The challenges of distributing North Slope gas to Alaskans

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Offtakes from a large North Slope natural gas pipeline could supply gas to Alaskans for decades, but delivery would come with an upfront cost of over a billion dollars.

Even then, only people in the state's population core might enjoy ready access to the gas; getting the Btus to more distant communities would take much more effort – and money.

Gas for Alaskans is a central goal of federal and state laws pertaining to any pipeline project.

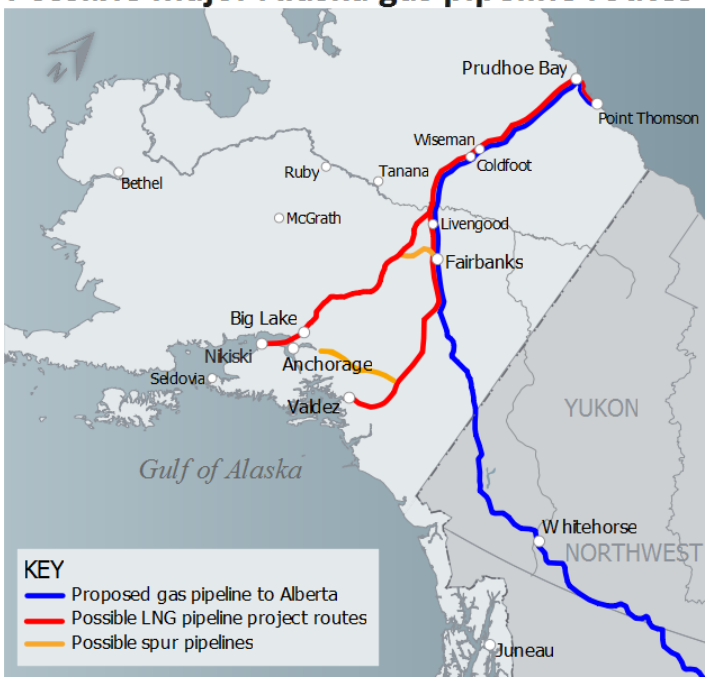
State leaders have long sought to forge an energy Eden where Alaska, although remote and northern, would tap its fossil-fuel bounty so that residents at least could burn their lights and furnaces warmly and cheaply through the dark chill of winter.

In 2007, during her first state-of-the-state speech, then-Gov. Sarah Palin called gas for Alaskans one of the "bedrock, must-have requirements" for any pipeline project.

The late U.S. Sen. Ted Stevens, running for re-election the next year, said: "Fishermen can't afford to fish, rural Alaskans are migrating, and families choosing between groceries and fuel oil. To restore a vibrant economy, our priority must be to address the high cost of energy. We must develop our resources to create jobs and invest in hydropower, geothermal, and methane energy projects."

Alaska's commissioners of natural resources and revenue echoed Stevens during their approval that same year of the TransCanada proposal to build a North Slope gas line: "Ever-rising fuel prices are increasing hardships for Alaska communities and families, and there is no single solution to ease this energy crunch. However, in-state supply of North Slope natural gas could help reduce energy costs in some regions of the state."

Possible major Alaska gas pipeline routes



Source: Office of the Federal Coordinator, Alaska Natural Gas Transportation Projects

Almost four years later, no one has fully worked out how much it would cost to achieve the goal of gas for Alaskans.

The scattered information that exists suggests it would be possible to deliver gas from a large-volume pipeline to the state's population center in Anchorage and surrounding areas for about the price consumers there now pay for gas – possibly less.

It also suggests that many Fairbanks residents in the state's Interior might see their cost of heating and electricity fall – possibly a lot.

For the vast but sparsely populated rural Alaska – whether far from a major North Slope gas pipeline corridor or even along the route – the price of natural gas or propane extracted from the gas could be too high to win customers without state help in covering construction costs.

At a minimum, delivering gas to Alaskans could involve:

- Building one or two plants to receive gas from a mainline. The plants would depressurize gas flowing under extreme compression from Prudhoe Bay. They also would cleanse the gas of higher-end gas liquids such as ethane, propane and butane, a step necessary before a home furnace or power plant can safely burn the methane that remains.
- Constructing a thousand miles of gas transmission and distribution pipelines in Fairbanks, a town where the fuels of choice are heating oil and coal.
- Possibly laying a spur pipeline to bring gas to the Anchorage area, depending on the route of the mainline.

Natural gas is only one fragment of the state's efforts to clip high energy prices. Besides subsidizing planning and design of both a large-diameter *and* a small-diameter gas pipeline from Prudhoe Bay, the state's all-things approach involves spending to date several hundred million dollars to annually underwrite rural electricity bills, advance the gigantic proposed Susitna River hydroelectric project, bankroll small-scale renewable-energy concepts and weatherize homes.

