The Imperatives of Arctic Natural Gas Development

By
Ronald Oligney, University of Houston
James Longbottom, University of Houston

November 2001
Primary Messages

1. The United States must pursue 12 Bcf/d of natural gas production from the Arctic, not 4 or 6 Bcf/d—America needs the gas!

2. Oil or natural gas supply disruptions—whether geopolitical or infrastructure related—quickly destroy 10 million U.S. jobs.

3. The $3.00 per Mscf price floor for natural gas necessary to support Arctic pipeline development will emerge in the next 24 months.

4. Risk and uncertainty are the greatest roadblocks to Arctic pipeline construction, not the much-debated standard financial variables.

5. Staged pipeline construction is the obvious mechanism to materially reduce costs, risk and uncertainty.

6. Under almost any political, financial or price scenario, a natural gas pipeline down the Mackenzie corridor will be developed first.
U.S. Natural Gas Demand and Supply Sources

Tcf per year

- Economides and Oligney “twist” demand forecast
- DOE/EIA demand forecast

Japan-sized LNG
Natural gas hydrates?

Conventional
Unconventional
Shallow Offshore
Deepwater
Canada
Arctic
U.S. Employment and Major Energy Supply Disruptions in OPEC Era

U.S. Employment (Millions)

Supply Disruptions (Mbopd)

- Arab Oil Embargo
- Iran Revolution
- Iran/Iraq War
- Iraq Invades Kuwait
- OPEC Cuts Production
- Natural Gas Disruption of 2000

- 10 million jobs

- 9 mo.
- 8 mo. mo.
- 6 mo.
- 3 mo.
- 14 mo.
Forecast U.S. Natural Gas Supply and Prices—Moderate Demand and Mild Decline Rate

New production to meet 2010 demand, including decline

Blue line indicates cumulative additions to U.S. supply (right axis)

Height of bars indicates equilibrium natural gas price (left axis)

Forecast U.S. Natural Gas Supply and Prices—Moderate Demand and Mild Decline Rate

New production to meet 2010 demand, including decline

Blue line indicates cumulative additions to U.S. supply (right axis)

Height of bars indicates equilibrium natural gas price (left axis)
Message to Alaskans

1. Near-term stable jobs involving Alaskan gas should focus on Kenai development rather than a North Slope gas pipeline.

2. Any pipeline route from the North Slope will be 60 percent or more in Canada:
   - Routing decisions based on Alaska construction jobs do not serve your long-term financial interests.
   - Canada will ultimately have the final say on routing decisions.

3. Support the lowest-cost, highest-netback pipeline solution:
   - Generates the greatest corporate revenues and State income.
   - Translates to permanent jobs and a strong Alaska economy.
   - Prevents job leakage to out-of-state commuters.

4. False environmental claims made today may be your undoing later when ANGTS route is dead and you change your vote to "Over-the-top"—be careful!
Which Route Creates Most Permanent Jobs for Alaskans?

- South Total Construction
- North Total Construction
- South Alaskan Employment
- North Alaskan Employment

Man-Years

2005 2010 2015 2020 2025 2030
Escopeta Oil & Gas and B.B.I., Inc. 
Announce Exploration Results in Cook Inlet Basin, Alaska 
Estimated 12 Tcf of Recoverable Natural Gas Reserves Located

FOR IMMEDIATE RELEASE
September 26, 2001

Contact: Mr. Danny Davis
(713) 623-2219

Houston, TX – Escopeta Oil & Gas and BBI, Inc. of Houston, Texas, today announced new seismic reprocessing results that show estimated recoverable reserves of 12 trillion cubic feet (Tcf) of natural gas near the East Forelands area of Alaska’s Cook Inlet Basin, at depths of 18,000 to 21,000 ft. Known producing horizons in the same structural trend would likely recover 1.35 billion barrels of oil and an additional 6.1 Tcf of gas.

The reprocessed seismic data reveal the presence of a significant complex fault system on the east flank of the Middle Ground Shoal Field (200 million barrels reserves), forming an immense trapping mechanism, possibly the largest untested structural fault block in the Cook Inlet Basin. Geophysical and geological mapping reflect approximately 9000 feet of vertical closure against this fault system representing approximately 69,000 acres of structural closure. The depth of the main targets suggests accumulations of thermogenic gas.

(cont.)
Message to Canadians

1. Canada has the lead in Arctic pipeline development—get busy before you lose it!
   - Natural gas in the North, takeaway capacity in the South.
   - No need for international agreement before proceeding.
   - Environmental/regulatory framework in place.

2. Mackenzie Valley will develop as pipeline “corridor”:
   - Historical and modern imperative of market forces.
   - Construction of first segment reduces risk of corridor route for future expansion and (ult.) connection to Alaska.

