

3/31/11
Overview by
Alaska Natural
Gas Development
Authority:
Alaska Propane
Project

<TARGET><BILL></BILL><SUBJECT>3-31-11 Overview by Alaska
Natural Gas Development Authority Alaska Propane
Project</SUBJECT><COMM>HENE27</COMM></TARGET>

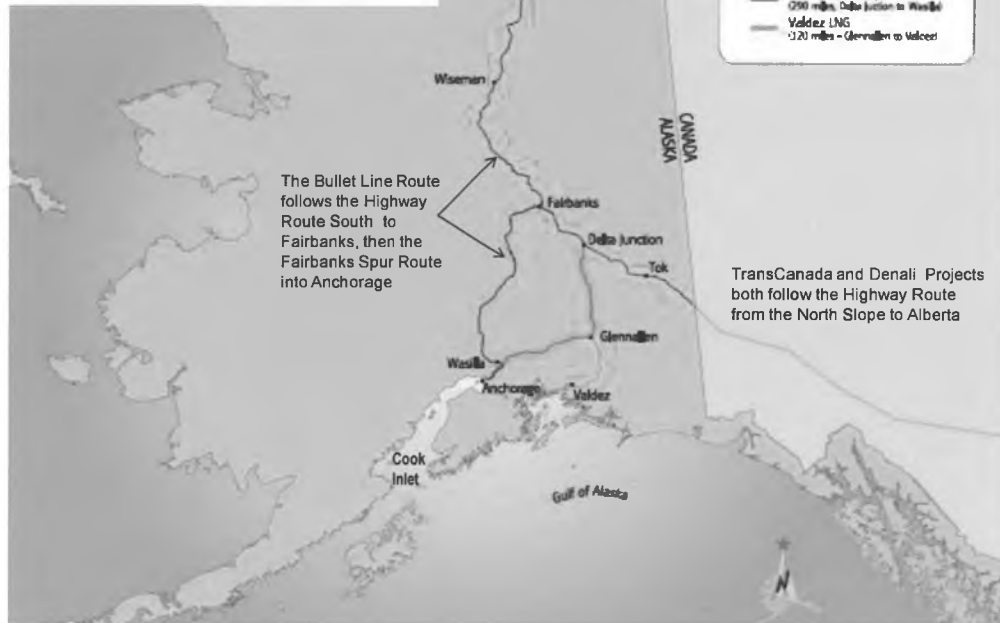
Alaska North Slope Propane Conference

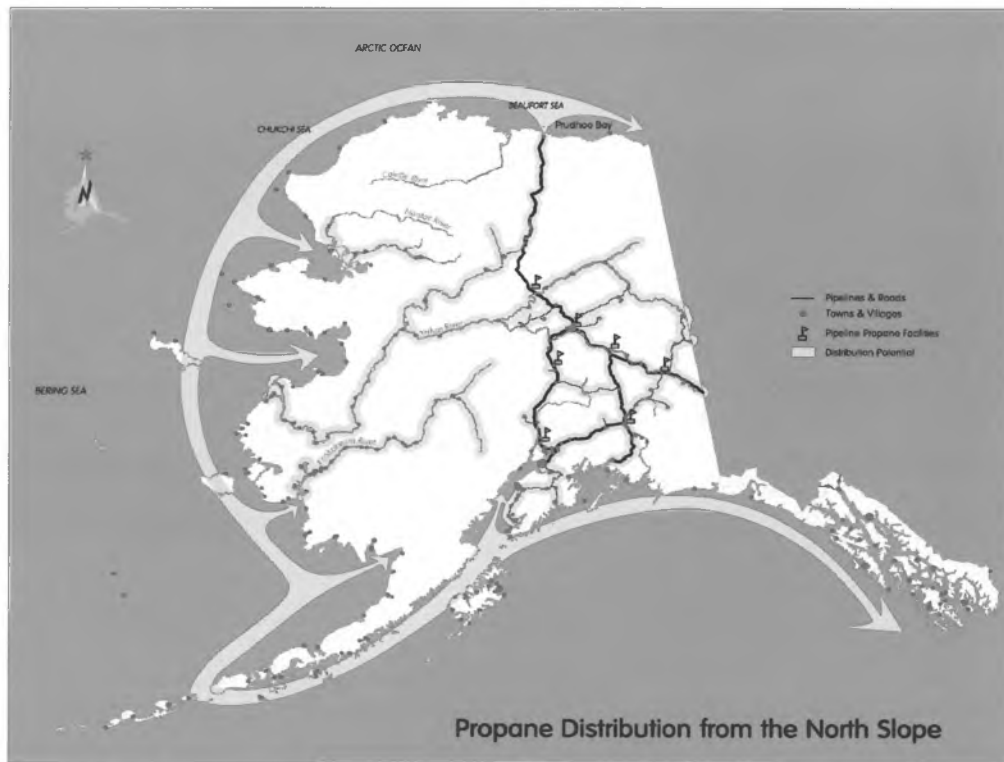
March 31, 2011 - April 1, 2011

Presentation by Mary Ann Pease, Consultant
Alaska Natural Gas Development Authority (ANGDA)

"Connecting Alaskans To Their Natural Gas"

Proposed Gas Pipeline Routes-
Still many parts of the State where a
gas pipeline will never reach....Propane
is an attractive alternative to diesel





Propane's Benefits and Opportunities

- ▶ Alternative clean fuel for rural Alaska
- ▶ Price advantage of North Slope gas btu value
- ▶ Extends reach to Alaskans that transcends gas pipeline route.
- ▶ Opportunities
 - World class C_3 volumes currently produced and injected in PBU
 - Gas pipeline is designed to transport entire C_3 production stream
 - Current CGF configuration captures only one-third of C_3 processed

North Slope Propane Opportunity

- ▶ With no market for C₃, CGF operational target is maximum NGL (C₄+) in TAPS and enough C₃ for miscible injection
- ▶ A petrochemical market of 20 k bpd C₃ can be supplied by direct marine export due to reduced polar ice extent & thickness
- ▶ ANGDA is willing to facilitate logistical & market (both in-state & export) development consistent with the PBU developing a propane delivery point

LPG's & NGL's in North Slope Pipeline

North Slope Gas Pipeline Flow --- 4.5 BCFPD

Component	Mole Percent	Bbls/Day	Thousand Tonnes Per Year
C2 Ethane	7.23	206,000	4,250
C3 Propane	3.76	110,250	3,250
C4 Butane	0.76	26,250	900
C5+ Pentanes	0.03	1,250	45

