Alaska Natural Gas Market / Needs Assessment

Advisory Group Meeting

Anchorage, AK
November 9, 2005

Preliminary Assumptions/Results

Work funded by the U.S. Department of Energy, National Energy Technology Laboratory

Agenda

1. Introduction
2. Recap of Overall Study Objectives
3. Approach
4. Assumptions
5. Preliminary Results
6. Schedule
7. Discussion and Feedback

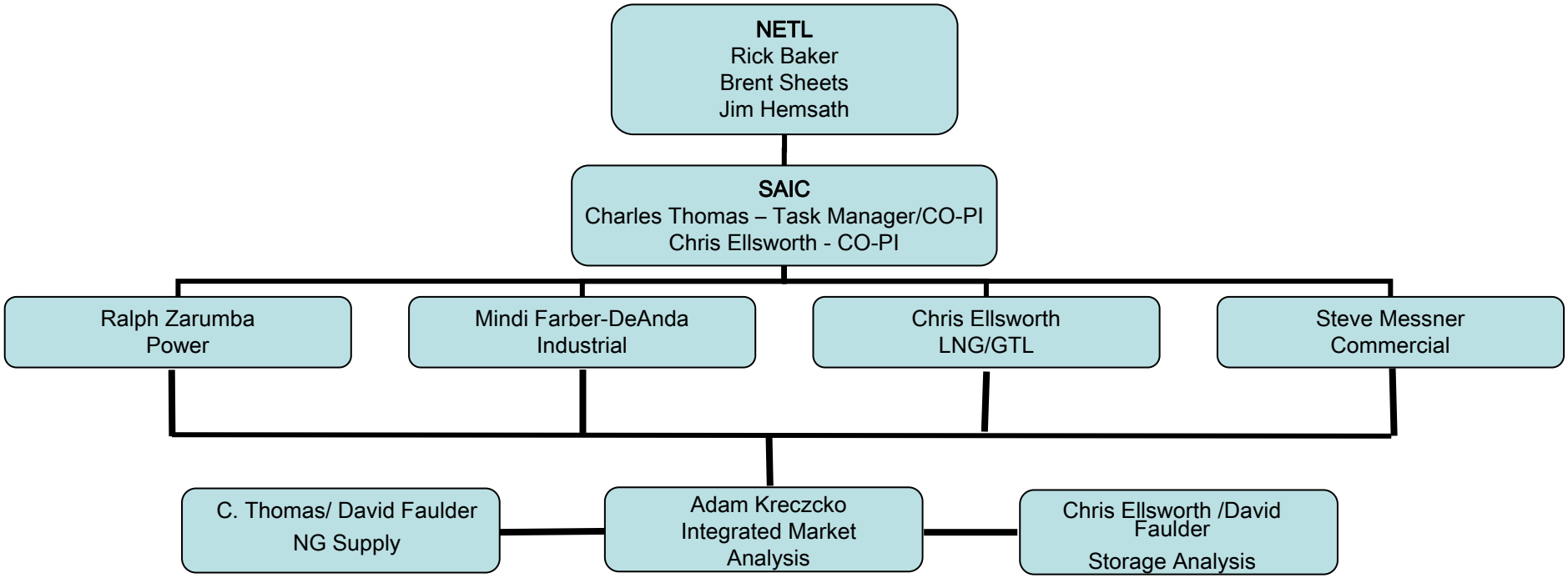
1. Introduction -- Advisory Group

Purpose

- Assist DOE and SAIC in understanding and framing the issues
- Assist in obtaining current and complete data
- Provide critical review of approach, analysis, and results

Organization/Member
Alaska Industrial Development and Export Authority: Ron Miller, Executive Director
Alaska Natural Gas Development Authority: Harold Heinze, CEO
Anchorage ML&P: James Posey, General Manager
ASRC Constructors, Inc.: Marvin Swink
Chugach Electric Association: Lee Thibert, General Manager - Distribution Division/ Bradley Evans, General Manager – Generation and Transmission Division
ENSTAR Natural Gas: Tony Izzo, President
Fairbanks Natural Gas, LLC: Dan Britton, President
Kenai Peninsula Borough: Bill Popp, Oil, Gas and Mining Liaison