3. Impact on Canadian employment will be huge:
   - Construction peak employment in 2013 is 23,161 man-years
   - Gas industry job impact by 2020 is 39,694 permanent jobs

4. Employ ARC strategy:
   - Best financial parameters.
   - Sensitive to Aboriginal needs.
Multiple Pipeline Stages Used to Access Arctic Gas

Phase I: 30” Mackenzie Stand Alone
1.6 Bcfd Canada

Phase 2: 36” Northern Alaska Tie-in & Mackenzie Loop
2.5 Bcfd Alaska

Phase 3: 42” Full Length Loop
2.5/1.5 Alaska/Canada

Phase 4: 42” Full Length Loop
2.5/1.5 Alaska/Canada

Summary
4.6 Bcfd Canada
7.5 Bcfd Alaska
12.1 Bcfd Total
# Model Results of Recommended Capacity Additions

<table>
<thead>
<tr>
<th></th>
<th>Mackenzie Only</th>
<th>Northern Tie-in + Loop</th>
<th>Full Length Loop</th>
<th>Full Length Loop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Cost (Billion USD)</td>
<td>$3.353</td>
<td>$6.128</td>
<td>$8.326</td>
<td>$8.572</td>
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<tr>
<td>Length (miles)</td>
<td>1040</td>
<td>1700</td>
<td>1700</td>
<td>1700</td>
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<tr>
<td>Alaska Capacity (Bcf/d)</td>
<td>0</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Canada Capacity (Bcf/d)</td>
<td>1.6</td>
<td>0</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Size (inches)</td>
<td>30</td>
<td>36</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>Tariff Prudhoe to L48 ($/Mcf)</td>
<td>NA</td>
<td>$1.83</td>
<td>$2.22</td>
<td>$2.27</td>
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<tr>
<td>Tariff Mackenzie to L48 ($/Mcf)</td>
<td>$0.96</td>
<td>NA</td>
<td>$1.45</td>
<td>$1.50</td>
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<tr>
<td>Assumed Gas Price ($/Mcf)</td>
<td>$2.63</td>
<td>$2.71</td>
<td>$2.85</td>
<td>$2.93</td>
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<tr>
<td>Netback to Producers ($/Mcf)</td>
<td>$1.07</td>
<td>$0.88</td>
<td>$0.63</td>
<td>$0.66</td>
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<tr>
<td>Recommended On-line Date</td>
<td>2007</td>
<td>2010</td>
<td>2015</td>
<td>2018</td>
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<tr>
<td>Cumulative Capacity (Bcf/d)</td>
<td>1.6</td>
<td>4.1</td>
<td>8.1</td>
<td>12.1</td>
</tr>
</tbody>
</table>
Study

- Emerging U.S. natural gas economy and price environment
- U.S. employment impact
- Alaska dynamics
- A new economic model for development of Arctic natural gas infrastructure
  - Alaska Gas Employment Impact
  - Canada Gas Employment Impact
- Kenai development
- Environmental Impact and Aboriginal Issues
- Conclusions and Recommendations
- Reference List
Energy Consumption as an Indicator of the Wealth of Nations

The world’s 15 largest economies

Per capita oil consumption (bbl/yr)
Historical Imperative for Natural Gas (from Hefner)
Worldwide energy mix forecast (from EIA/DOE)
Worldwide energy mix “twist” forecast (Economides and Oligney)
Various forecasts of U.S. natural gas consumption

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>NPC/DOE</td>
<td>21.5</td>
<td>22.1</td>
<td>Tcf</td>
<td>27.7</td>
<td>30.6</td>
<td>82</td>
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<tr>
<td></td>
<td>59</td>
<td></td>
<td>Bcfd</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>CERA</td>
<td>21.5</td>
<td>59</td>
<td></td>
<td>30.0</td>
<td>82</td>
<td></td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Bernard</td>
<td>21.9</td>
<td>60</td>
<td>30.0</td>
<td>82</td>
<td></td>
<td></td>
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<tr>
<td>El Paso</td>
<td>21.9</td>
<td>60</td>
<td>“plus 25 Bs”</td>
<td>31.0</td>
<td>85</td>
<td></td>
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<tr>
<td>Duke</td>
<td>21.5</td>
<td>59</td>
<td>“200,000 megawatts of new generation over the next 12 years”</td>
<td>32.0</td>
<td>88</td>
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<tr>
<td>Economides/Oligney</td>
<td>21.9</td>
<td>60</td>
<td>26.5</td>
<td>32.9</td>
<td>90</td>
<td></td>
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<tr>
<td>Simmons</td>
<td>21.9</td>
<td>60</td>
<td>40.0</td>
<td>146</td>
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“Low”  
“Mid”  
“High”
U.S. Natural Gas Demand and Supply Sources

Tcf per year

- Conventional
- Unconventional
- Shallow Offshore
- Deepwater
- Arctic
- Canada
- Unconventional

Economides and Oligney “twist” demand forecast
DOE/EIA demand forecast

Japan-sized LNG
Natural gas hydrates?
Supply and demand analysis

- Potential Gas Reserves
- Proved Gas Reserves
- Gas Deliverability
- Activation Index

- Gas Price, $/Mscf
Ultimate Proved U.S. Gas Reserves

- **Additions:**
  - Long-term History: 27.5 Tcf/yr
  - Recent History: 13.7 Tcf/yr
  - Forecast (NPC 1999): 17.7 Tcf/yr

- **History** and **Forecast**

- **Ultimate Reserves**, Tcf:
  - 1965: 500
  - 1970: 750
  - 1975: 1000
  - 1980: 1250
  - 1985: 1500
  - 1990: 1750
  - 2000: 2250
  - 2005: 2500
  - 2010: 2750
  - 2015: 3000