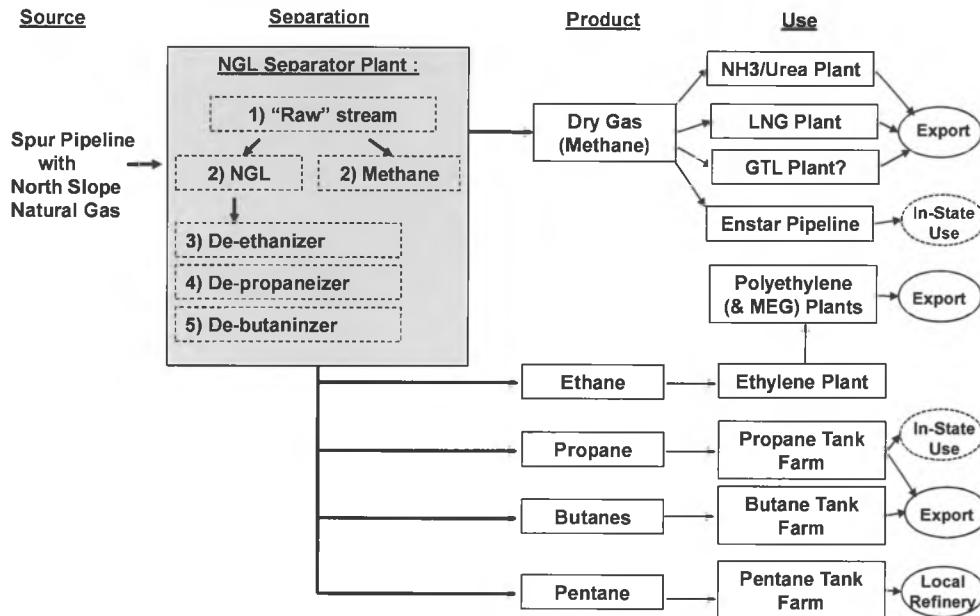
Feedstock Based Cracker Production Capacities

Carbon Number		C2	C3	C4	C5+
Product Name		Ethane	Propane	Butane	Pentanes
Concentration	Mole Pct	7.23	3.76	0.76	0.03
Volume of Feedstock	Bbbls/Day	206,000	110,250	26,250	1,250
Total Available Feedstock	KTA	4,250	3,250	900	45
After Liquids Separation	KTA	1,934	1,479	410	21
Feed Used/MT of Ethylene	MT/MT	1.29	2.38	2.50	3.25
Ethylene Capacity	KTA	1,500	621	164	6
Propylene/MT of Ethylene	MT/MT	0.04	0.40	0.43	0.53
Propylene Capacity	KTA	54	248	71	3

There'll Be Enough Ethane for Three World Scale PE Plants (or Two PE + One Ethylene Glycol Plant),
But Not Enough Other Feeds for a World Scale Propylene Derivative Plant, Even if They All are Used

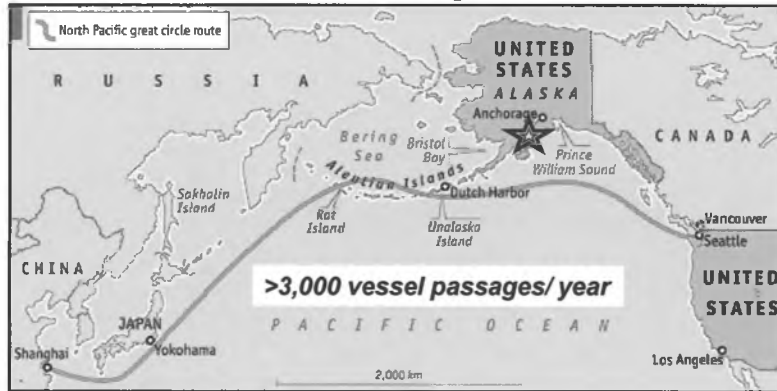
Composition Based on ANGTS – Alaska ROW Application (June 1, 2004) – Page 9 of 34

Alaska Gas & NGL Potential Uses



Logistics to Asia & US West Coast

Cook Inlet has advantaged logistics to the US West Coast and Asia due to its location in the middle of the great circle route, with the potential for additional backhaul freight rate reductions to Asia.



- ▶ Specific advantages include:
 - Favorable logistics costs versus Alberta production for Asian markets
 - Favorable logistics costs versus Asian production for US West Coast markets
 - Competitive logistics costs versus USGC for US West Coast markets

Channel to Market Issues– Export

- ▶ An Asian company would be considered a domestic supplier in the US market if it has production capacity in Alaska, which could help in marketing to customers and in its dealings with the government.
- ▶ An Alaskan plant would not only have duty free access to the entire US market, but would also be able to participate in the North American Free Trade Agreement with Canada and Mexico, as well.
- ▶ The first mover on petrochemical investment in Alaska will understand the local situation better than latecomers will, and is better positioned for additional future petrochemical and downstream investments.
- ▶ Partnering with or buying a US company could facilitate market development activities for an Alaskan plant's owner (IPIC bought Nova, and SABIC bought GE Plastics).

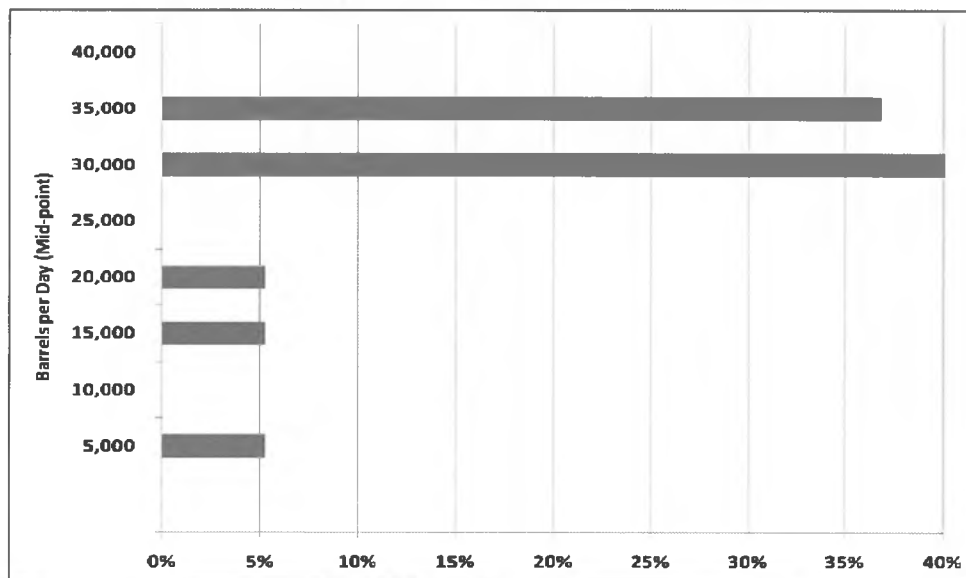
ANGDA's Ask of PBU owners

- ▶ PBU Operator to perform technical evaluations of:
 - CGF Process shift to increase C₃
 - Design concept for new C₃ separation facilities
 - VROM Cost Estimate of modifications & new construction
- ▶ PBU to consider development of a non-unit logistical facility to receive individual owner C₃ sales



Potential Alaska In-State Demand For Propane (Alaska Pipeline Project In-State Gas Study)

Figure 25. Chances of Propane Demand, Alberta Route, Years 10-15



Source: Northern Economics, Inc.