Alaska has the ironic distinction of hosting a large proportion of the United States' oil and gas reserves while its residents pay some of the nation's highest prices for products made from those hydrocarbons.

Below we look at the preliminary, and in some cases only conceptual, work that's been done on the decades-long yearning to provide Alaskans with low-cost natural gas.

THE ANCHORAGE AREA: AFFORDABLE GAS

North Slope natural gas likely could be delivered in Anchorage and other Southcentral Alaska communities for about the same total cost as Cook Inlet gas today.

That is if the gas traveled most or all of the way in a big gas pipeline.

No one has pinpointed the gas shipping fee, or tariff, all the way from Prudhoe Bay to the Anchorage area in a big pipeline. The tariff would depend on whether the gas exits the big pipeline near Anchorage, Fairbanks, on its way to Valdez or somewhere else along the route. The tariff also would depend on the pipeline's construction cost and the volume it carries.

But parts of the route have been priced, at least preliminarily.

Prudhoe to Valdez – big pipeline	
Tariff per million Btu	$2.96 to $3.85*
Kind of gas	Wet gas**
Pipeline volume	2.7 billion cubic feet/day
Notes: Includes initial treatment at Prudhoe Bay	
Source: TransCanada/ExxonMobil, 2010	

Prudhoe to Big Lake – small pipeline	
Tariff per million Btu	$7.75
Kind of gas	Wet gas**
Pipeline volume	500 million cubic feet/day
Notes: Includes initial treatment at Prudhoe Bay; tariff is rough estimate that could be 30% higher or lower depending on construction costs	
Source: Alaska Gasline Development Corp., 2011	

Prudhoe to Fairbanks – big pipeline	
Tariff per million Btu	$2.59 to $3.37*
Kind of gas	Wet gas**
Pipeline volume	2.7 billion cubic feet/day
Notes: Includes initial treatment at Prudhoe Bay	
Source: TransCanada/ExxonMobil, 2010	

Prudhoe to Fairbanks – small pipeline	
Tariff per million Btu	$8.99
Kind of gas	Wet gas**
Pipeline volume	500 million cubic feet/day
Notes: Includes initial treatment at Prudhoe Bay; tariff is rough estimate that could be 30% higher or lower depending on construction costs	
Source: Alaska Gasline Development Corp., 2011	

* Tariff varies based on length of contract and volume shipped; range shown is for 20- and 25-year negotiated contracts.
** Wet gas includes methane plus such gas liquids as propane and butane.
Note: Tariffs do not include costs charged by gas producer or local gas utility.

In 2010, the Alaska Pipeline Project, a partnership of TransCanada and ExxonMobil, published proposed rates it would charge for a 2.7 billion-cubic-feet-a-day line ending at a liquefied natural gas export terminal in Valdez. The two partners now are teaming with ConocoPhillips and BP to explore an LNG project that could export North Slope gas from somewhere in Southcentral, possibly Nikiski on the Kenai Peninsula or Valdez. A pipeline from Prudhoe Bay to the Anchorage area would be roughly the same length as one to Valdez.

TransCanada/ExxonMobil's proposed rates to Valdez varied depending on how many years the shipper committed to using the pipeline and how much the pipeline project cost. The companies estimated the project would cost $20 billion to $26 billion for the line itself and a Prudhoe Bay gas treatment plant.

For example, at pipeline start-up the tariff would total $3.85 per million Btu of gas treated and shipped from Prudhoe Bay to Valdez under a 20-year negotiated contract on a $26 billion pipeline. The price would drop to $2.96 for a $20 billion line. The liquefaction plant would add its own fee, which would be charged to the export customers, not Alaskans.

Assuming the tariff for a large-diameter pipeline to the Anchorage area would be the same as to Valdez, the $2.96 to $3.85 fee would be a base. Other costs would be added on. The Southcentral gas utility, ENSTAR Natural Gas Co., charges about $2 to pipe gas to homes and businesses. In addition, the North Slope producers would expect payment for the gas itself – no one knows exactly how much they would charge but several analyses have assumed a placeholder of $2.

That would bring the price to roughly $6.96 to $7.85 per million Btu delivered to a homeowner's furnace.

ENSTAR currently delivers residential gas from Cook Inlet for about $8.60 per thousand cubic feet. A thousand cubic feet is approximately equal to a million Btu.

So in that hypothetical scenario North Slope gas would cost Southcentral customers less than or close to the same as the Cook Inlet gas they use today.

If the LNG plant were in Valdez rather than linked to the ENSTAR system near Anchorage, North Slope gas would cost more for residents of Southcentral Alaska.

How much higher is not clear, probably between $8 and $10 per million Btu.