- **R/P, years**:
  - 1965: 10
  - 1970: 8
  - 1975: 6
  - 1980: 4
  - 1985: 2
  - 1990: 1
  - 1995: 0
  - 2000: 1
  - 2005: 2
  - 2010: 3
  - 2015: 4
## Determination of Activation Index for Select Areas

<table>
<thead>
<tr>
<th>Play</th>
<th>Depth (ft)</th>
<th>1995 Avg. Cost ($k)</th>
<th>Cost Escalation (%)</th>
<th>Est. Tie-in Cost ($k)</th>
<th>1st 12 mo. Production (Mcf/D)</th>
<th>Activate Index ($/Mcf/D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anadarko - Watonga-Chicksha</td>
<td>11,450</td>
<td>676</td>
<td>24</td>
<td>20</td>
<td>464</td>
<td>1.85</td>
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<tr>
<td>Arkoma - Choctaw Thrust</td>
<td>14,545</td>
<td>2382</td>
<td>24</td>
<td>20</td>
<td>2438</td>
<td>1.22</td>
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<tr>
<td>Arkoma – Jackfork</td>
<td>9136</td>
<td>1237</td>
<td>24</td>
<td>20</td>
<td>1362</td>
<td>1.14</td>
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<tr>
<td>Cotton Valley Reef</td>
<td>15,975</td>
<td>3687</td>
<td>24</td>
<td>20</td>
<td>1813</td>
<td>2.53</td>
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<tr>
<td>Deep Austin Chalk</td>
<td>16,645</td>
<td>3591</td>
<td>24</td>
<td>20</td>
<td>1621</td>
<td>2.76</td>
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<tr>
<td>Wilcox - Lobo trend</td>
<td>9900</td>
<td>523</td>
<td>24</td>
<td>20</td>
<td>844</td>
<td>0.79</td>
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<tr>
<td>GOM Deep Water</td>
<td>15,150</td>
<td>14,350</td>
<td>48</td>
<td>100</td>
<td>7832</td>
<td>2.72</td>
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<tr>
<td>GOM Extended Reach</td>
<td>15,600</td>
<td>3175</td>
<td>48</td>
<td>100</td>
<td>4526</td>
<td>1.06</td>
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<tr>
<td>Green River - Moxa Arch</td>
<td>12,272</td>
<td>488</td>
<td>24</td>
<td>30</td>
<td>830</td>
<td>0.77</td>
</tr>
<tr>
<td>Green River - Wamsutter</td>
<td>10,144</td>
<td>394</td>
<td>24</td>
<td>30</td>
<td>432</td>
<td>1.20</td>
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<tr>
<td>Val Verde - Strawn &amp; Penn</td>
<td>11,907</td>
<td>1202</td>
<td>24</td>
<td>20</td>
<td>3812</td>
<td>0.40</td>
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</tbody>
</table>
Weighted Average Activation Index by NPC Region

<table>
<thead>
<tr>
<th>Area</th>
<th>Area Avg. Active Index k$/McfD</th>
<th>Reserves + Potential Tcf</th>
<th>Contribution to Harmonic Mean AI %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid-Continent</td>
<td>1.40</td>
<td>119</td>
<td>11.7</td>
</tr>
<tr>
<td>Ark-LA-TX</td>
<td>2.53</td>
<td>72</td>
<td>3.9</td>
</tr>
<tr>
<td>South Texas</td>
<td>1.78</td>
<td>121</td>
<td>9.4</td>
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<tr>
<td>GOM Deep Water</td>
<td>2.72</td>
<td>181</td>
<td>9.2</td>
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<tr>
<td>GOM Extended Reach</td>
<td>1.06</td>
<td>105</td>
<td>13.6</td>
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<tr>
<td>Foreland Basins</td>
<td>0.98</td>
<td>199</td>
<td>27.8</td>
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<tr>
<td>Permian</td>
<td>0.40</td>
<td>70</td>
<td>24.4</td>
</tr>
<tr>
<td><strong>Weighted Harmonic Mean Activation Index</strong></td>
<td><strong>1.195</strong></td>
<td><strong>867</strong></td>
<td><strong>Total Reserves + Potential</strong></td>
</tr>
</tbody>
</table>

\[
\overline{AI} = \frac{\sum_i (\text{Reserves + Potential})_i}{\sum_i \left(\frac{\text{Reserves + Potential}}{\text{Activation Index}}\right)_i}
\]
Forecast U.S. Natural Gas Supply and Prices—Moderate Demand and Mild Decline Rate

New production to meet 2010 demand, 10% decline

Height of bars indicates equilibrium natural gas price (left axis)

Blue line indicates cumulative additions to U.S. supply (right axis)

Forecast U.S. Natural Gas Supply and Prices—Moderate Demand and Mild Decline Rate
GOM GAS DECLINE RATE IS ACCELERATING

Source: EOG Resources 7/00.
Forecast U.S. Natural Gas Supply and Prices—High Demand and Accelerated Decline Rate

New production to meet 2010 demand, 15% decline

Blue line indicates cumulative additions to U.S. supply (right axis)

Height of bars indicates equilibrium natural gas price (left axis)
Cash Natural Gas Price
(1999 dollars)