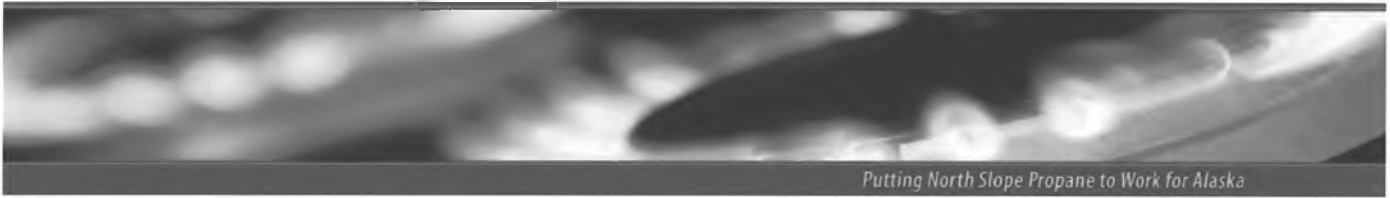
In-State and North Slope Opportunity

- ▶ Potential Fleet Services operation on the North Slope converted to less expensive N.S. propane rather than trucked ULSD
 - ▶ Utilization of propane for new development staging facilities
 - ▶ Transitional development from in-state and N.S. use to longer-term export
 - ▶ Industrial applications, such as generation
 - ▶ Rural community and village opportunity for home heating
- 

Propane Barging / Tankering Direct From North Slope

- ▶ **Mining operations**
 - ▶ **Cook Inlet Utilities**
 - ▶ **The Gas Company in Hawaii**
 - ▶ **Petrochemical Manufacturing Plants**
 - ▶ **Lower 48 for peak seasonal demand**
 - ▶ **Other worldwide applications and markets**
- 

Alaska North Slope Propane Conference



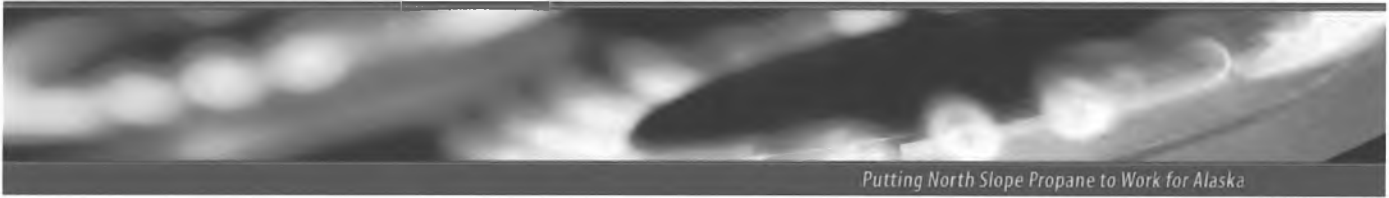
Putting North Slope Propane to Work for Alaska

**Commons Building, University of Alaska
3700 Sharon Gagnon Lane
Anchorage, Alaska**

Thursday, March 31st, 2011

- 9:00 – 10:00 **Welcome and Introduction**
Mayor Dan Sullivan, City of Anchorage
Chancellor Tom Case, University of Alaska Anchorage
Scott Heyworth, ANGDA Board Chairman
- Update on the North Slope Propane Project – Stakeholders in the Discussion**
Mary Ann Pease, ANGDA
- 10:00 – 10:45 **Alternative Energy for a Sustainable Future**
Lt. Governor Mead Treadwell
- 15 Minute Break-----
- 11:00 – 11:30 **Technical Discussions**
Mary Ann Pease, ANGDA
- 11:30 – 12:00 **Infrastructure Status – ISO Containers and Storage**
Pat Malara, Western Cascade
- 12:00 – 1:00 **LUNCH**
Keynote Speaker: Propane Sourcing – Alaskan and National Perspective
Randy Bradford, Amerigas
- 1:00 – 3:00 **Transportation Opportunities and Issues with Deliveries to Rural Alaska**
Randy Breaux, Crowley
Opportunities for Propane Expansion – North Slope Operations, Mining, etc.
Chris Birch, NANA
- 15 Minute Break-----
- 3:15 – 4:00 **AIDEA Financing Opportunities**
Jim Hemsath, AIDEA
Randall Finken, First Southwest
- 4:00 – 5:00 **Distribution and Equipment**
CleanFuel USA, ABS Alaskan, Rural Energy Enterprises, and Yanmar

Alaska North Slope Propane Conference



Putting North Slope Propane to Work for Alaska

Friday, April 1st, 2011

- 9:00 – 9:30 **Welcome and Recap from Day One**
Mary Ann Pease, ANGDA
Chancellor Tom Case, University of Alaska Anchorage
- 9:30 – 10:30 **Demonstration Projects – Current Projects in Alaska, Proposed Future Projects and National/International Applications**
New technologies and Rural Applications
Baron Glassgow, National Propane Gas Association
Larry Osgood, Propane Education & Research Council
- 15 Minute Break-----
- 10:45 – 11:45 **Private Sector Opportunity for Resource Development**
Dave Harbour, Publisher, Northern Gas Pipelines
- 11:45 – 12:00 **Letter from Senator Murkowski**
Robert Dillon, US Senate Energy and Natural Resources
- 12:00 – 1:00 **LUNCH**
Keynote Address: Propane Fueled Vehicles for Fleet and Oil Field Services
Todd Mouw, ROUSH CleanTech
- 1:00 – 1:30 **Alaskan Petrochemical Investment Opportunities**
Bill Popp, Anchorage Economic Development Corporation
- 1:30 – 3:00 **Rural Energy Needs – A Community Perspective**
Chris Rose, Renewable Energy Alaska Project
Ingemar Mathiasson, Northwest Arctic Borough
Bear Ketzler, City of Tanana
Gwen Holdmann, Alaska Center for Energy and Power, UAF
Paul Fuhs, Fuhs Professional Services
- 15 Minute Break-----
- 3:15 – 4:00 **Legislative Roundtable – Update from Juneau on Energy**
- 4:00 – 5:00 **NPGA Discussion – Initiatives, Opportunities and Next Steps**