A spur line would be needed, probably starting in Glennallen and ending at the ENSTAR system in the Matanuska-Susitna Borough outside Anchorage. In 2008, the Alaska Natural Gas Development Authority estimated a $1.40 tariff to pipe methane from Glennallen in a $725 million, 250 million-cubic-feet-a-day spur.

Or perhaps the spur line could start in Interior Alaska. **ANGDA estimated** a $2.34 tariff in a pipeline if the gas started north of Glennallen at Delta Junction. This spur would cost $1.25 billion to build.

Source: NOAA
The Monopod platform produces oil and gas from Cook Inlet.

In 2011, the Alaska Gasline Development Corp., another state agency, estimated a 500 million-cubic-feet-a-day gas pipeline from Fairbanks to the Anchorage area would cost $1.99 billion and charge about $2.25 per million Btu. The bigger volume would help hold the tariff below the estimated tariff of a Delta Junction-to-Anchorage pipeline, as would a difference in the gas stream: Besides methane, the AGDC line would carry propane and other valuable liquids; the liquids would comprise just over 10 percent of the volume but those shippers would pay 25 percent of the tariff – subsidizing the cost of

methane for Southcentral Alaska residents. AGDC estimated its tariff would rise by about 60 percent if the pipeline carried just methane without the liquids.

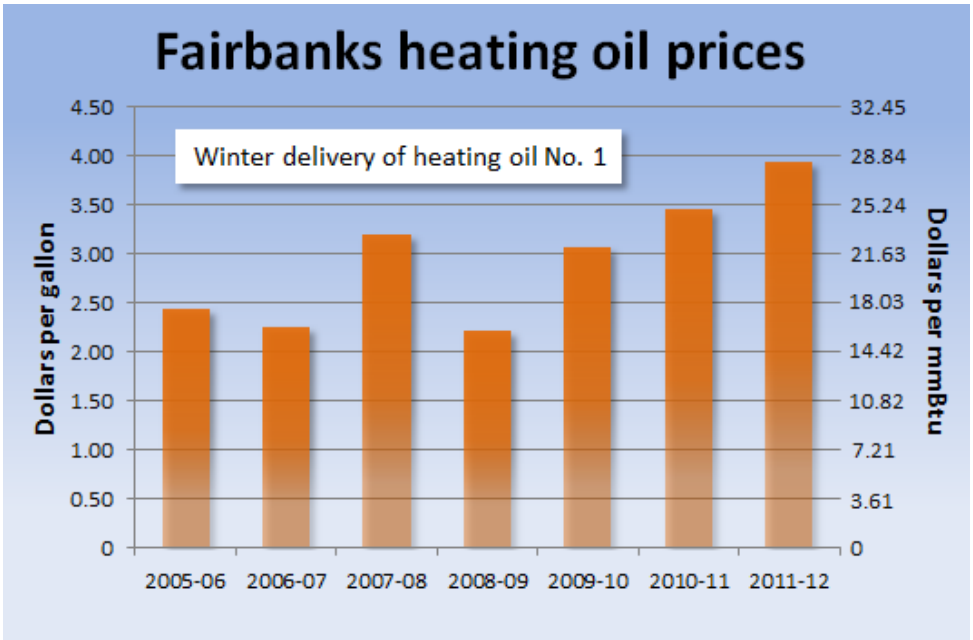
That big economies of scale can result in lower prices is well known in business – it's why the world has a few large automakers rather than many small ones; it's why Wal-Mart can use bulk purchasing and the power of streamlined distribution to beat mom-and-pop store prices.

To illustrate how volume matters in the gas pipeline business, the small-diameter pipeline pitched by AGDC would carry one-fifth the gas of the TransCanada/ExxonMobil 2010 proposal to Valdez. As a result, its tariff would be higher. **AGDC estimates its line** from Prudhoe Bay could deliver North Slope gas to Anchorage residents for roughly $11.75 per million Btu at pipeline start-up, assuming that ENSTAR and the gas producers each would add $2 to the delivered gas price, and assuming that someone finds local and export markets for propane and other liquids. (Many supporters of the smaller AGDC line see it as a back-up plan in case a big line is not in Alaska's near-term future.)

FAIRBANKS: THE COST OF GETTING WARM

Fairbanks North Star Borough residents currently are out in the cold when it comes to low-cost energy to heat their homes, stores and office buildings.

Mostly they burn fuel oil to generate heat, with the price chained to today's high oil prices – the highest winter prices ever for Alaska North Slope oil.



Source: Alaska Division of Community and Regional Affairs

Fuel oil cost about $27.67 per million Btu of energy (or $3.84 a gallon) during the just-ended winter, according to a **preliminary study for the borough released in February**. (The price this spring was over $4 a gallon, but for this article we've stuck with the $3.84 used in the new study.)