- DOE Reference Forecast (1992)
- DOE Reference Forecast (2000)
- Annual Average

Source: P.E. Lewis
• U.S. employment impact
U.S. Employment (1000s)
Major Energy Supply Disruptions

Source: EIA

- Six Day War
- Arab Oil Embargo
- Iran Revolution
- Iran/Iraq War
- Iraq Invades Kuwait

Millions of barrels per day

Source: EIA
U.S. Employment

- All negative job growth periods in OPEC era correlate directly to oil supply disruptions greater than 2 million barrels per day.
- Employment trend lines illustrate clearly that jobs lost are never regained.
- As economy transitions lower carbon fuels, natural gas infrastructure and not oil embargoes may pose the greatest threat of supply disruptions.
- U.S. natural gas supply and power shortages in 2000 exacerbated latest oil supply disruption.
U.S. Employment and Major Energy Supply Disruptions in OPEC Era

U.S. Employment (Millions)  Supply Disruptions (Mbopd)

- Arab Oil Embargo
- Iran Revolution
- OPEC Cuts Production
- Natural Gas Disruption of 2000
- Iraq Invades Kuwait
- Iran/Iraq War

- 9 mo.
- 8 mo. mo.
- 6 mo.
- 3 mo.
- 14 mo.

10 million jobs
U.S. Employment

- Last major energy disruption (1990) resulted in permanent loss of 10 million U.S. jobs.
- Latest energy supply disruption may ultimately result in 20 to 40 million jobs lost.
- Delaying action on energy situation may nominally cost 1 million U.S. jobs per month.
## Alaska Employment Impact

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Mandate uneconomic pipeline, natural gas demand materializes</td>
<td>– 10 million jobs</td>
</tr>
<tr>
<td>• Mandate uneconomic pipeline, demand does not materialize</td>
<td>0 jobs</td>
</tr>
<tr>
<td>• Clarify requirements, allow market solution(s)</td>
<td>+225,000 jobs</td>
</tr>
</tbody>
</table>
Arctic Pipeline Direct Employment

- Production: 5 Bcf per day
- Natural gas price: $2.50 per Mscf
- Direct contribution to GDP: $12 million per day, $4.5 billion per year
- GDP per employee (U.S.): $69,230
- Direct employment: 66,000 jobs
• Alaska dynamic
Debate in Alaska

- Natural gas supply for Fairbanks/Anchorage
- Alaska construction jobs
- Environmental issues

• Concerns are poorly quantified, but opinions are strongly held.
• Alaska politicians are ready to take action, and have been for 20 years.
TITLE VII—PIPPINES

SEC. 801. PROHIBITION ON CERTAIN PIPELINE ROUTE.

No license, permit, lease, right-of-way, authorization or other approval required under Federal law for the construction of any pipeline to transport natural gas from lands within the Prudhoe Bay oil and gas lease area may be granted for any pipeline that follows a route that traverses—

(1) the submerged lands (as defined by the Submerged Lands Act) beneath, or the adjacent shoreline of, the Beaufort Sea; and

(2) enters Canada at any point north of 68 degrees North latitude.
ANWR MSNBC

The Real ANWR in Summer

Oligney and Longbottom, Nov. 2001
Fairbanks Natural Gas LDC is Forming

- Fairbanks Natural Gas, LLC
- Alaska minority owners, Houston funding
- Built LNG facility in Wasilla
- Adding 10 miles of pipe per summer in Fairbanks
- 400 customers now
- $7 per Mscf at the burner tip
- Expect to ship 25,000 gallons per day this winter (2 MMscf/d)
- Selling the LDC is clearly the endgame
Did you know . . . 

Oil Heat: It still makes good $ense

Natural Gas vs Heating Oil

Cost Comparison

It's as easy as 1-2-3!

Here's a simple way to make a direct comparison between your costs for Heating Oil and Natural Gas. Just plug in your annual heating oil consumption and the rest is simple math. If you don't know your usage, your dealer can supply you with it.

1. Convert your annual gallons into BTUs (British Thermal Units), an accurate way of measuring heat energy. Select the grade of oil you use and multiply it times your annual gallonage.

<table>
<thead>
<tr>
<th>#1 Oil</th>
<th>#2 Oil</th>
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</thead>
<tbody>
<tr>
<td>134,000</td>
<td>137,000</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Your annual usage in gallons</td>
<td>Your annual BTUs from 1 above</td>
</tr>
<tr>
<td>=</td>
<td>=</td>
</tr>
<tr>
<td>Tool annual BTUs required</td>
<td>Billable units of Natural Gas in BTUs</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

1 This is the total heat energy it takes to heat your structure for one year.

2. Now convert your annual BTUs into the amount of natural gas necessary to produce the same heat energy. Natural gas is measured in cubic feet. 100 cubic feet of natural gas equals one billing unit. There is approximately 100,000 BTUs in each billable unit (100 cubic feet) of natural gas. Divide the annual BTUs (from Step 1) by the BTUs of a natural gas billing unit.

\[ \frac{134,000}{100,000} = 1.34 \text{ annual Natural Gas billing units} \]

2 This equals the total number of billable Natural Gas units it will take to heat your structure for one year.

3. Natural Gas has a posted 3 rate per gas unit, plus an annual service fee. This rate is fixed for each class of business. Choose the class of business you fall into and multiply your annual billable units of natural gas (from Step 2) by that rate. Then add to it the annual service fee.