**PROPANE PRODUCTION, TRANSPORTATION
AND UTILIZATION IN RURAL AND URBAN ALASKA**

**PREPARED FOR
ALASKA NATURAL GAS DEVELOPMENT AUTHORITY**

**BY PAUL FUHS
DECEMBER 2010**



PROPANE PRODUCTION, TRANSPORTATION AND UTILIZATION IN RURAL AND URBAN ALASKA

ALASKA NATURAL GAS DEVELOPMENT AUTHORITY

PRINCIPAL FINDINGS:

This report considers and analyzes a number of transportation and technical issues related to potential large scale use of propane produced on the North Slope and consumed in rural and urban Alaska. The overall conclusion of this investigation is that it is feasible to transport and utilize large quantities of propane and save consumers money, if the product can be purchased and produced at a reasonable price on the North Slope, ideally below \$1 per gallon.

The access point at which propane can be extracted from gas processing facilities on the North Slope has a dramatic effect on the price of producing propane. Negotiations are currently underway between ANGDA staff and the Prudhoe Bay Unit operator's group to gain access to the most favorable access point.

Transportation costs are reduced substantially when bulk shipping methods are used. As the recent Northern Economics report points out, propane use is expected to ramp up over the years as it is shown to produce cost savings to consumers. Once a tipping point is reached to justify bulk shipping, the additional transportation savings are substantial.

Propane can be used as a fuel for generating electricity and the maintenance profile for propane generators is much lower than diesel generators. In recent years the State of Alaska has focused on alternative electrical generation strategies. Propane generation of electricity should also be considered in the mix of alternatives. However, even if advances can be made in reducing electrical generation costs, there will still be a strong need for home heating and cooking fuel which could be even more important to reducing household energy costs than electricity.

According to the Alaska Energy Authority, In Western rural Alaska, households can spend as much as four times as much on home heating than they do for electricity. In Fairbanks, households spend twice as much on home heating as they do on electricity. In Southcentral Alaska, households spend about as much on home heating as they do for electricity. (for detailed data see Propane Residential Use section below.)

Even when any of the proposed gasline projects are completed there will still be a need for propane for home heating in urban areas where the housing densities are not high enough to justify the extension of local distribution systems.

The primary purpose of the ANGDA propane project is to provide an alternative energy source which results in cost savings to residential and business consumers in Alaska.

PROPANE PRODUCTION COSTS

According to the ANGDA North Slope propane acquisition team, there are several points of entry on the North Slope where propane can be extracted. The points at which propane is at its highest concentration in the gas processing facility are the points that will require the least amount of gas processing and result in the lowest priced propane. The ANGDA team is in the process of negotiating these agreements with the North Slope producers. NANA/Worley Parsons and CH2MHILL are on contract to provide costs estimates for the various scenarios. Since the negotiations with the producers have not been concluded, it is not possible to forecast a price for propane at the gate on the North Slope. This paper focuses on the transportation, storage and other costs associated with using propane. These costs would be added to the purchase/production cost of propane on the North Slope to estimate ultimate delivered costs.

If any of the proposed gasline proposals moves forward, propane can also be extracted anywhere along the line through a straddle plant which removes the desired gases for consumer use or value added processing and then puts the remainder back into the gasline. This would be similar to the operation of the Flint Hills refinery with the Trans Alaska Pipeline. The propane extraction facilities on the North Slope are designed so that they can be relocated if desired.

PRICING ISSUES COMPARED TO DIESEL FUEL

Propane starts with a thermal disadvantage to diesel fuel in that it contains one third less heating value compared to diesel. So to be competitive with diesel at \$6/gallon, propane would have to be sold at \$4/gallon. This will affect storage also in that you must store 50% more propane than diesel to create an equal amount of BTU's. If you required 2000 barrels of diesel storage, you would have to have 3000 barrels of propane storage. However, there are other advantages to using propane that mitigate this thermal disadvantage and they are discussed later in this report.

PRICING ISSUES RELATED TO COMPETITION

It appears that if ANGDA can obtain agreements to access propane at the most favorable offtake point on the North Slope, propane can be delivered at a very favorable price. What are the assurances that savings in producing and transporting propane would be ultimately passed on to consumers? There are several factors which could affect this outcome.

First, in the urban areas such as Fairbanks and in rural areas where there are competing suppliers, this unregulated competition should result in savings to consumers while providing a reasonable level of profit for the distributors.

In areas where there is no competition, it is more difficult to ensure that cost savings will be passed on to consumers. In these areas local entities have taken steps to achieve savings, primarily through consolidated purchase of fuel through a regulated utility, such as an electric utility. Most of these are non profit cooperatives that exist to provide the lowest cost of energy to their customers. In addition, most of them are regulated by the Regulatory Commission of Alaska which ensures that consumers will receive the lowest energy prices. Some of the larger rural electric utilities have even considered establishing their own fuel shipping operations.

At the AFN convention last year, there were several references made to forming a fuel purchasing coop to create more competitive conditions in these remote areas. This could also contribute to competition by combining the demand from many villages and then going out to bid for the service.

However, there are also issues of local distribution which could affect these savings. Although it has not received much publicity, in many cases, village fuel distribution is owned by the village native corporation or by the municipality or tribe. Fuel sales are one of their only sources of income and they are responsible for some of the high prices we have seen. While storage and distribution costs range from \$0.25 to \$1.00 per gallon, in many cases the local markups are from \$2 to \$4 per gallon. These are tough decisions to make when the viability of these organizations may hang on highly marked up fuel sales.

Propane could also be competitive when applied to a portion of the demand of a community, for instance, a school or new HUD housing development. In that case micro generators could provide the electricity and also provide waste heat for home heating, or refrigeration for community freezers. However, the impact on local utilities must be carefully weighed. If a school representing 1/3 of local electrical demand went off the local grid and generated its own power with propane, the local utility would lose 1/3 of its market and the remaining fixed costs they have would have to be spread among the remaining customers, increasing the energy costs to residential and business users.