Fairbanks lies far off the natural gas grid built for Anchorage and other communities near Alaska's Cook Inlet fields to the south. About 1,100 customers in Fairbanks – mostly commercial accounts – burn natural gas that a distributor purchases from Cook Inlet producers, superchills into liquefied natural gas for ease of transport, then trucks 300 miles to town. Of roughly 25,000 homes in the borough, fewer than 500 burn gas, the preliminary study by Northern Economics found.

All that handling and the small economies of scale make delivered natural gas pricey for Fairbanks consumers – $23.35 per million Btu, compared with **about $8.60 in Anchorage** and **a similar price in the Lower 48**. But $23.35 looks attractive compared with heating oil prices – Fairbanks households would save an average of $820 a year if they were burning gas at $23.35 rather than oil at $27.67, the study estimated.

If the delivered cost could be slashed to $14 per million Btu through mass conversions to gas heating, economies of scale and other efficiencies, the average household savings would approach $2,600 a year, the study found.

Fairbanks-wide, the heating-cost savings for all users, not just households, would total $114 million a year at today's oil and gas prices, or $238 million if the delivered gas price were $14 and today's high oil prices lingered, the report said.

Courtesy of Golden Valley Electric Association
The North Pole Expansion Plant currently runs on naphtha, but could be converted to natural gas.

The report also noted additional savings in electricity bills if a Golden Valley Electric Association turbine in North Pole that now burns a costly oil-based fuel called naphtha switched to natural gas. But it did not quantify the potential savings to consumers.

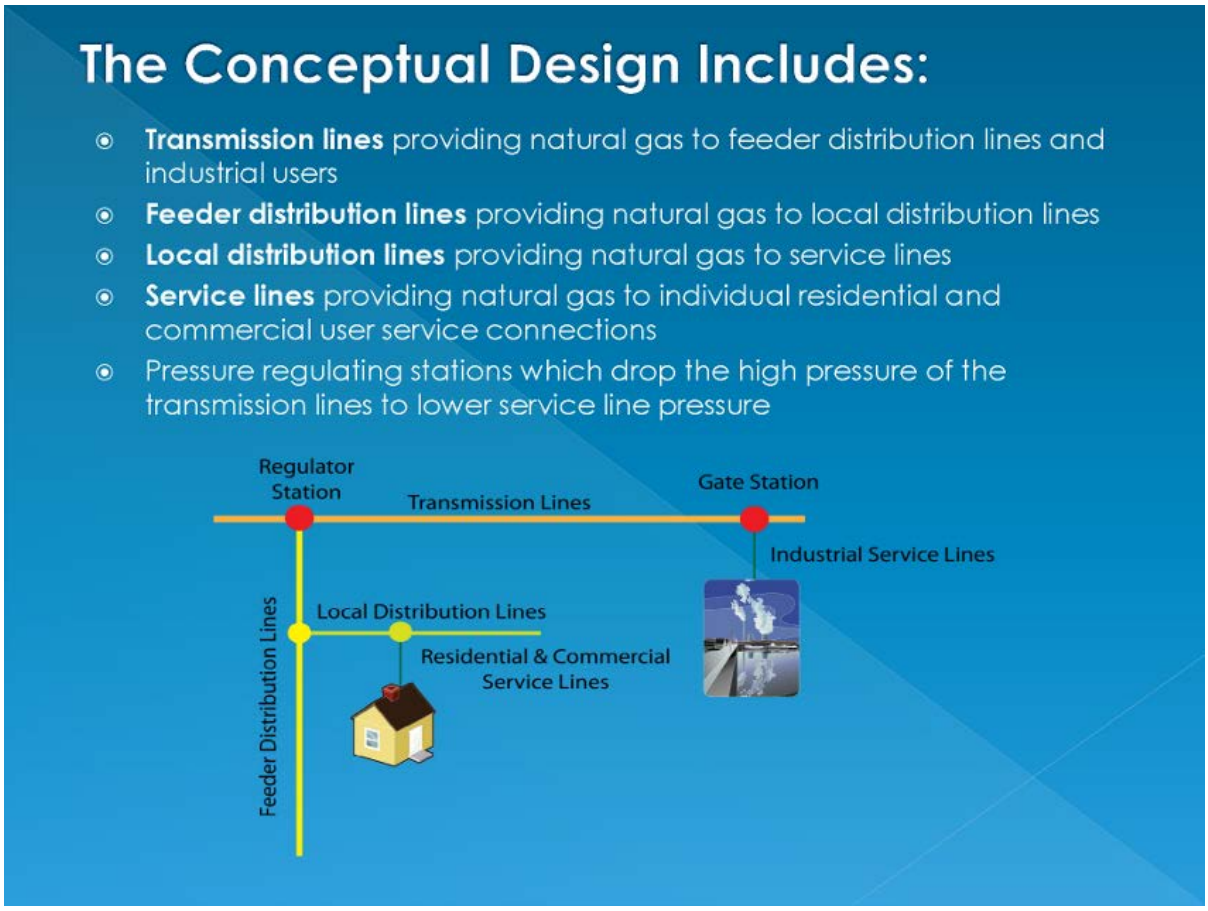
A **2009 study for the Alaska Natural Gas Development Authority** pegged the potential annual savings to Golden Valley in the low millions of dollars a year if it switched from naphtha to *propane* extracted from North Slope natural gas. Last year, Golden Valley began investigating how much it might save if it