<table>
<thead>
<tr>
<th>Residential</th>
<th>Small Commercial Business</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas has a posted 3 rate per gas unit, plus an annual service fee. This rate is fixed for each class of business. Choose the class of business you fall into and multiply your annual billable units of natural gas (from Step 2) by that rate. Then add to it the annual service fee.</td>
<td></td>
</tr>
<tr>
<td>Your annual BTUs from 1 above</td>
<td>Your annual BTUs from 1 above</td>
</tr>
<tr>
<td>$696*</td>
<td>$696*</td>
</tr>
<tr>
<td>Current posted rate per Natural Gas unit</td>
<td>Current posted rate per Natural Gas unit</td>
</tr>
<tr>
<td>=</td>
<td>=</td>
</tr>
<tr>
<td>Estimated annual Natural Gas cost</td>
<td>Estimated annual Natural Gas cost</td>
</tr>
<tr>
<td>+</td>
<td>+</td>
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<tr>
<td>Annual fixed service fee</td>
<td>Annual fixed service fee</td>
</tr>
<tr>
<td>=</td>
<td>=</td>
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<tr>
<td>Total annual Natural Gas cost</td>
<td>Total annual Natural Gas cost</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

3 This is how much you can expect to spend on Natural Gas to heat your structure for one year.

Compare For Yourself

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<tbody>
<tr>
<td>Annual Natural Gas cost from 3 above</td>
<td>Current annual Oil Heat cost (contact your heating oil dealer if you don't know this)</td>
</tr>
<tr>
<td>=</td>
<td>=</td>
</tr>
<tr>
<td>Total annual savings with Oil Heat</td>
<td></td>
</tr>
</tbody>
</table>

Contact your heating oil dealer for more specific information or questions.

Alaska Oil Heat Association

Making sure you have accurate information about oil heat so you can make an educated and informed choice.

- Heating oil jobbers in Fairbanks upset by new natural gas infrastructure (ad at left).
- Refiners (e.g. Williams) don't care, would rather focus on making jet fuel anyway.
Natural Gas Supply for Fairbanks

Owners looking to…
- Prudhoe Bay (ANGTS pipeline)
- Nenana (conventional)
- Coalbed methane (“research”)

We suggest…
- Dedicated pipeline from North Slope maybe, but hard to justify (est. $400 million/Mustang, $1 billion/ARC)
- Nenana or coalbed methane potential limited, maybe enough
- Cook Inlet supply most likely, LNG for now, then by pipeline
- Total ultimate market just 100 MMscf/day
• A new economic model for development of Arctic natural gas infrastructure
## Summary of Results from Other Studies—AKA “A Pig’s Breakfast”

<table>
<thead>
<tr>
<th>Route</th>
<th>CERI Miles</th>
<th>CERI</th>
<th>AGPPT</th>
<th>AGPPT</th>
<th>Purvin &amp; Gertz</th>
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<td>Miles</td>
<td>1218</td>
<td>2450</td>
<td>1803</td>
<td>2139</td>
<td></td>
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<tr>
<td>Size (inch)</td>
<td>42/48</td>
<td>36/48/30</td>
<td>52</td>
<td>52</td>
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<td>42/48/30</td>
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<td>Alaska Capacity (Bcf/d)</td>
<td>2.5</td>
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<td>4</td>
<td>4</td>
<td>2.5</td>
<td>4.0</td>
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<td>Canadian Capacity (Bcf/d)</td>
<td>1.6</td>
<td>1.6</td>
<td>0.8</td>
<td>0.8</td>
<td>1.5</td>
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<td>Pipeline Cost</td>
<td>$5.570B CAD</td>
<td>$8.100B CAD</td>
<td>$7.7B</td>
<td>$11.3B</td>
<td>$7.1B</td>
<td>$12.0B</td>
<td>$7.4B</td>
<td>$10.3B</td>
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<td>Tariff per mmBtu</td>
<td>$0.53* CAD/gj</td>
<td>$1.26* CAD/gj</td>
<td>$1.29</td>
<td>$1.61</td>
<td>$1.14</td>
<td>$1.41</td>
<td>$0.53†</td>
<td>$0.74†</td>
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<td>Gas Price</td>
<td>$3.00</td>
<td>$3.00</td>
<td>$2.59</td>
<td>$2.59</td>
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<td></td>
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<tr>
<td>Netback to Alaska</td>
<td>$0.93**</td>
<td>$0.61**</td>
<td>$0.77</td>
<td>$0.50</td>
<td></td>
<td></td>
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</table>

* Tariff given for only Canadian gas in Canadian dollars with no mention of gas conditioning cost or its impact on tariff
** No experience with 52” high pressure gas lines, 4.8 bcf/d requires new takeaway capacity with notional $0.78/mcf toll
† No mention of gas conditioning plant cost, 6 bcf/d rate not compatible with 42” line unless pressure extreme
Our Modeling Process

- Financial Variables
- Project Variables & Cost Calc.
- Pipeline Expense & Tariff Calc.
- Gas Price Forecast
- Alaska Impact
- Canada Impact
- Job Impact

