude oil, given a $6/bbl pipeline transportation cost. Further, the propane price at the factory gate includes a producer mark-up of 5% which is assumed to cover storage costs. Operation of the plant is assumed to cost $16.22 million annually with an output of 2,000 bbl of propane a day. It turns out that model results are highly sensitive to this assumption which we analyze in the sensitivity analysis below. The default setting for capital costs are outlined in Table 1.

[2] Note, that 1000 CFS equals 1 MMBtu

Table 1 Capital costs for plant, dock facilities, and containers

	cost	interest rate	life [years]
Production plant	$74,090,000	6%	25
Barge dock on Yukon River	$ 6,000,000	6%	25
ISO 40 ft container	$ 84,386	6%	25
ISO 20ft container	$ 49,000	6%	25

Transportation Costs

For this analysis, we assume that propane is produced on the North Slope and stored for transport and consumption in ISO containers of either 40 feet (ft) or 20 ft length. The propane is trucked to distribution hubs at the Yukon River Bridge or Fairbanks. From the bridge, propane is barged to communities along the Yukon River and from Fairbanks either distributed to commercial and residential customers in Fairbanks or transported by rail/truck to Anchorage. Anchorage serves as the hub for coastal communities that are part of this case study. Table 2 specifies the distribution hubs for each of the study communities.

Table 2 Communities and their distribution hubs

Community	Hub
Unalaska	Anchorage
Dillingham	Anchorage
Bethel	Anchorage
Upper and Lower Kalskag	Anchorage
McGrath	Anchorage
Emmonak	Yukon River Bridge
Mountain Village	Yukon River Bridge
Galena	Yukon River Bridge
Tanana	Yukon River Bridge
Fort Yukon	Yukon River Bridge
Kotzebue	Anchorage
Gambell	Anchorage
Fairbanks	Fairbanks

We calculate transportation costs on a per gallon basis and include the cost of returning empty ISO containers to the producer. Carlile Transportation Systems, Inc. provided the "cost to the carrier" for trucking between Prudhoe Bay, Fairbanks, and Anchorage. We received price quotes for rail transport from the Alaska Railroad Corporation and quotes for barge transport from Inland Barge Services. For six communities we estimated barge transportation costs for 20 ft and 40 ft containers based on river miles and price quotes by Inland Barge Services. For the remaining communities, we relied on previous transportation cost estimates developed by PND, Inc (2005). Note, the PND, Inc. (2005) estimates are generic and on a per gallon basis whereas the quotes by Inland Barge Services are on a per pound basis. For the latter, we account for differences in weight between filled and empty ISO containers on the way in and out of the communities, respectively. Table 3 compares barge transportation costs on a per gallon basis.

Table 3 Barge transportation costs

Origin	Destination	$/gal [20 ft, 40ft]	Source
Anchorage	Unalaska	1.34	PND, Inc. (2005)
Anchorage	Dillingham	1.68	PND, Inc. (2005)
Anchorage	Bethel	1.68	PND, Inc. (2005)
Anchorage	Kalskag	1.37, 1.26	ISER
Anchorage	McGrath	3.97	PND, Inc. (2005)
Yukon River Bridge	Emmonak	2.46, 2.26	Inland Barge Company, ISER
Yukon River Bridge	Mountain Village	1.98, 1.82	Inland Barge Company, ISER
Yukon River Bridge	Galena	0.56, 0.52	Inland Barge Company, ISER
Yukon River Bridge	Tanana	0.56, 0.51	Inland Barge Company, ISER
Yukon River Bridge	Fort Yukon	1.19, 1.10	Inland Barge Company, ISER
Anchorage	Kotzebue	2.24	PND, Inc. (2005)
Anchorage	Gambell	2.24	PND, Inc. (2005)
Anchorage	Juneau	1.01	PND, Inc. (2005)

The rail transportation cost between Fairbanks and Anchorage as quoted on August 31st 2009 is $910 per 20 ft container and includes loading and unloading to place of first rest. Carlile Transportation Systems quotes trucking costs of $2.83 per mile between Prudhoe Bay and Fairbanks and $2.37 per mile between Prudhoe Bay and Anchorage. Comparing the above transportation costs between Fairbanks and Anchorage by rail versus truck, trucking is currently 5 cents less on a per gallon basis.