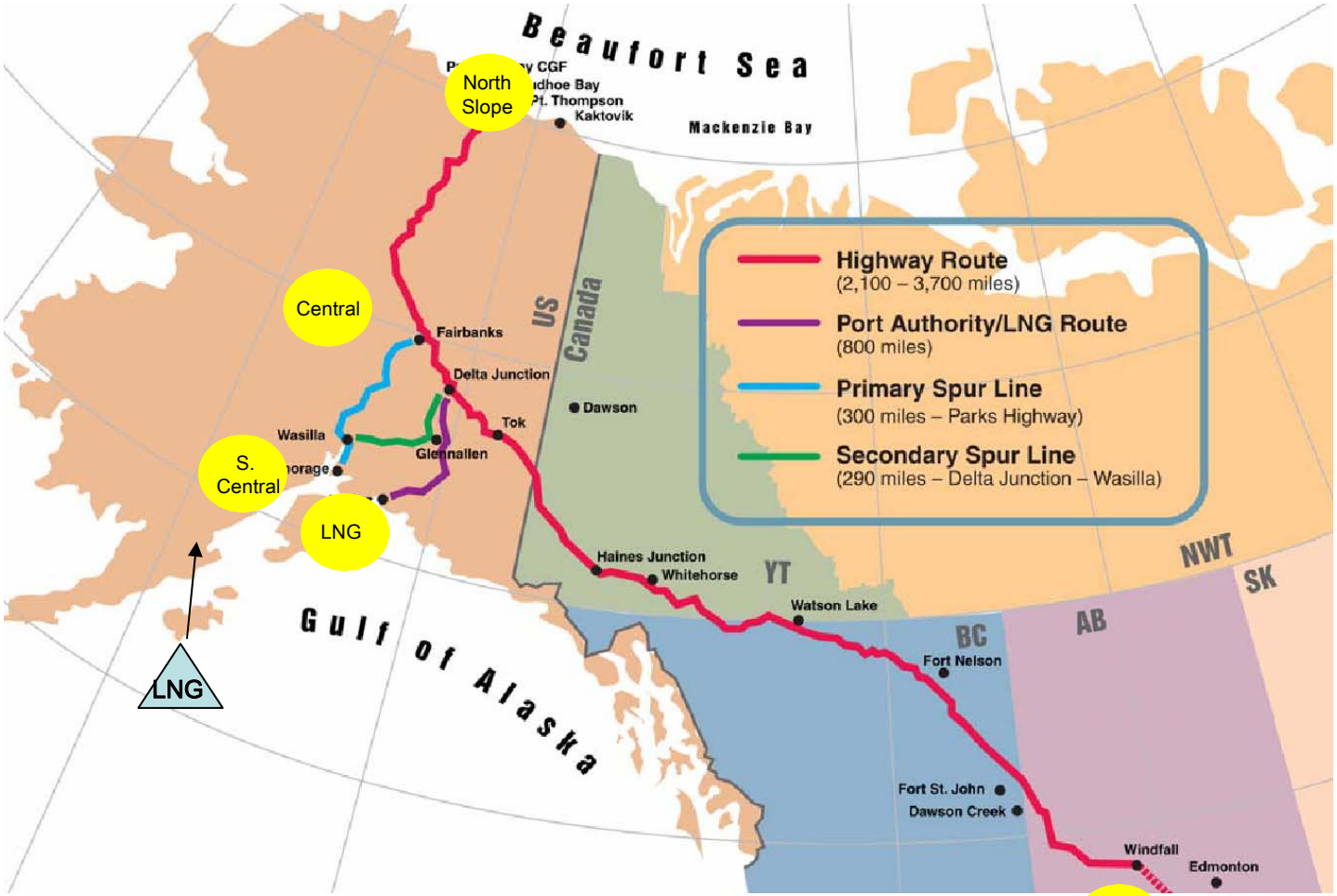
1. Introduction -- Organization



1. Introduction -- Background

- The Arctic Natural Gas Transmission System (ANGTS) would transport 4.5 – 6.0 Bcf/d of natural gas with NGLs from Prudhoe Bay to the Lower 48, beginning in approximately 2015
- Cook Inlet gas supply is being rapidly depleted
- A spur pipeline connecting ANGTS to SC Alaska would alleviate a supply shortfall and could provide stimulus to industry and regional economic development

1. Introduction -- Background



West Coast — AECO — Chicago $4.44

- This study is investigating the:
  - Level of sustainable dry gas demand for South Central and Central Alaska.
  - Level of sustainable demand for NGLs
  - The impact of ANGTS and the resulting connection with the Lower 48 gas market on the South Central Alaska gas market.
  - Determine the optimal level of storage.
- The study is will provide inputs to other studies that will determine the engineering specifications of the pipeline and the socio-economic impacts on the Alaska community.*

**Detailed technical characteristics and specifications will be developed by ASRC*

- SAIC is using a dual approach to this investigation:

  - To determine sustainable demand
    - Current Uses
    - New or Potential Uses

  - To show the impact of an integrated Lower 48 gas market and integrated Lower 48 gas market and global product markets on the development of South Central Alaska's gas market
    - Competitiveness with Lower 48 markets.
    - Competitiveness with global product markets.

[illegible]