Reports and Observations
Key Assumptions

• Pipeline life is 25 years
• Interest on debt is 7.5%
• Expected ROE is 15%
• Gas conditioning plant costs are included in pipeline tariff
• Annual O&M cost for pipeline is 2.2% of capital cost
• Annual O&M for gas conditioning plant is 5.4% of plant capital cost
• Pipeline load factors in years 1/2/3 are 85/90/95 percent
• Canadian federal and provincial income taxes are 37%
• U.S. federal corporate income tax rate is 35%
• Alaska state corporate income tax is 9.4%
Drivers Used in Calculation of Alaska Construction Jobs

A. 10,000 man-years labor required per billion U.S. dollars un-inflated capital cost with distribution over 5 years, based on TAPS job and capital history as reported by Alyeska Pipeline and recent reports by Alaska Gas Producer Pipeline Team

B. Alaskan and Canadian jobs split based on cost incurred within each state/country (cf. modeling results)
Drivers Used to Calculate Employment Impact

- $2.561 billion annual netback
- 6 rigs
- 300 drilling company personnel
- 4050 energy industry personnel
- 22,650 other Alaska jobs

a. Based on Alaska Oil and Gas Association report, “Economic Impact of the Oil and Gas Industry on Alaska.” Also reference producer spending and Baker Hughes rig count from Alaska during same period as reported on internet.
b. Based on employment statistics from Alaska Department of Labor.
## Southern Route Not Economic—Even at $3.00

<table>
<thead>
<tr>
<th></th>
<th>Southern</th>
<th>Northern</th>
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<tbody>
<tr>
<td>Capital Cost (Billions)*</td>
<td>$10,906</td>
<td>$8,500</td>
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<td>Length (miles)</td>
<td>2139</td>
<td>1700</td>
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<tr>
<td>Alaska Capacity (Bcf/d)</td>
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<td>4.0</td>
</tr>
<tr>
<td>Canada Capacity (Bcf/d)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pipeline Size (inches)</td>
<td>42</td>
<td>42</td>
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<tr>
<td>Tariff to Lower 48*</td>
<td>$2.20</td>
<td>$1.91</td>
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<tr>
<td>Tariff to Alberta*</td>
<td>$1.48</td>
<td>$1.19</td>
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<tr>
<td>Assumed Gas Price</td>
<td>$3.00</td>
<td>$3.00</td>
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<tr>
<td>Netback to Producer ($/mcf)</td>
<td>$0.80</td>
<td>$1.09</td>
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</table>

* Includes gas conditioning plant
Maybe the producers want more than a $1.00 netback

Potential pipeline profits
- 15% simple return
- 50% equity in $15.1 billion Northern route

- $1.00 per Mscf netback
- 15% profit, 4.8 Bcfd
Which Route Creates Most Permanent Jobs for Alaskans?

- South Total Construction
- North Total Construction
- South Alaskan Employment
- North Alaskan Employment
Basic Comparison of Northern and Southern Routes

Forcing the Southern route…

- Gains 30,378 man-years of construction work.
- Loses 124,811 man-years of state-wide employment, including a loss of 27,262 man-years of high paying energy sector jobs.
- Trades permanent jobs for Alaskans in return for 3 years of seasonal construction jobs filled largely by out-of-state commuters.
- Runs the risk that no gas pipeline is built for another 15-20 years to access Alaskan reserves.
Mr. Knowles, gas prices make an $8 billion gas pipeline a huge gamble. What's your solution?

I'm proposing a $20 billion pipeline.

Tony ... today the key is flexibility, not scale.

Alaska Gov. Tony Knowles

Soviet-style economics resurface in Alaska.
A New Strategy

• Use a staged development approach to address the price and environmental/regulatory risk with reduced emphasis on financial variables.

“Opportunity cost is highly sensitive to uncertainty over future value of a project. New economic conditions that may affect the perceived riskiness of future cash flows can have a large impact on investment spending… Much larger than interest rates. Viewing investment as an option puts greater emphasis on the role of risk and less emphasis on interest rates and other financial variables.” – Harvard Business School Press

**Strategy**

2. Expand deliverability target to 12 Bcf/d; Arctic reserves are sufficient.
3. Finance Phase I with 100% debt in bite-size Canada-only line that squarely attacks producer risk.
What a market-driven pipeline corridor looks like.
Multiple Pipeline Stages Used to Access Arctic Gas

Phase I: 30” Mackenzie Stand Alone 1.6 Bcf/d Canada

Phase 2: 36” Northern Alaska Tie-in & Mackenzie Loop 2.5 Bcf/d Alaska

Phase 3: 42” Full Length Loop 2.5/1.5 Alaska/Canada

Phase 4: 42” Full Length Loop 2.5/1.5 Alaska/Canada

Summary
4.6 Bcf/d Canada
7.5 Bcf/d Alaska
12.1 Bcf/d Total
The Value of Project Staging

**Phase 1: 30”**
**Mackenzie Stand Alone**
- Establish M. Delta ROW
- Clear Canadian regulatory path
- Establish roads, camps, route details for Mackenzie corridor
- Identify and solve real M. Delta technical challenges
- Create clearly lower cost option for additional infrastructure expansion
- Defer larger capital deployment until more data available on gas price/demand trends and risk is reduced