In a recent development the Alaska Village Electric Coop (AVEC) which aggregates demand and makes bulk purchases of fuel for many villages in Western Alaska, has proposed to begin shipping its own fuel through its subsidiary Vitus Marine. This could provide a transportation service dedicated to its customers for all forms of fuel. In discussions with AVEC and Vitus Marine, they are interested in exploring shipping and utilizing propane for electrical generation and home use if the purchase price of propane at the Yukon River bridge or Nenana would result in savings to the utility and its customers.

The issue of competition and savings to customers will have to continue to be addressed as ANGDA proceeds with this project.

POTENTIAL USES OF PROPANE

RURAL RESIDENTIAL PROPANE USE

Propane is already in use in many residences in rural Alaska primarily for home cooking and some water heating. As previously stated, home heating costs far exceed electricity costs in Western Alaska by a factor of up to 4 to 1. If the delivered price of propane is competitive, it could be a practical alternative to diesel for home heating.

Alaska Energy Authority Regional Energy Cost Comparisons, August 2008
Average household energy costs by use category

Anchorage	Fairbanks
\$1,371 Electricity	\$1,912 Electricity
\$1,086 Heating	\$4,027 Heating
\$5,726 Transportation	\$3,521 Transportation
\$8,182 Total Energy	\$9,461 Total Energy
12.2% Percent of income	15.3% Percent of income
Southeast Alaska	Rural Alaska
\$1,374 Electricity	\$1,843 Electricity
\$1,704 Heating	\$7,715 Heating
\$2,291 Transportation	\$2,282 Transportation
\$5,368 Total Energy	\$11,840 Total Energy
8.5% Percent of income	20.2% Percent of income

The cost of converting a home to propane would be approximately \$3,000, including a space heater with flush mount exhaust, an on demand water heater and a 250 gallon buried fuel tank which should last for about a month depending on the season.

As previously mentioned, a very efficient use of propane could be in a small housing development in which propane is used to generate electricity through a micro generator, the waste heat is used to heat homes, and waste heat is also used to provide refrigeration for a community freezer to keep subsistence foods. If this system were installed by the local utility, it would not detract from covering their fixed cost of operating the utility.

URBAN RESIDENTIAL PROPANE USE

When a gasline is eventually built, it will connect many Alaskan communities to gas that have never been connected before. However, as we have seen in Southcentral Alaska, there are still many residents who cannot connect to gas because they live in areas that are not dense enough to justify the extension of local distribution pipelines. It is estimated that in Fairbanks, about 20,000 residents would be connected to a local gas grid. The remaining 60,000 residents could use propane for home heating and cooking.

PROPANE USE BY ELECTRIC UTILITIES

Propane is a good fuel for electrical generation. It burns clean and the maintenance on propane turbines is a fraction of diesel generators. Diesel generator maintenance has been a persistent problem in rural Alaska. In addition, it appears that propane generators may be a more appropriate fit with the wind generation systems being deployed throughout rural Alaska. When large diesel generators are required to keep running to maintain maximum load when the wind generators are only partially meeting the need, the benefits of wind power are diminished. An array of smaller propane turbines could respond to fluctuating wind energy by switching entire units off.

Diesel engines can also be retrofitted by installing an input orifice on the intake manifold to inject propane in a mixture of up to 25% with diesel fuel without further modifications to the unit. The unit then burns cleaner due to the higher combustion achieved with the addition of the propane.

The bottom line for electrical utilities will be the delivered price of propane compared to diesel. Electrical prices in rural Alaska are already so high that a savings will have to be shown to entice utilities to convert to propane.

PROPANE USE BY MINES

Propane could be an attractive fuel for mines to use in electrical generation. The reduced emissions can help them achieve their air quality requirements. Propane generators also operate on a much lower maintenance schedule than diesel generators. As previously mentioned, existing diesel generators can be retrofitted to use up to 25% propane. The Donlin Creek mine is installing generators that can burn diesel, methane or propane.

The amount of fuel anticipated to be used in these mines is very large indicating that a pipeline may be the most efficient way to move propane. In fact, Nova Gold is proposing a gasline from Beluga to Crooked Creek to fuel its generators. If a propane solution can be shown to be a cost effective alternative, this mine and any others including the prospect at Livengood have said they would consider it. Delivered price will once again be crucial.

PROPANE AS A TRANSPORTATION FUEL

Propane has been used as a transportation fuel for many years. Roush Clean Tech has recently placed two Ford F250 trucks into service on Dalton Highway and North Slope operations. Over this winter they have performed very well. Using propane as a fuel is an alternative to the required use of ultra low sulfur diesel on the North Slope. If propane can be produced for a reasonable price in Alaska, it could be an alternative to gasoline and diesel fuel. It may also help communities reduce violations of the Clean Air Act.

BULK PROPANE TRANSPORTATION METHODS WITHIN ALASKA

RIVERINE MARINE TRANSPORTATION OF PROPANE

Self contained tanks: Propane is currently delivered in 100# to 1000 gallon tanks using existing barge and off loading equipment. The cost of shipping in 100# weights is listed below.

Representative prices for 100# weights to communities on the Yukon River.

These quotes were obtained from local barge shipping companies. These rates represent one time per 100# rates. If a regular trade is established and regular bulk shipments are made, these prices are traditionally lowered by 20% for long term customers.

Trucking costs to Nenana:

\$.50 per gallon based on either a single bulk tank of 10,000 gallons or two 20 foot ISO's. These limits are consistent with weight restrictions on the Dalton Highway.

Marine component shipping rates including bulk rate reductions of 20%:

Nenana to Tanana - $\$11.34/100\# = \$.81/\text{gallon}$ minus 20% = $\$.64/\text{gallon}$

Nenana to Galena - $\$14.00/100\# = \$1.00/\text{gallon}$ minus 20% = $\$.80/\text{gallon}$

Nenana to Marshall - $\$24.26/100\# = \$1.75/\text{gallon}$ minus 20% = $\$1.40/\text{gallon}$

Nenana to St Marys - $\$27.50/100\# = \$1.96/\text{gallon}$ minus 20% = $\$1.57/\text{gallon}$

To obtain the total transportation cost add the \$.50/gallon cost of trucking to Nenana.

It would be even more economical to utilize 20 foot ISO propane containers which can hold 5000 gallons of propane. These containers are post flats and can be stacked with other consumer goods on a barge. However, given the tank weight and product, these ISO's would weigh 30,000 pounds. Most villages do not have the equipment available locally to move items of this weight so the barge carrier would have to carry that equipment on board, for instance a Cat 988 loader (or equivalent) to move the tanks into the community.

An advantage of large, self contained tanks is that there is no local tank storage required. As demand ramps up, more containers can be supplied to accommodate the demand. 20 foot ISO containers cost in the range of \$50,000.00 each used, or \$65,000.00 each new.