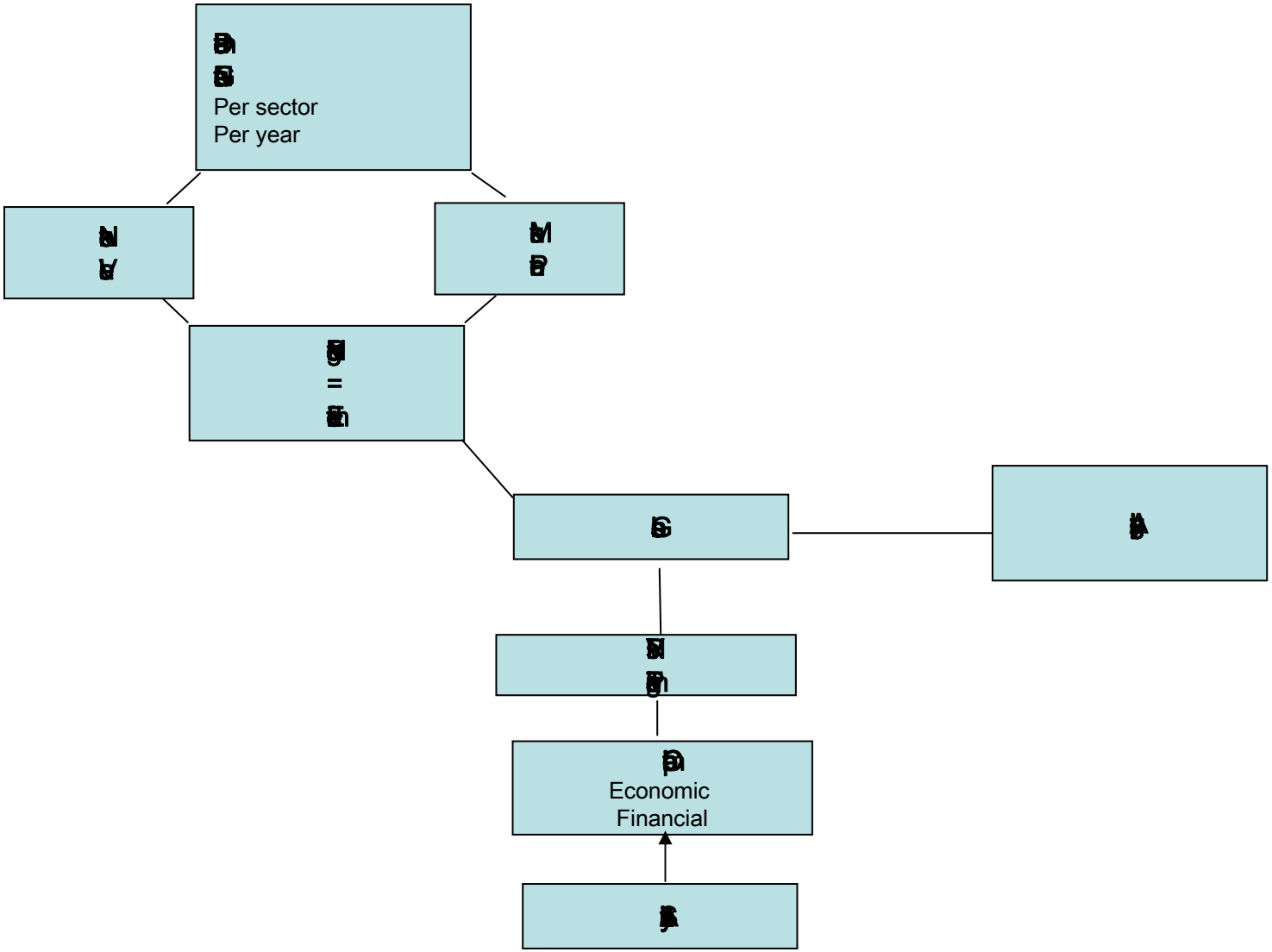
[illegible] will determine current and potential future demand and potential future demand for NG, and define the sustainability requirements for this demand by:

- Identifying the candidate demand sectors and sub-sectors – *Who uses and who can use the gas? How much? When? At what price?*
- Identifying & evaluating long-term competition – *What is needed to maintain NG demand, by industry application?*
- Developing requirements to be met – *What set of integrated requirements are needed?*

[illegible]

[illegible] will determine:

- The feasibility of constructing and operating a pipeline on the basis of projected demand *(Scenario based)*
- The throughput characteristics of the pipeline *(How much, where, when – annual and seasonal throughput?)*
- The market price of natural gas delivered in South Central Alaska