**Phase 2: 36”**
**Northern Alaska Tie-in & Mackenzie Loop**
- Establish Beaufort Sea ROW
- Clear U.S. regulatory path
- Establish roads, camps, route details for northern tie-in
- Identify and solve real arctic offshore technical challenges
- Create clearly lower cost option for additional infrastructure expansion
- Defer larger capital deployment until more data available on gas price/demand trends and risk is reduced

15% reduction in $ rate per dia.-inch-mile
The Value of Project Staging

Phase 2

5% reduction in $ rate per dia.-inch-mile

Phase 3: 42” Full Length Loop

• Establish procedures for 42-inch line
• Create clearly lower cost option for additional infrastructure expansion

Phase 4: 42” Full Length Loop

• Exact duplicate of Phase 3 line, allowing further incremental cost reduction

5% reduction in $ rate per dia.-inch-mile
## Model Results of Recommended Capacity Additions

<table>
<thead>
<tr>
<th></th>
<th>Mackenzie Only</th>
<th>Northern Tie-in + Loop</th>
<th>Full Length Loop</th>
<th>Full Length Loop</th>
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<tr>
<td>Capital Cost (Billion USD)</td>
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<td>Alaska Capacity (Bcf/d)</td>
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<td>Canada Capacity (Bcf/d)</td>
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<td>Size (inches)</td>
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<td>Tariff Prudhoe to L48 ($/Mcf)</td>
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<td>Assumed Gas Price ($/Mcf)</td>
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<td>Netback to Producers ($/Mcf)</td>
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<td>Recommended On-line Date</td>
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<td>2018</td>
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<td>Cumulative Capacity (Bcf/d)</td>
<td>1.6</td>
<td>4.1</td>
<td>8.1</td>
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Model Results of Recommended Capacity Additions

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<td>Capital Cost (Bil.)</td>
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<td>Size (inches)</td>
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<td>Tariff ($/Mcf)</td>
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<td>Recommended On-line Date</td>
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<td>2015</td>
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<tr>
<td>Cumulative Capacity (Bcf/d)</td>
<td>4.0</td>
<td>8.0</td>
</tr>
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</table>
Excess capacity from Alberta is estimated to be 1.5 to 2 Bcf/day today.

Sources:
BP Alaska (stylized pipelines)
TransCanada
Alliance Pipeline
Northern Border Pipeline Co.
Department of Energy
Intl. Petroleum Encycl.
Bruce Bernard Consulting
Detailed View of Pipeline Connections From Alberta

Source: EIA, plotted by Bruce Bernard Consulting
Where is the Profit if Gas Price allows 15% ROE investment and $1.00 netback?

![Graph showing profit over time for different pipeline phases.]

- Canada Producers
- Alaska Producers
- ROE Phase 2 Pipeline
- ROE Phase 3 Pipeline
- ROE Phase 4 Pipeline
- ROE Chicago Line 1
- ROE Chicago Line 2
U.S. Natural Gas Demand and Supply Sources

Tcf per year

- Economides and Oligney “twist” demand forecast
- DOE/EIA demand forecast

Japan-sized LNG Natural gas hydrates?

- Arctic
- Deepwater
- Canada
- Shallow Offshore
- Unconventional
- Conventional

0 10 20 30 40 50 60

Proposed New Gas Availability for North America Markets

Annual Gas Production (BCF)

- Mackenzie
- North Slope

Alaska Gas Employment Impact

- Alaska pipeline construction peak employment in 2008 is 10,412
- Natural gas industry job impact by 2020 is 35,386 permanent jobs
- Gas industry impact in Alaska now to 2030 is 758,628 man-years
Canadian Gas Employment Impact

- Canadian pipeline construction peak employment in 2013 is 23,161 man-years
- Natural gas industry job impact by 2020 is 39,694 permanent jobs
- Gas industry impact in Canada now to 2030 is 901,802 man-years
• Kenai development

Where will Alaska Source its energy if North Slope Gas Leaves the State via Northern Route?
Cook Inlet Oil and Gas Activity, September 1999
Cook Inlet Reserves (1998)

- Original Reserves: 8,468 Bcf
- Produced: 5,493 Bcf
- Remaining: 2,975 Bcf
- Estimated reserve life: 13 years
  @ 214 Bcf/year (thru 2011)
- Undiscovered Recoverable: 7,720 Bcf

Source: MMS
Cook Inlet Consumption

- LNG Exports 34%
- Ammonia/Urea 24%
- Electrical Power 18%
- Gas Utilities 13%
- Field Operations 8%
- Miscellaneous 3%

Source: Anchorage Economic Development Council
Hand Wringing in Kenai/Anchorage

- During last round of permit extension hearings, local opposition to LNG exports surfaced in response to fears of supply constraints.
- Study done by Anchorage Economic Development Corporation advocates that industrial use of natural gas be cut in half in 2010.
- Sen. John Torgerson (State Senator from Kenia Peninsula) is afraid Kenai will become a “ghost town” after 2009, introduced legislation to prohibit construction of Northern route pipeline.
Prudhoe-Sized Reserves Still to be Discovered in Cook Inlet