A disadvantage of self contained tanks is that the cost of shipping the tanks themselves puts costs on the delivery system that does not produce any energy. Whether it is a 100# tank or a 20 foot ISO, the tank weight is approximately 30% of the total weight. Shippers charge by the pound so 30% of the cost of shipping the propane is the tank shipping cost. Then the container must be shipped back empty to be refilled. The carriers we contacted had an empty tank haul back rate of 50% of the shipping rate, resulting in an additional 15% charge on the total shipping weight, so this means that combined, 45% of the costs of shipping propane are tank shipping costs. How this compares to permanent local storage and bulk shipments of propane is discussed in the STORAGE ISSUES section below.

BULK RIVERINE TRANSPORTATION OF PROPANE

Bulk shipments of propane could result in substantial savings in transportation costs. Two scenarios are: dedicated bulk shipment of 20 foot ISO's deck loaded on top of a diesel delivery barge and a dedicated pressurized propane barge that would deliver in bulk to permanent onshore storage tanks.

While the resources were not available for this study at this time to do a detailed analysis of the costs of these shipments, I was able to obtain enough information from shippers to describe how the system would work and provide some preliminary numbers. Barge companies were reluctant to provide proprietary information so an independent analysis would need to be done.

The bulk shipment of 20 foot ISO's would be most efficient in conjunction with delivery of diesel fuel. These barges would pick up diesel from distribution hubs like Bethel or take on loads from ocean going barges (the more common source) and then proceed up river to make deliveries of diesel. Following delivery of their most up river destination, they would proceed to the Yukon river bridge to take on a full deck load of 20 foot ISO's. To use the design of the Vitus Marine barges as an example, they would be able to carry 48 loaded ISO's of propane on one barge and 60 on the other. At 5,000 gallons of propane per ISO this translates into a total of 240,000 gallons and 300,000 gallons respectively.

They would then deliver these ISO's going down the river and pick up the empties on their way back up river making diesel deliveries. This would provide for maximum utilization of equipment and the lowest shipping costs. Although these loading operations could be accomplished with current conditions at the Yukon River crossing, they would be more efficient if mooring dolphins or an open cell sheet pile dock were installed at an estimated cost of \$2-3 million. Loading at the Yukon River would also reduce trucking costs to \$.35/gallon due to reduced mileage.

Propane could also be delivered in a pressurized tank barge and loaded to permanent onshore tanks through a discharge hose as is currently done with diesel fuel. Such a truck based operation was conducted in the 1990's with diesel being delivered by truck from the Flint Hills refinery in Fairbanks and then loaded to the barge at the Yukon River crossing via a floating hose. This service was discontinued due to refinery pricing issues, but it did show feasibility from an operations standpoint. Again, construction of a basic barge landing structure and storage tanks at the Yukon River crossing would improve the efficiency of the operation.

Offloading propane at communities would be accomplished by connecting discharge lines from the barge to headers on shore and then pumped to storage. Barge operators saw this as no different than discharging diesel.

Representative Inland River (Mississippi) Propane Barges Dimensions, Draft and Capacity				
USCG #	261064	262194	282474	271388
Dimension	195'x44'	195'x44'	210'x44'	210'x44'
Draft (ft)	6' 3"	6' 3"	8' 6"	7' 9"
Capacity (gal)	360,738	360,234	425,922	399,378
Pressure (PSI)	250	250	250	250
Source: Targa Midstream Services, LP				

There is an established port operation in Nenana that currently ships limited amounts of propane. However, the Yukon river is deeper than the Tanana river out of Nenana and could allow for deeper draft barges for bulk shipments.

In doing basic calculations of bulk shipments by pressurized propane barge from Nenana to Tanana with tug boat and crew charges at \$12,000.00 per day, the estimated cost of shipping to Tanana is \$.40/gallon, about 2/3 of the cost of shipping via container.

SHIPMENT TO TIDEWATER IN SOUTHCENTRAL ALASKA

Propane can be moved to tidewater in southcentral Alaska through a combination of truck to Fairbanks and then rail to the Port of Anchorage. The railroad rate is \$910.00 per 20 foot ISO which calculates to \$.18/gallon. This would amount to a total cost of \$.63/gallon from the North Slope to Southcentral. From there it could be shipped to other coastal communities by scheduled barge service. This service would be particularly appealing to southern coastal Alaska communities that are not icebound in the winter,

since they could receive regular shipments without having to incur the costs of substantial winter storage.

If a gasline is developed to tidewater in southcentral Alaska, propane could be extracted there and loaded directly onto barges for shipment to coastal Alaskan communities. Both southwestern and southeastern communities could be the beneficiaries of this propane distribution network. Although the concentration of propane in the gas stream of a gasline is low, (between 2% and 3%) these gases would have to be separated at tidewater to prepare methane for local distribution or for export, so these costs would be absorbed by the overall operation.

BULK PROPANE MARINE SHIPMENTS FROM THE NORTH SLOPE

While it is technically feasible to ship propane from the North Slope to coastal Alaska, there are a number of issues involved. First, the ocean depths on the North Slope are very shallow and would require the construction of a berthing facility, either ice deflecting dolphins or an open cell sheet pile dock. The cost of these facilities has not been estimated. There is an existing dock but it is extensively used during the short shipping season and it is also currently exempted from the Coast Guard port security requirements. Adding propane operations to the existing facility would change that designation and complicate its operation.

This option is further restrained by a short ice free shipping season typically of 7 to 8 weeks. Additional substantial storage would be required on the North Slope to store sufficient amounts to fill a barge with propane. The most likely customers for such shipments would be the Red Dog Mine or regional fuel hubs like Nome and Bethel.

Tug and Barge equipment would have to be leased since it could not sit idle during the iced in periods. Tugs in this area typically rent for \$15,000.00 per day. Barge leasing would be an additional cost.

STORAGE

As previously mentioned, 50% more propane is needed to produce the same energy as diesel. This means that either 50% more storage is needed or that deliveries would have to be made on a more frequent basis. However, propane storage is less costly than diesel storage due to not needing extensive diking and cleanup equipment. Due to this, the cost of propane and diesel storage tanks on an equivalent basis are roughly equal.

Many millions of dollars have been spent rebuilding diesel tank farms in rural Alaska. In our meetings with the Denali Commission, they indicated that if propane can be shown to provide a cost savings and displace the need for diesel tank storage, that they would invest in propane storage. This would equalize the subsidies between diesel and propane.