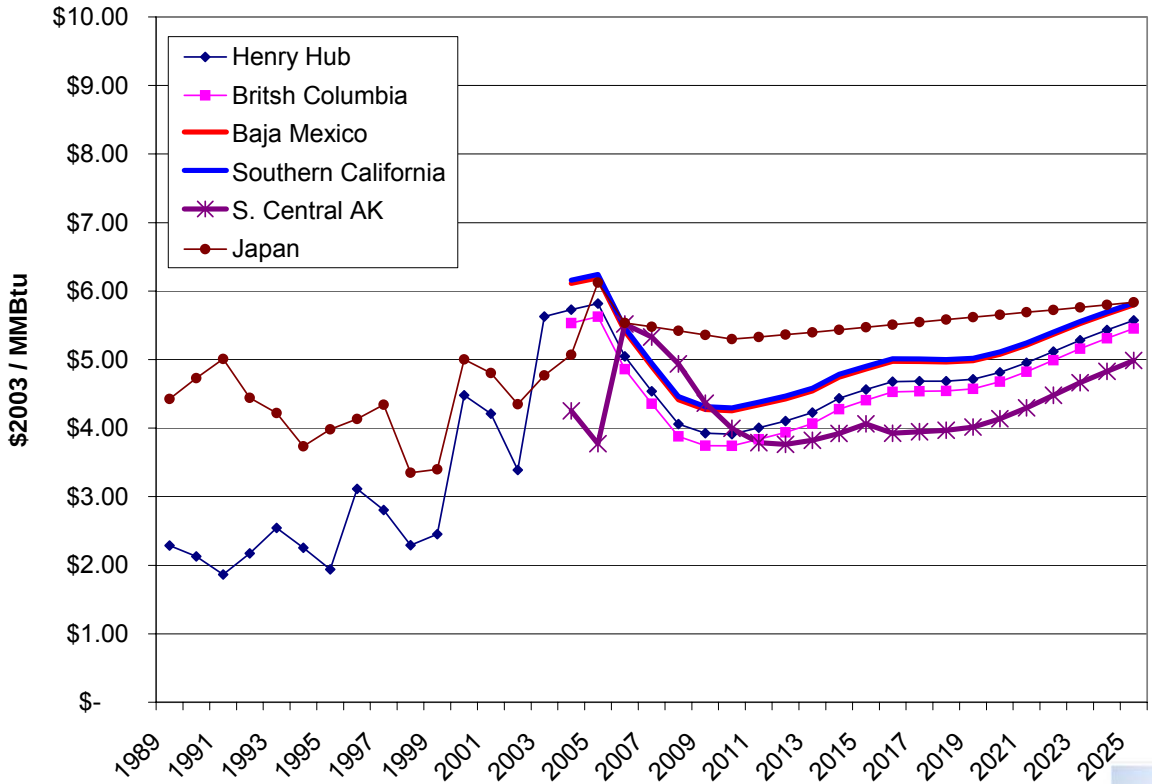

Per sector
Per year
Economic
Financial

4. Assumptions - Sectors Studied

- Overall Economic Assumptions
- Industry
  - LNG
  - GTL
  - Ammonia / Urea
  - Petrochemicals
  - Propane
  - Other
- Power
- Residential / Commercial

Overall Economic Assumptions and Price Forecast

- Population South Central Alaska: 407,000 (2005e)
- Population Growth Rate: 2%
- State Economic Growth Forecast: 2%
- Use EIA and NRCAN forecasts of gas demand and prices in the Lower 48 and Canadian markets.
- Discount Rate: 12%



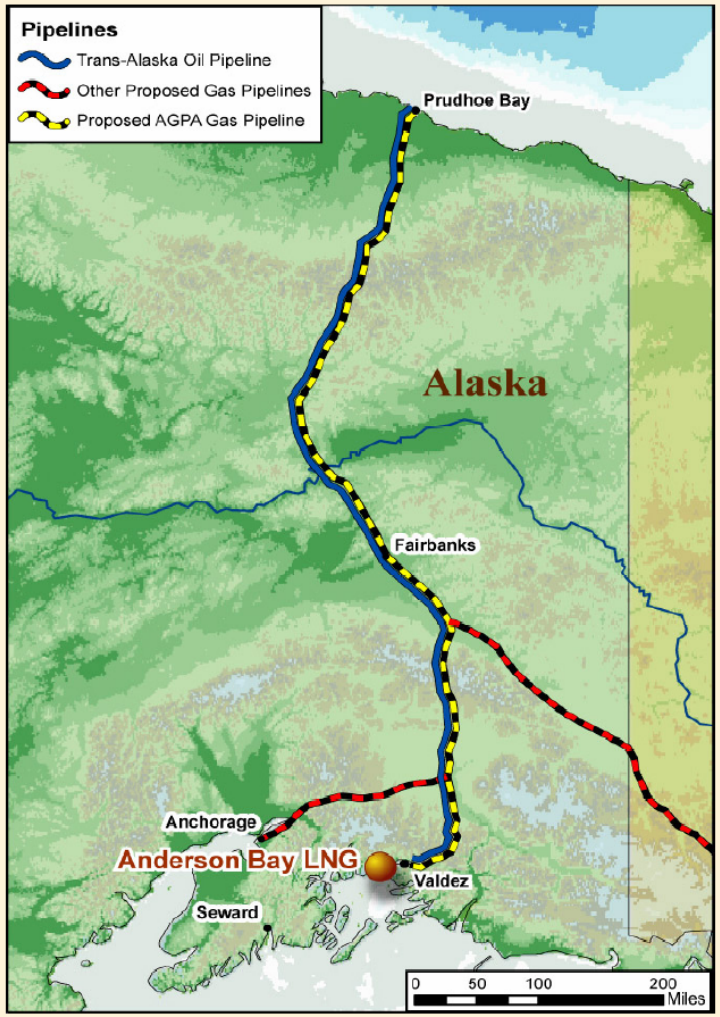
- Natural Gas Price 2015 – 2025
- Henry Hub = $7.41/MMbtu
- World Oil Price = $66.20/BBl