Electric Utility Energy Demand Assumptions

The analysis of whether an electric utility would switch to propane is based on current community specific PCE statistics, data from utilities themselves, and EIA generation statistics. The default setting for capital cost associated with utilities switching to propane is equal to $1,100 / kW of installed capacity. The model can be set to incorporate this capital cost into the electric rates calculated by the model.

Household Energy Demand Assumptions

Using recently collected consumer end use data and model assumptions in PND, Inc. (2005) we specify the following household energy demand characteristics:

Table 4 Household energy demand characteristics

		[gal of diesel/year]	[kWh/year]	[gal of propane/year]
Electricity			5,040	
Home heating				
	Electricity		3,524	
	Fuel oil - Monitor stove	675		
	Fuel oil - boiler/furnace	825		
Water heating				
	Electric water heater w/ tank		5,690	
	Fuel oil - Toyotomi (on-demand)	140		
	Fuel oil - boiler w/tank	180		
Cooking				
	electric range stove and oven		1,295	
	propane stove and oven			72

We calculate community energy demand based on recently collected data by Schwoerer (2010) that revealed the proportions of households using the above outlined technologies and Census 2000 information illustrating the type of fuel used in each of the study communities. The following Table 5 shows the technology proportions observed by Schwoerer (2010):

Table 5 Household energy technology

Home heating: proportion of hhs using …		
	boiler / furnace	37%
	high efficiency vents	63%
		100%
Water heating: proportion of hhs using …		
	Fuel oil - (on-demand)	23%
	Fuel oil - boiler w/tank	31%
	Electricity	24%
	Wood and other fuels	22%
		100%
Cooking: proportion of hhs using …		
	Propane	65%
	Electricity	35%
	Wood and other fuels	0%
		100%

We assume that households would not change their technology when switching to propane. For example, a household currently using direct vent technology will continue to use that technology with propane instead of fuel oil. Propane demand will depend on how many households switch from using fuel oil, electricity, wood, or other fuels to propane. The user of the model can adjust the latter assumption. Results presented in this study assume the following default settings:

Table 6 Default setting for household technology conversion assumptions

	home heating	water heating	cooking
boiler / furnace			
monitor stove	100%	100%	
boiler / furnace	100%	100%	
electricity	0%	0%	0%
wood and other fuels	0%	0%	0%

ISER updated the capital costs associated with residents switching to propane for their home heating and water heating. The costs presented below (Table 7) are the default settings for the model and **do not** include the labor costs of associated with installation which can easily double the initial investment in capital.[3]

[3] Personal communication with Rural Energy Enterprises Lonny Jackson, call: (907) 278 7441.

Table 7 Residential conversion costs per household (not incl. installation)

	cost	interest rate	life [years]
home heating			
monitor stove	$ 1,700	6%	15
boiler/furnace	$ 2,149	6%	15
electric	$ 1,700	6%	15
wood and other	$ 1,700	6%	15
water heating			
on-demand (e.g. toyotomi)	$ 1,750	6%	15
boiler / furnace	$ 2,149	6%	15
electric	$ 1,750	6%	15
wood and other	$ 1,750	6%	15
cooking	$ 650	6%	15

Savings associated with conversion from fuel oil to propane take the differences in efficiency of varying technologies into account. For example, fuel oil fired boilers are slightly less efficient than fuel oil fired direct vents, propane fired boilers, and propane fired direct vents. Thus, by switching from a fuel oil fired boiler to a propane fired boiler, households realize savings through an efficiency gain.

Limitations/Extensions

- Transportation costs are not fuel price sensitive, thus we developed a sensitivity analysis that shows how savings to the community change under varying transportation costs.
- A Net Present Value analysis based on this model could be used to determine long term viability of the project.