PROPANE SHIPPING TO KUSKOKWIM RIVER

Shipping to the Kuskokwim river could be accomplished by two methods: 1) coming out of the Yukon River with a bulk propane barge and going South by sea, then upriver to Bethel then transferring to a smaller lighter barge as is currently done with diesel fuel, or 2) constructing a propane pipeline connecting to the Yukon river below St. Mary's and on over to the Kuskokwim (about 60 miles). The Denali Commission is currently contemplating building a road to connect the two rivers at this point which is about 60 miles. The resources were not available to estimate the cost of this pipeline. Some storage would also be required at the terminus of the line on the Kuskokwim River. From there, the same shipping and delivery practices can be employed as those on the Yukon River.

PROPANE VAPORIZATION ISSUES

Propane does not vaporize below -45 degrees. This will require making an arctic grade of propane spiked with ethane or other lighter gas. An alternative may be burying propane storage tanks. A study by the Cold Regions Research Facility in Fairbanks shows that at one foot of burial depth, the temperatures never exceeded -19 degrees. Cold weather would not affect storage or distribution operations but would need to be considered in final storage just before the consumption point.

SECURITY OF ALTERNATIVE SUPPLY

To justify large scale conversion to propane, users will have to be assured that an alternative supply of propane is available should there be a failure of production or other disruption of supply from the North Slope. This alternative is represented by a supply point at Prince Rupert, British Columbia, connected to the Alaska rail system by the Hydrotrain barge system currently operating out of Whittier, Alaska. 10,000 gallon propane rail cars would be barged into Whittier, transferred to the Alaska Railroad and then railed to Nenana. While this supply option would incur an approximately 20% greater cost of service than North Slope propane, it could still serve as a secure supply of propane until North Slope operations could resume.

TRAINING

Training for everyone involved in the transportation and handling of propane will be necessary. Propane is regularly handled in the millions of gallons every day across the US and Alaska. However, it has some characteristics different from diesel that will require training to ensure safe operations. A class for 20 rural fuel handlers was held in Fairbanks last year but this will need to be expanded.

CONCLUSION

All the technical issues listed above can be handled with proper facilities and trained personnel. The costs of diesel remain high, opening the door to a more affordable energy source such as propane. The costs of transporting propane appear to be reasonable and are similar to or less than transporting and storing diesel. The determining factor in cost savings from use of propane in Western Alaska will be the purchase and production costs of propane on the North Slope, ensuring competitive or RCA regulated markets and reaching high enough utilization rates to justify bulk shipping methods.

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Energy Analysis

Propane from the North Slope: Could It Reduce Energy Costs in the Interior?

By Scott Goldsmith and Nick Szymoniak

University of Alaska Anchorage • Institute of Social and Economic Research • October 2009

Alaska
Natural Gas Development Authority

Could propane from the North Slope cut energy costs in Fairbanks and other Interior communities that heat buildings or generate electricity with fuel oil or naphtha? The Alaska Natural Gas Development Authority (ANGDA) thinks it could.

That's because a North Slope producer has agreed to sell ANGDA propane for considerably less than what it might otherwise cost, if there were a natural gas pipeline. Propane is a component of North Slope natural gas—and right now there's no way to get that gas to market.*

Naphtha and fuel oil, by comparison, are refined from oil—so their prices are closely tied to the volatile price of crude oil. ANGDA hopes getting a price break on propane could make it cheaper, at least until a pipeline is built—and it asked ISER to analyze the potential effects of one idea.

That idea is to build a plant on the North Slope, extract 2,000 barrels of propane a day from natural gas, and transport the propane to Fairbanks in tanker trucks. It assumes ANGDA would buy the propane, but that a private entity would build the plant, at a cost of \$74 million, and then operate the plant and truck the propane to Fairbanks, at a cost of \$16 million a year.

We analyzed how fuel prices in Fairbanks might compare, under those assumptions and at different crude oil prices. We estimated the price of propane delivered to Fairbanks, the wholesale price of fuel oil in Fairbanks, and the price of the naphtha that Golden Valley Electric Association (the Fairbanks utility) burns to generate electricity.

These aren't prices residential customers would pay. The propane price doesn't include costs of storing and distributing propane in Fairbanks, and we tried to make the fuel oil price comparable to that. This analysis is intended just to show relative fuel prices, given ANGDA's assumptions.

WHAT DID WE FIND?

• *At current crude oil prices, propane could be cheaper than either naphtha or fuel oil, for equivalent amounts of energy.* Liquid propane contains less energy per gallon than either naphtha or fuel oil, so to make fair comparisons we have to look at prices for equivalent amounts of energy. With crude oil at \$64 a barrel—close to what it was in mid-2009—a gallon of propane in Fairbanks would cost \$1.16. The energy-equivalent amount of naphtha would cost \$1.32 and fuel oil \$1.47.

• *Propane would be more attractive at higher oil prices.* That's because fuel oil prices would increase much more than propane prices, as crude oil prices increased. So for equivalent amounts of energy, propane would cost 79% as much as fuel oil, at a crude oil price of \$64 a barrel—but it would cost only 61% as much, at a crude oil price of \$100 a barrel.

• *Replacing naphtha with 2,000 barrels of propane per day could save about \$5.1 million a year, and replacing fuel oil could save \$7.6 million, assuming a crude oil price of \$64 per barrel.*

*Some propane is liquefied and shipped through the oil pipeline, but quantities are limited by the amount of vapor pressure that pipeline can withstand. Under terms and conditions that have been agreed on with a North Slope producer, ANGDA would pay the same price for propane that the producers pay each other, when they buy propane to fuel their North Slope operations.

The ANGDA Idea

Build plant to extract propane from natural gas

- Building plant: \$74 million
- Operating plant and transporting propane: \$16.2 million per year

Prudhoe Bay



Truck propane to Fairbanks

- 10 tanker trucks
- 2,000 barrels/day

Fairbanks

How Might Fuel Prices in Fairbanks Compare at Different Oil Prices?

Fuel prices per gallon	Price of North Slope crude oil	
	\$64/barrel	\$100/barrel
Propane at Fairbanks ^a	\$1.16	\$1.34
GVEA naphtha ^b	\$1.85	\$2.76
Wholesale fuel oil ^c	\$2.13	\$3.18
<i>Prices for an amount of energy equivalent to a gallon of propane</i>		
Propane at Fairbanks	\$1.16	\$1.34
GVEA naphtha	\$1.32	\$1.97
Wholesale fuel oil	\$1.47	\$2.19
<i>Propane price as percent of price of other fuels</i>		
GVEA naphtha	88%	68%
Wholesale fuel oil	79%	61%

How Much Might Annual Savings Be From Propane?