switched to *LNG* trucked from Prudhoe Bay; its rough estimate is that its fuel savings would reach as much as about $20 million a year at today's oil price of about $120 a barrel.

A BILLION-DOLLAR BUILD OUT?

Piping natural gas to Fairbanks homes and businesses would be an expensive undertaking, according to estimates collected from a variety of studies and reports.

Someone would need to snake a network of gas pipelines through town to individual furnaces.



Source: Fairbanks Economic Development Corp.

In a sense, the network would resemble a road system. The big North Slope gas line through Alaska would be the freeway. Gas would exit that line into a multimillion-dollar lateral pipe that would channel gas to Fairbanks (think of this pipe as a four-lane highway, as opposed to an interstate freeway). Once in Fairbanks the gas would enter transmission lines that would route gas to different parts of town (like main streets routing traffic), then into feeder pipes (neighborhood feeder streets), then distribution lines (neighborhood streets) and finally service lines to houses and buildings (driveways).

No one has definitively nailed down the cost of such a system. But rough estimates put the total cost at possibly $580 million to $930 million for infrastructure to handle gas after it leaves an Alaska gas pipeline somewhere outside of Fairbanks. That price range is obtained by combining estimates from two studies released in the past 12 months. Consider the cost range to be soft.

Here's how that cost breaks down:

Delivering gas to Fairbanks	
From a North Slope methane and gas-liquids pipeline	
$210 million	Straddle plant
$60 million	Spur pipeline
$309-$662 million	Gas pipelines within town
$25-$200 million?	Conversion of homes to use natural gas

Sources: Northern Economics; Alaska Gasline Development Corp.

$210 million

This is an estimated cost of a straddle plant alongside a big gas trunkline.

The plant would solve two problems:

- Gas in the big line would be under high pressure, and that pressure must be reduced.
- Gas in the big line would contain a blend of ethane, propane, butane and other natural gas liquids besides the main component, methane, which is the gas burned in furnaces.

Gas in the big pipeline would be compressed to a potent 2,500 pounds per square inch, or psi, to propel the molecules through the pipe.

But methane when it passes a home's gas meter is pressurized to as little as a lazy quarter-pound psi, **less than the pressure exerted** when a child blows bubbles into a glass of milk through a straw.