Industrial Opportunities Investigated

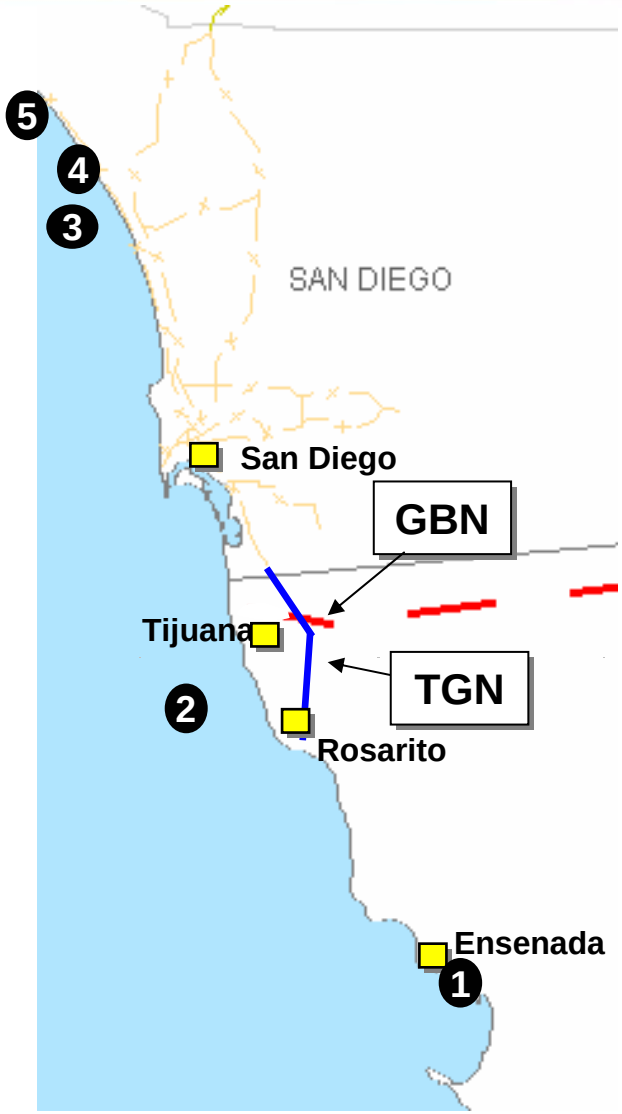
Dry Gas	NGL
◆LNG ◆GTL ◆Fertilizers ◆Petrochemicals ◆Gold/copper mine ◆Internet server farm ◆Insulated wallboard ◆Seafood processing ◆Rolled steel/pipe forming ◆Chipboard/fiberboard	◆Petrochemicals ◆Propane

LNG Analysis

- Estimate demand for gas from a 15 MMt/y LNG terminal at Kenai.
- LNG Feasibility:
  - Estimate a netback price of LNG at an Alaskan liquefaction terminal using World LNG Trade Model.
    - Transportation costs
    - LNG prices in Pacific basin markets
    - Competitiveness of Alaskan LNG versus other sources in the Pacific Basin market.
  - Based on the cost of liquefaction, use the netback LNG price to determine a REQUIRED cost of gas at the liquefaction plant.
  - Determine plant size that competes on world market.



Favored Markets for Alaska LNG
North Baja & Southern California

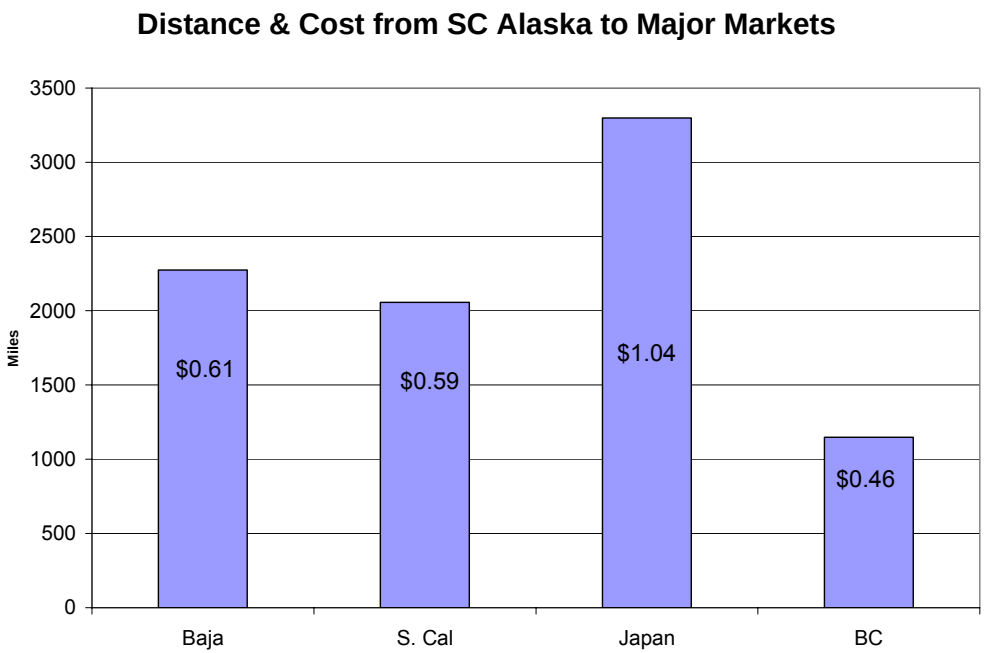


	Project Sponsor	Proposed Capacity (Bcf/day)	Potential Supply Source
1a	Chevron/Texaco	1.40	Australia
1b	Sempra/Shell	1.00	Sakhalin II
2	Chevron/Texaco	0.75	Australia
3	Crystal Energy	0.50	Indonesia
4	Mitsubishi	0.70	Sakhalin II
5	BHP Billiton	1.50	Australia

Other market includes British Columbia (Kitimat)