(Use of 2,000 Barrels Propane Daily and Crude Oil at \$64 per Barrel)

	Annual Savings
Replaced GVEA naphtha ^d	\$5.1 million
Replaced fuel oil ^d	\$7.6 million

^aPrice for propane delivered to Fairbanks, not including costs of storing and distributing it in Fairbanks. The price assumes the cost of the extraction plant is amortized at a 6% annual interest rate over 10 years and that the system is operating at full capacity year-round.

^bPrice paid by Golden Valley Electric Association for naphtha it burns to generate electricity.

^cWe roughly estimated wholesale fuel oil prices by adjusting retail prices, based on mark-up data from the Energy Information Administration. Actual wholesale prices are not available.

^d2,000 barrels of propane generates 7,661 mmBTUs of energy

How Would ANGDA Get the Propane?

Oil and gas are intermingled in the North Slope fields, so natural gas, —which contains propane—is produced with the oil. But without a gas pipeline, almost all the gas produced has been re-injected into the fields, to help increase the amount of oil that can ultimately be recovered. Under this proposal, ANGDA would pull off a small share of the gas when it was produced, leaving the rest to be compressed and re-injected.

Why Propane?

Propane used in Alaska today is almost all barged in from Outside, making it more expensive than other fuels. The U.S. Energy Administration estimates that propane accounts for about 1% of Alaska's residential energy use. Besides price, propane has other potential advantages and drawbacks Alaskans might want to consider, if North Slope propane became available.

- *Propane and natural gas can be used in many of the the same appliances and facilities, without major modifications.* So if Fairbanks consumers switched to propane, they could convert to natural gas later.
- *Propane condenses to a liquid under relatively little pressure, so it can be transported more easily by truck or barge than natural gas.* Natural gas is mostly methane, which requires more pressure to condense. But it can, with adequate pressure, also be liquefied and then trucked or barged. The Alaska Gasline Port Authority (made up of several municipalities) has announced it will try to sell revenue bonds, so it can build a plant to liquefy natural gas on the North Slope—and then truck the gas to Fairbanks. A Fairbanks company already trucks some Cook Inlet natural gas to Fairbanks.
- *Propane reverts to a gas when released from pressure, so spills are not a problem, as they are with fuel oil.* But because propane is heavier than air, it can be a fire threat if accidentally released.
- *Propane takes more space to transport and store than an equivalent amount of energy in fuel oil.* That's because liquid propane produces less energy, per gallon, than fuel oil or naphtha. Propane would require pressurized storage tanks, and more of them.
- *Residential propane tanks and lines need to be well-insulated from the cold, because at very cold temperatures, propane turns from gas to liquid—meaning whatever was fueled by the propane would stop working.*
- *Propane burns cleaner than fuel oil or naphtha.* But natural gas is even cleaner (see table).

Conclusions and Limits of This Analysis

Propane could be a less-expensive bridge fuel to the time North Slope natural gas is available to many Alaskans who currently have to rely on fuel oil. Once a pipeline is built, propane might lose its advantage, because: (1) its price would be determined by the market; and (2) natural gas would become available along the pipeline route.

A gas pipeline is at least a decade away, and there's no guarantee it will be built by then. In our analysis, we assumed the costs of a propane extraction plant would be recovered in 10 years. But if the pipeline were delayed, the plant could operate longer and the costs be spread out over a longer time, which would also reduce propane prices in Fairbanks. Also, some Alaska places won't have access to gas, even after a pipeline is built. And even at market prices, propane might have some advantages over fuel oil.

We analyzed one idea for using North Slope propane. It's by no means a complete analysis of propane's potential in Alaska. But it demonstrates that propane is worth considering, to help reduce and stabilize energy costs.

Energy Content and CO₂ Emissions of Selected Fuels

Content by Volume (BTUs per Gallon)		CO ₂ Emissions (Pounds per Million BTUs)
Propane	91,200	139
Naphtha	127,500	161
Fuel Oil	132,669	161
Natural gas	N/A*	117

*Natural gas isn't sold by the gallon. But as measured by standard cubic foot (scf), the heating value of propane is more than twice that of methane.

Sources: ANGDA, personal communication; U.S. Energy Information Administration; Michael Baker Jr., Inc., *Transport of Natural Gas to Tidewater*, April 2005

What is Natural Gas?

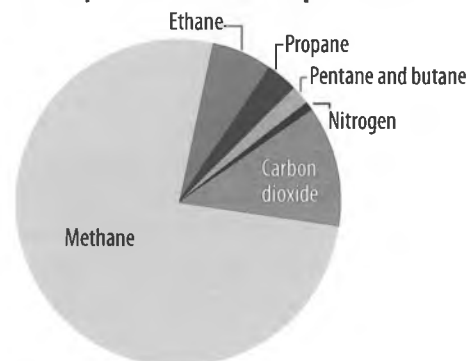
Finally, to help put propane in context, here we take a brief look at the overall composition of North Slope natural gas. Many Alaskans probably think of North Slope natural gas as some single, specific kind of gas—and it is true that it's mostly methane. But it also contains carbon dioxide, nitrogen, and various gases known collectively as natural gas liquids (NGLs).

Propane is one of those NGLs, which also include ethane, butane, and pentane. They're called "natural gas liquids" because they condense from gas to liquid at much lower pressure than methane. They're valuable as part of the natural gas mix—they have higher heating values, by volume, than methane. Also, they can be separated from the mix and sold on their own for many uses.

It is known that North Slope gas contains significant quantities of propane, ethane, and butane. But the exact composition isn't public information. The leaseholders consider that proprietary information. Also, as a report prepared for ANGDA points out, the composition of North Slope gas can vary from one field to the next.

The pie chart shows an estimate, done for ANGDA in 2005, of the general composition of North Slope natural gas before processing. We're including it here just to help readers understand what's in natural gas. Most of the carbon dioxide—which has no heating value—is taken out of the mix during processing.

Estimated Composition of North Slope Natural Gas*



*Before processing. The actual composition of North Slope natural gas is proprietary information of the leaseholders. Also, the composition varies among individual gas fields. This figure is intended only to show a general picture of the gases that make up natural gas.

Source: *Transport of Natural Gas to Tidewater*. Prepared for Alaska Natural Gas Development Authority by Michael Baker Jr., Inc., April 2005

To get more Alaskans thinking about North Slope propane, ANGDA held a conference in Fairbanks last June, inviting potential propane users and distributors and financial institutions. ISER did this analysis for that conference. To learn more about the conference, go to ANGDA's Web site: www.angda.state.ak.us