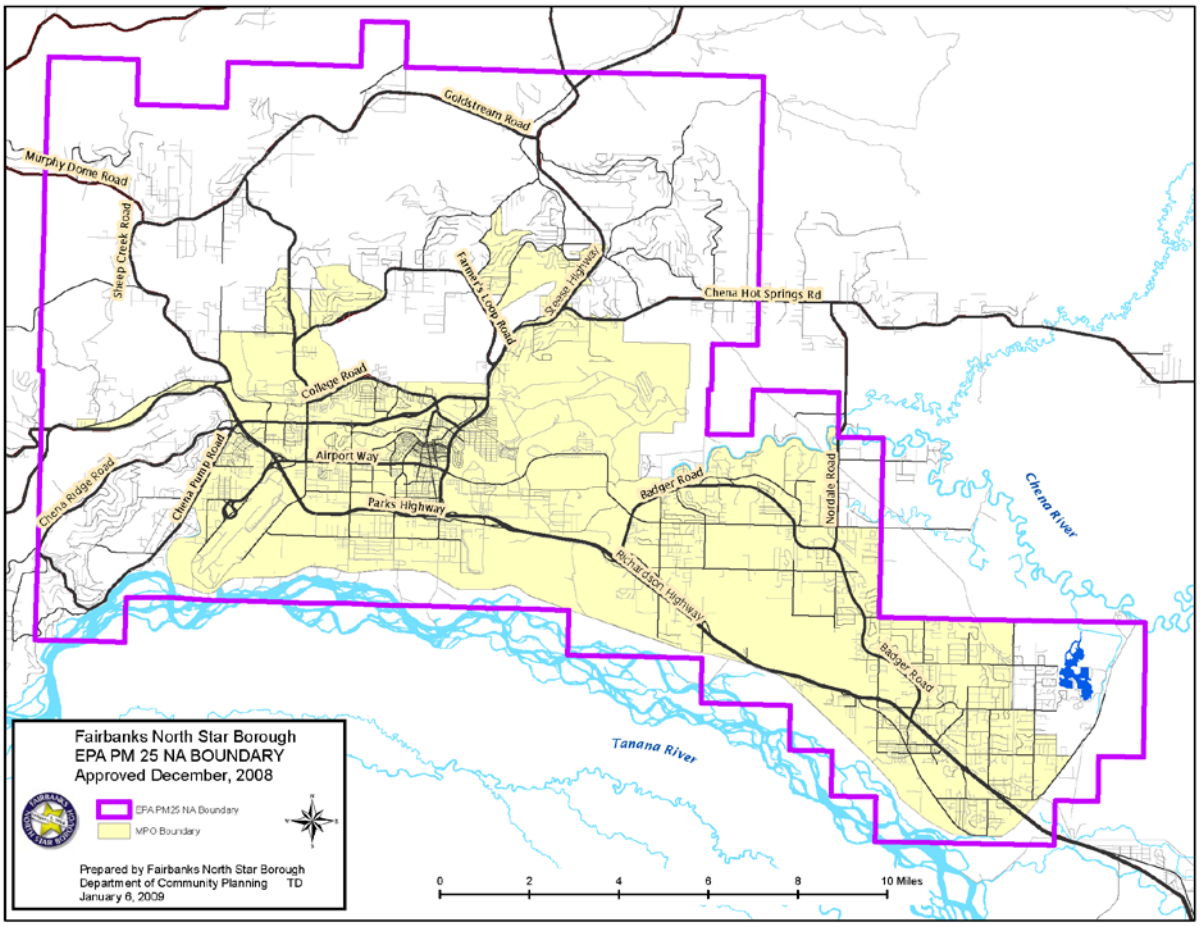
So a lot of decompressing needs to happen along the way.

Much of the decompression would occur at the straddle plant.

This plant also would extract propane and other liquids so that just methane would flow toward the Fairbanks users. The extracted liquids then would get reinjected into the main pipeline flow, unless an industry sprouted there that could process and sell the liquids.

The **Alaska Gasline Development Corp. in July 2011** estimated that a straddle plant would cost about $210 million.

The plant likely would be located well outside of where most Fairbanks residents live. Development is restricted in the Fairbanks core because of poor air quality, especially during winter's cold-weather inversions as oil, coal and even wood are burned for fuel.



Source: Alaska Division of Air Quality
Development is restricted in the Fairbanks North Star Borough non-attainment area, which includes the most populated areas of the borough.

Cleaner air would be a welcome bonus of piping natural gas to Fairbanks. The February 2012 Northern Economics preliminary report says widespread use of natural gas rather than oil or coal would cleanse Fairbanks air now dirtied by particulate matter – soot, smoke and such – as well as carbon monoxide, nitrogen oxide and sulfur dioxide.

$60 million

This is a rough cost estimate for a 35-mile pipeline connecting the straddle plant to town.

The estimate also comes from the July 2011 Alaska Gasline Development Corp. report. The report said the gas would be pressurized at 1,400 psi within a 12-inch-diameter pipe.

$309 million to $662 million

This is the estimated cost range for a pipeline network within Fairbanks.

The Northern Economics preliminary study figured Fairbanks would need 111 miles of 8- to 10-inch transmission pipe, 118 miles of 6-inch feeder lines, 804 miles of 2-inch distribution lines and 325 miles of 5/8-inch to 1-inch service lines (the smaller diameter for houses, the larger for businesses).

Fairbanks also would need nine pressure-regulating stations – stops along the pipeline network where the gas pressure gets reduced.

Separately, Fairbanks residents would need to convert their homes and businesses to gas systems. This would be expensive, too.

$25 million to $200 million or more?

This is a cost range for converting Fairbanks home water heating and furnace systems to natural gas. To be blunt about it: The wide range reflects imprecise cost estimates.

For hot-water boilers, Fairbanks Natural Gas, the local gas utility that trucks in LNG from the Cook Inlet area, estimates converting an oil-fired gun to a gas-fired gun costs $1,000 to $1,500.

The **National Energy Technology Laboratory in 2006** pegged the cost in Fairbanks at $1,400 for replacing the burner to $3,000 for replacing the entire unit.

Changing out furnaces could be more pricey. The 2012 preliminary Northern Economics study estimated the furnace replacement cost at $8,000 to $15,000, depending on the extent of work needed. The authors said they will refine their cost estimates in their final report later this year, and they're still investigating the cost of commercial-building conversions.