LNG Plant Assumptions
Located at Valdez or Kenai

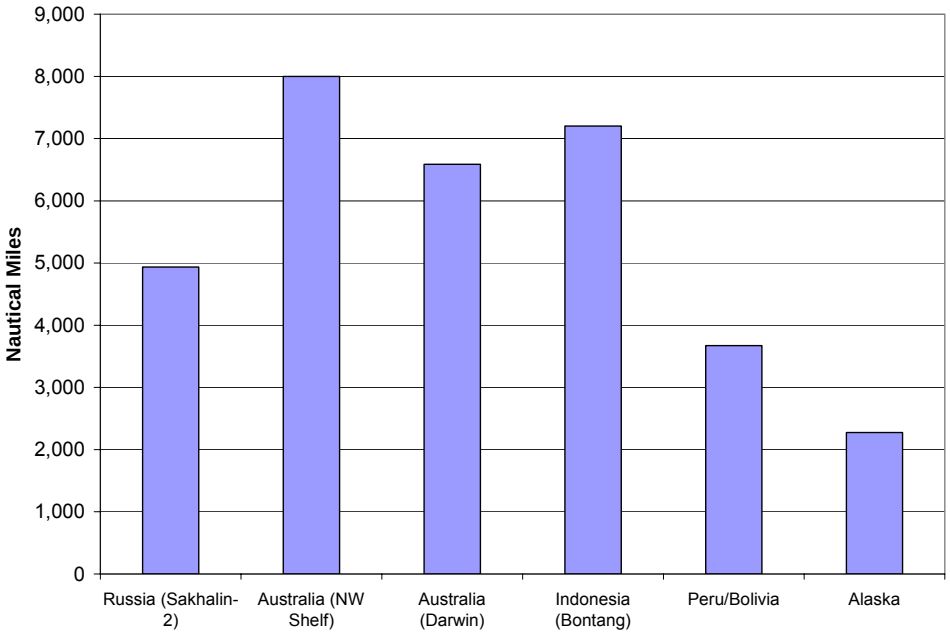
- Capacity: 15 MMt/y (3 trains)
- Feed Gas Required 2.0 Bcf/d
- Liquefaction Costs
  - Capital (Liquefaction): $4.8 billion*, $320 / ton
  - Operating: $96 million / year
- Shipping Costs
  - Capital: $1.1 billion (Based on seven 135,000 cubic meter tankers at $160 MM each)
  - Operating Cost
    - $100,000 /day at sea
    - $35,000 /day in port