- While 7 or 8 years of excess supply is very short in, for example, a Soviet-style planning cycle, it is closer to eternity in a market-driven environment.
- The Reserves-to-Production ratio in Cook Inlet is 14, much higher than the national average of 9.
- A positive price signal to the E&P sector in 2000 has already led to new exploration activity.
- Exploration activity now underway by Phillips, Forest Oil, Unocal and Escopeta.
- Anticipate 20 Tcf+ reserves to be announced in Cook Inlet over the next 24-36 months.
Number of Exploratory Gas Wells Drilled in Cook Inlet, and the Calculated/Prevailing Value and Royalty Production Wellhead Value of Cook Inlet Gas, 1992-2000

Source: Anchorage Economic Development Corporation
Escopeta Oil & Gas and B.B.I., Inc.  
Announce Exploration Results in Cook Inlet Basin, Alaska

*Estimated 12 Tcf of Recoverable Natural Gas Reserves Located*

FOR IMMEDIATE RELEASE

September 26, 2001

Contact:  Mr. Danny Davis
(713) 623-2219

Houston, TX – Escopeta Oil & Gas and BBI, Inc. of Houston, Texas, today announced new seismic reprocessing results that show estimated recoverable reserves of 12 trillion cubic feet (Tcf) of natural gas near the East Forelands area of Alaska’s Cook Inlet Basin, at depths of 18,000 to 21,000 ft. Known producing horizons in the same structural trend would likely recover 1.35 billion barrels of oil and an additional 6.1 Tcf of gas.

The reprocessed seismic data reveal the presence of a significant complex fault system on the east flank of the Middle Ground Shoal Field (200 million barrels reserves), forming an immense trapping mechanism, possibly the largest untested structural fault block in the Cook Inlet Basin. Geophysical and geological mapping reflect approximately 9000 feet of vertical closure against this fault system representing approximately 69,000 acres of structural closure. The depth of the main targets suggests accumulations of thermogenic gas.

(cont.)
Cook Inlet Natural Gas Changes the Picture

Natural gas and power to Fairbanks

Asian LNG exports extended/expanded

LNG, GTL and Ethylene to West Coast

20 Tcf

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Kenai Development

MMscfd Natural Gas Usage

Regional Power Gen.  Regional Gas Utilities
Fairbanks Export  Field Operations
Other  Ammonia-Urea
Petrochemical/Ethylene  LNG
GTL Train I  GTL or LNG Train II
Kenai Development Assumptions

- Base of electric power generation and gas utilities in Anchorage area.
- Fairbanks consumption grows ultimately to 100 MMscfd.
- Field operations use of natural gas grows back to 1990s levels following second round of Cook Inlet oilfield development.
- Ammonia-Urea production expands by 30 Bcf annually beginning in 2004, expansion already on drawing board at Agrium.
- Ethylene production of 2 billion lb/yr established by 2009, with ultimate expansion to 4 billion lb/yr, Williams petrochemical study ongoing.
- LNG exports expand gradually to a still-modest 0.5 Bcf per day by 2008.
- GTL production in Kenai starts with 300 bpd pilot in 2002, followed by a 10,000 bpd (100 MMscfd) unit in 2010 and (subject to reserve base and market demand) a 50,000 bpd (0.5 Bcfd) unit in 2014.
Kenai Gas Field 'Type Curve'

Best fit:
\[ Q = 9000e^{-0.053t} \]
with \( t \) in years

Use:
\[ Q = 10000e^{-0.05t} \]
with \( t \) in years
Demand forecast was translated to drilling activity using historical decline “type curve” for Kenai gas wells and drilling rig-days per well estimates provided by the Alaska Oil and Gas Conservation Commission.
Gas Contribution to Permanent Fund, including Kenai

- Interest Income to Permanent Fund due to Gas
- Permanent Fund Balance due to Gas
- Dividend check contribution from gas
- Alaska Population
Environmental Impact

- Construction scheduled not to interfere with whale migration periods in Beaufort Sea.
- Boulder feeding grounds and barrier reefs avoided.
- Design for minimum impact on Caribou herds and Polar Bear dens.
- Impact of pipeline rupture negligible—natural gas and gas liquids are nearly benign.
- Issues related to pipeline access for maintenance must be addressed.
- Energy from natural gas produces far fewer emissions than coal or oil.
Comparison of Annual Air Pollution from Consumption of 4 BCF/D Energy Equivalent

Source: EIA

Olligney and Longbottom, Nov. 2001
Aboriginal Issues

• Jobs, benefits, training and Aboriginal businesses must be accommodated.
• Most environmental issues have been addressed.
• Neutral to negotiations with Canadian Federal government on Aboriginal Claims issues.
• Canadian Crown will not subsidize pipeline.
Conclusions

• Natural gas demand growth over next 20 years will far exceed the 4 Bcfd everyone discusses.
• Failing to address natural gas demand has major ramifications for U.S employment, as well as Alaska.
• The Southern route for Alaska natural gas is not economic, even at $3.00 gas price.
• A staged development through the Mackenzie Valley corridor that employs the ARC approach can provide common ground for all well-meaning parties.
• Cook Inlet potentially holds enough reserves for Alaska intrastate consumption as well as major industrial development and exports.
Reference List

Reference List (cont.)


28. Alaska Oil and Gas Property and Production Taxes, Alaska Department of Revenue website, www.tax.state.ak.us/divisions/.