WHAT PRICE FOR FAIRBANKS GAS?

It's unclear how much delivered gas would cost Fairbanks consumers.

The 2012 Northern Economics preliminary study said, "It is too soon to develop preliminary distribution costs. ... As the project evolves, the number of miles of pipeline and prospective connections per segment will generate preliminary distribution costs."

Among other variables, the cost would depend on who paid for the infrastructure, how many customers signed up, where they live and how quickly gas became the fuel of choice in Fairbanks.

There's some sentiment in Fairbanks to ask the state for money to build a local gas pipeline network. Separately, the Alaska Legislature has considered a measure to create a state loan fund to help Fairbanks homeowners convert their heating systems to natural gas.

PROPANE OR WET GAS FOR ROAD-SYSTEM TOWNS?

Away from the city, North Slope gas for Alaskans becomes an iffy prospect. However, no one has fully analyzed the subject.

The state's Alaska Gasline Inducement Act deal with TransCanada requires the company to provide at least five places along its pipeline where gas can be withdrawn for in-state use. Fairbanks and the Anchorage area are obvious in-state markets – they harbor over 60 percent of Alaska's 722,000 residents.

Perhaps the gas could be tapped by mines, such as a proposed gold mine at Livengood, or other industry.

But what about other locations? How about the hamlets the pipeline would skirt?

A **2010 study by Northern Economics** on potential in-state demand for gas from a major North Slope pipeline was skeptical.

"Many of the communities along the pipeline routes have very small populations and typically have relatively small demand for natural gas or propane," the study said. "The capital cost for taking natural gas or propane off of the gas pipeline is very high per unit of energy, and for most small communities it would be more cost-effective to truck propane from Fairbanks or another location to meet their energy requirements."

The 2011 AGDC report echoed that opinion: "Due to the need for NGL removal, it is not economical to serve the smaller areas along the pipeline route, regardless of the alignment, except via a new distribution system developed off the proposed Fairbanks Lateral. Even if the main pipeline transported only utility-grade gas [as opposed to methane laced with propane and other gas liquids], development of local distribution systems for the smaller communities and users along the pipeline would very likely be cost-prohibitive regardless of the alignment."

An AGDC consultant, R.W. Beck, found that rural residents along Alaska's road system might benefit from propane extracted from a big pipe's gas stream. Propane might be cheaper than heating oil for them, **Beck concluded**. The estimated savings could be as great as 51 cents a gallon in the Big Lake and Nikiski areas of Southcentral Alaska, and 76 cents a gallon in rural Fairbanks.

In late 2011 another study came along that planted a small seed of hope for residents of pipeline-corridor towns. At a relatively low cost, they might be able to tap the great stream of gas flowing past them.

A small community right next to the pipeline would need solutions to three problems:

- How to ramp down the gas's high pressure to make it usable.
- What to do with the natural gas liquids mixed in with the methane.

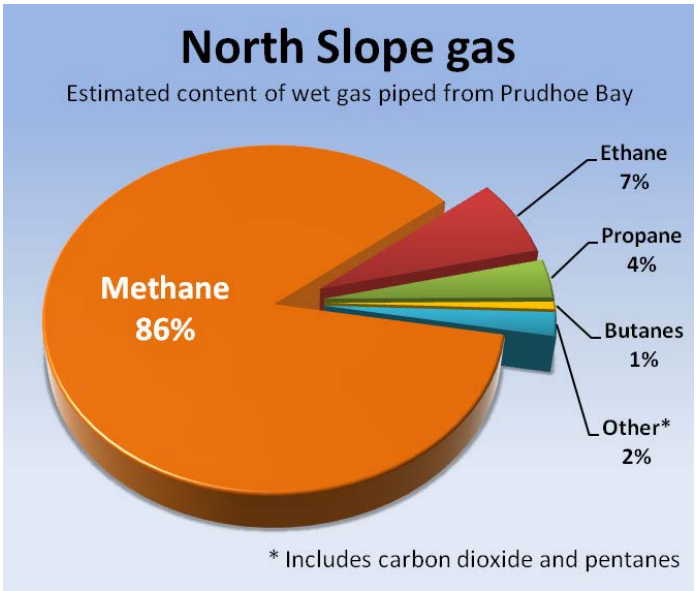
- How to pay for piping gas from the big line to their homes.

The **November 2011 study by Black & Veatch** for the state showed a path through the first two problems. It didn't discuss the third problem (some along the pipeline corridor believe the state should pay the cost of piping gas to homes).