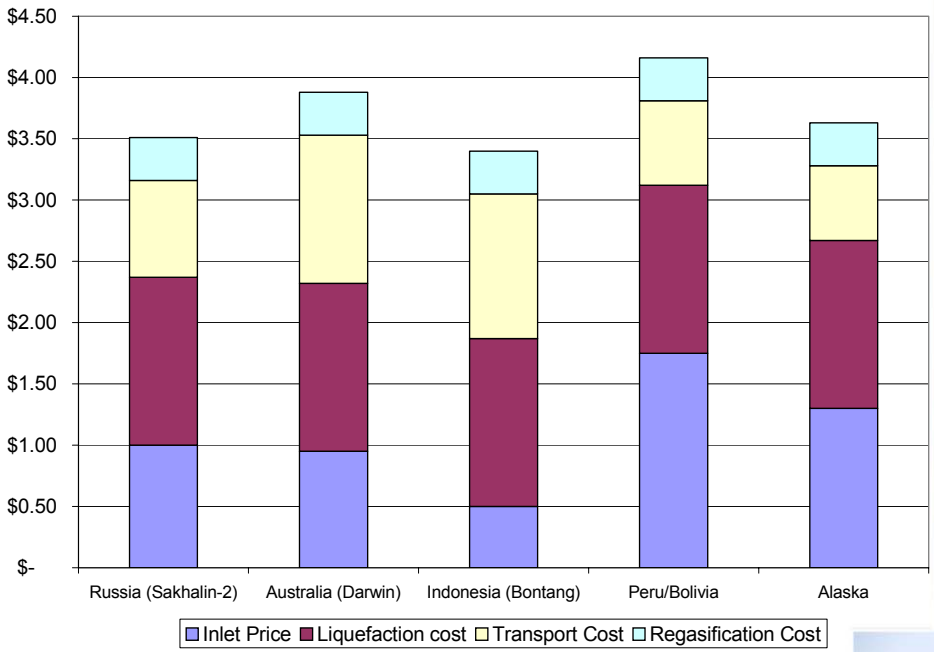


* Stone & Webster

Competing Pacific Basin Projects
LNG to Southern California / Baja Mexico

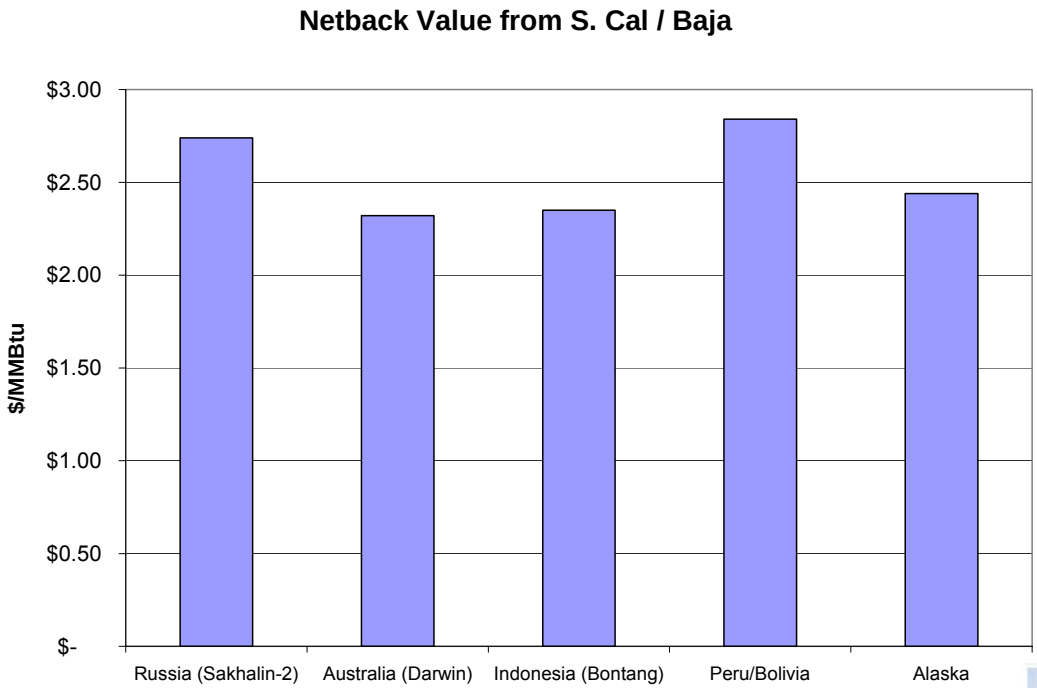
- Sakhalin II – Low Transportation cost
- Australia/ Indonesia – Low production / High transportation cost
- Peru/Bolivia – High Production / Low transportation cost
- Alaska has a transportation cost advantage, which can make it competitive with other LNG sources and provide high value





LNG Assumptions: Pacific Basin Netbacks

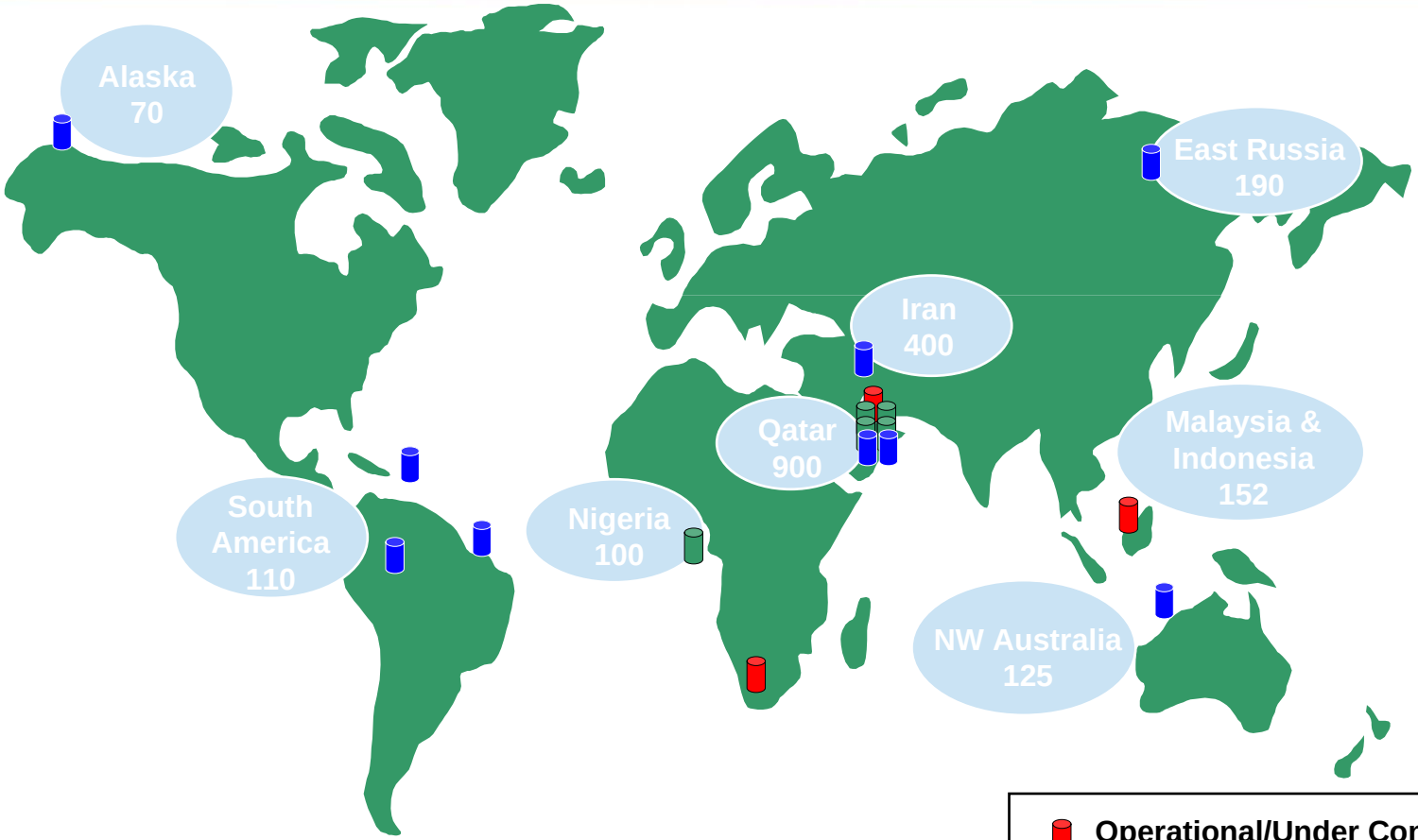
- Net revenue is difference between the price of natural gas in S. California and the total cost to liquefy, transport, and regasify gas in Southern California.
- Assumes a price between 2015 and 2025 of $5.39/MMBtu ($2003)
- Netback value in S. Central Alaska is $2.45 between 2015 and 2025.
- This is eroded by cost of gas delivered to the LNG terminal.