Results and Sensitivity Analysis

For the communities for which converting to propane makes economic sense, annual savings to households from converting to propane from fuel oil can reach $1,270 at $50 per barrel of crude oil, and $5,300 at $140 per barrel.[4] Interesting to note is that switching to propane for water heating makes more sense at lower crude oil prices than home heating. The viability of using propane for home heating depends on higher oil

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prices, as does the viability of electric utilities switching to propane for electricity generation. The results show that Fairbanks could benefit from converting to propane for electric generation starting at crude oil prices of $50/bbl and more. Three of the fourteen communities would benefit from switching to propane for home heating, at crude oil prices higher than $80/bbl and four communities would realize savings for space heating at crude oil prices higher than $110. In regards to using propane for water heating, nine of the fourteen communities would benefit starting at crude prices of $50/bbl and more.

The realized household savings are also sensitive to assumptions surrounding the operating cost of the production facility and changes in barge transportation costs. If the default operating costs of $16.22 million annually could be cut in half, maximum annual savings to households would increase from $1,900 to $2,600 annually (equal to a 40% increase), while an increase in operating costs of 50% would reduce maximum annual savings observed across all communities to $1,200 from $1,900 (equal to a 40% reduction).

We observe similar but slightly more dramatic sensitivities in savings when analyzing potential changes in overall transportation costs. Given the case of a 50% reduction in overall transportation costs, the maximum value of savings observed across all study communities is equal to $2,750 (equal to a 45% increase), while a 50% increase in transportation costs results in a reduction of maximum savings to $1,000 (equal to a 45% reduction).

Whether propane makes sense for different applications used by residential and commercial consumers, depends on crude oil prices. Table 8 illustrates optimal conversion strategies across communities for a low price ($64/barrel) and a high price ($140/barrel) scenario. The red cells in Table 8 indicate that it makes no sense for the community to switch to propane for the application stated in the corresponding column heading. On the other hand green cells show that it would be beneficial to switch to propane for the application.

Table 8 suggests that, after Fairbanks, communities along the Yukon River are the primary potential candidates for conversion to propane, followed by Kuskokwim communities and Gambell. If crude oil prices increase in the future, conversion to propane water heaters may be the obvious choice for the immediate future. Conversion to propane for space heating would require higher oil prices and low transportation costs, as observed in communities along the Yukon River, to be economically feasible.

Table 8 Results by community under low and high crude oil prices

Crude oil $64 (default setting)	electric utility	home heating	water heating	cooking
Bethel	NO	NO	YES	new propane
Dillingham	NO	NO	NO	new propane
Gambell	NO	NO	YES	new propane
Kotzebue	NO	NO	NO	new propane
McGrath	NO	NO	YES	new propane
Emmonak	NO	NO	YES	new propane
Fort Yukon	NO	NO	YES	new propane
Galena	NO	NO	YES	new propane
Kalskag	NO	NO	YES	new propane
Mountain Village	NO	NO	NO	new propane
Fairbanks	YES	YES	YES	new propane
Juneau	NO	NO	NO	current propane
Unalaska	NO	NO	NO	new propane
Tanana	NO	NO	YES	new propane

Crude oil $140	electric utility	home heating	water heating	cooking
Bethel	NO	NO	YES	new propane
Dillingham	NO	NO	NO	new propane
Gambell	NO	NO	YES	new propane
Kotzebue	NO	NO	NO	new propane
McGrath	NO	NO	YES	new propane
Emmonak	NO	NO	YES	new propane
Fort Yukon	NO	YES	YES	new propane
Galena	NO	YES	YES	new propane
Kalskag	NO	NO	YES	new propane
Mountain Village	NO	NO	NO	new propane
Fairbanks	YES	YES	YES	new propane
Juneau	NO	NO	NO	current propane
Unalaska	NO	NO	NO	new propane
Tanana	NO	YES	YES	new propane

Conclusion

This analysis estimates that there may be savings associated with switching to propane for utilities and for residential space and water heating and cooking needs.

References

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http://www.dog.dnr.state.ak.us/oil/programs/royalty/royaltyvalue.htm

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Schwoerer, T. (2010) Energy data collection field trip to four selected Norton Sound communities, March 2010.

Appendix: Associated Excel Workbooks

Two Excel workbooks are associated with this report. They have been placed on the ISER Web site along with this report. The report can be found by searching the ISER publications database using the term “propane.” The worksheets are:

Spreadsheet model used for analysis:
Schwoerer_Fay(2010)propane_phase2.xlsx

Protected web version of spreadsheet model:
Schwoerer_Fay(2010)propane_phase2_web.xlsx