To depressurize the gas, Black & Veatch recommended something called a "stub gas delivery" system. It would cost $150,000 to $200,000 to install at each location when the big pipeline is built. Each one would cost $50,000 to $75,000 a year to operate and maintain. (Those modest sums might not feel too modest if prorated among, say, **the seven year-round households of Wiseman or Livengood or the six of Coldfoot**.)

"It is anticipated that the small diameter stub size will allow for sufficient gas supply volumes for all potential delivery point sites except for Fairbanks or Anchorage," the consultant said.

Here's how it would work:



Source: State of Alaska

A small pipe stub would be welded onto the side of the big pipeline where the gas offtake would occur. Once gas customers are secured, the pipeline would be tapped at the stub.

The gas would flow to a metering/regulating station. There the gas would get heated and cooled in four stages to ease the pressure from 2,500 psi to a more usable 125 psi. Gas pressure is **reduced further to a usable level** when it passes through a regulator on a home's meter.

What about the propane, butane and other gas liquids? They're normally extracted because they have their own markets and they're more valuable than methane. Black & Veatch says: For these small communities, keep the liquids blended with the methane.

Channeling pure propane into methane-based household appliances would be a bit like trying to funnel a tornado through a windsock. The Btu content of both propane and butane is over two times that of methane. Propane also flows into propane appliances at higher pressure than methane into methane appliances.

Energy content of different fuels		
Thousand cubic feet methane	=	1.01 million Btu
Thousand cubic feet ethane	=	1.77 million Btu
Thousand cubic feet propane	=	2.52 million Btu
Thousand cubic feet n-butane	=	3.25 million Btu
One gallon propane	=	91,333 Btu
One gallon heating oil	=	138,690 Btu

Source: U.S. Energy Information Administration

But propane and butane together would comprise less than 5 percent of the gas stream. They raise the Btu content of the entire gas stream above what most methane pipelines carry, but they don't push the Btu content off the scale, Black & Veatch suggested. While the targeted heat **content of marketed gas is 1,035 Btu per cubic foot**, Black & Veatch said the heat content of the big pipeline's gas would be about 1,118. (A cubic foot of pure propane contains 2,520 Btu.) Black & Veatch said a handful of communities in the United States and Canada burn gas that rich without "any significant issues."

Still, the North Slope gas stream could be near the upper end of acceptable Btu-richness for home and commercial use, and if the liquids separate from the methane, the community gas-distribution system could encounter big problems.

REMOTE TOWNS COULD BE OUT OF LUCK

Residents of remote towns and villages disconnected from Alaska's road system endure some of the highest fuel prices in the United States.

This winter, when Fairbanks homeowners were suffering $4-a-gallon heating oil, **residents of Ruby paid $5.30**, Bethel $5.78, Gambell $6.75 and McGrath $7.47. McGrath residents paid about $53 per million Btu of energy.

The best-case scenario for getting North Slope gas to these towns would be to ship propane to them.

But the **Beck study last year** concluded this scenario simply won't work unless oil prices were sky-high. Propane would cost so much that no one would switch to it.

How high is sky-high?

Beck looked at delivering propane to two towns – Tanana and Seldovia – just off the road system. If propane is too expensive to transport to these towns, it will be too expensive everywhere else off the road system, Beck reasoned.

For Tanana, Beck said, the price of crude oil must top $165 a barrel to justify converting from heating oil to propane for space heating, and $186 a barrel to convert to propane for water heating.

For Seldovia, oil prices must exceed $215 and $246 a barrel to trigger switching to propane for space heating and water heating, respectively.

"Rural consumers that lack highway access are only likely to switch fuels under extreme oil price(s) due to very high intermodal transportation, storage, and distribution costs for propane," Beck concluded.

As with other analyses of in-state gas delivery, no one has done the kind of detailed engineering, precise demand studies and humorless financial number crunching that, say, a bank would require before lending money to build the gas-delivery infrastructure. And the cost of switching to propane could look very different to consumers if the state subsidized construction.

Older reports also have explored the economics of widespread in-state propane delivery from North Slope gas:

- A **2005 report from PND Inc. Consulting Engineers** for the Alaska Natural Gas Development Authority said propane might work in some ice-free coastal communities that could take deliveries year-round. Propane could provide less expensive electricity for cooking. In larger towns, propane could work for water and space heating. Coastal power plants could use propane if they could get year-round deliveries of the fuel to minimize storage costs, or if the government subsidized propane deliveries. A key to making all of this work: Most of the gas liquids extracted from the North Slope gas must get sold outside of Alaska to create economies of scale that make the in-state propane price more affordable.
- A **2009 study** for the same state agency said a small amount of propane probably could be extracted at the North Slope oil fields and trucked to Interior Alaska towns for a lower price than oil-based fuels.