Gas to Liquids (GTL)

- Estimate demand for gas from a greenfield GTL plant.
- GTL Feasibility:
  - Determine likely location of GTL terminal.
  - Estimate a netback price of distillate at GTL terminal
  - Based on the GTL conversion costs, determine a **REQUIRED cost** of gas at the liquefaction plant.
  - Determine plant size that competes on world market.

GTL Projects Worldwide

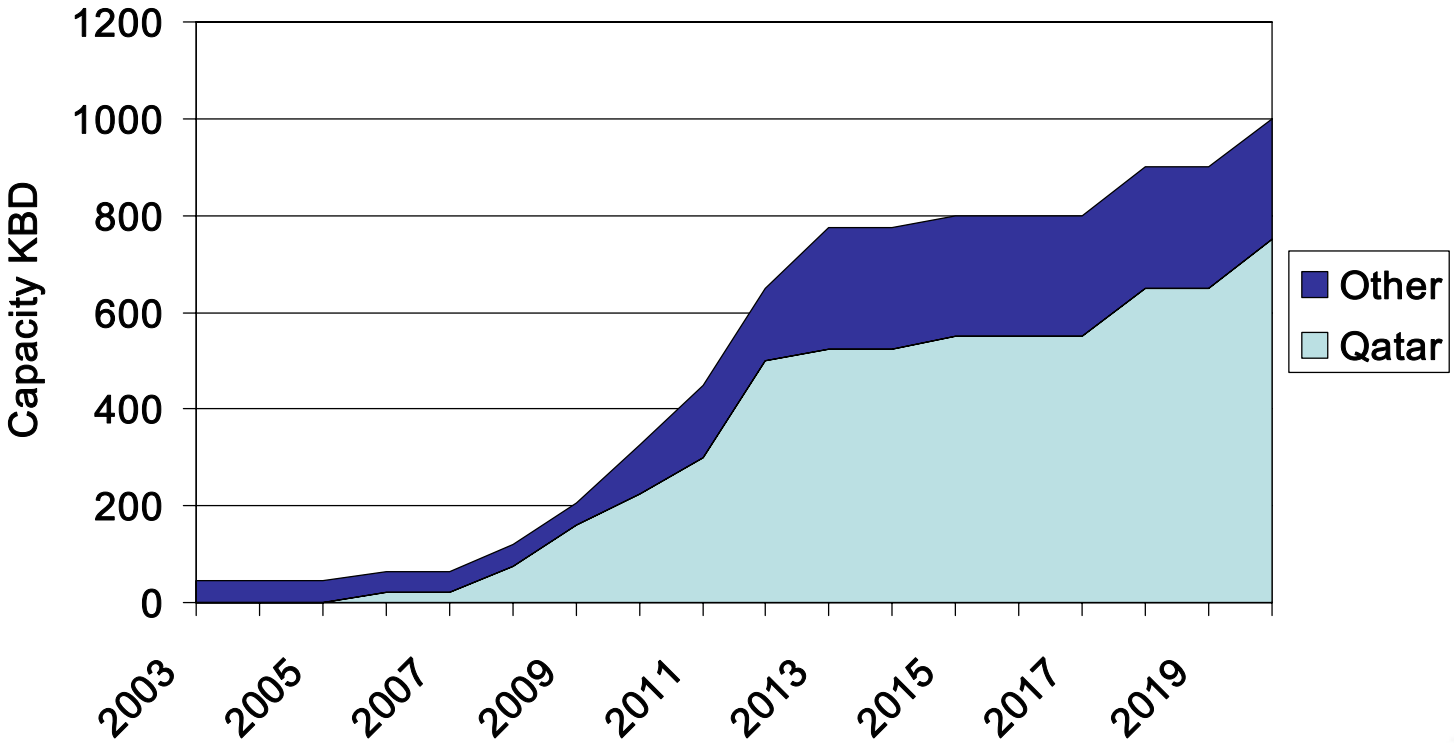


- Qatar is GTL location of choice
- Most GTL projects have significant technical and commercial hurdles to overcome

Operational/Under Construction
Probable
Proposed
Discovered Gas (TCF)

GTL Requires Access to Low Cost Gas

- Total GTL capacity could grow from 45,000 b/d currently to 1 million b/d by 2020.
- Qatar could account for 66% of capacity.



Source: ExxonMobil

GTL Projects Are Being Sized
at 100,000 – 180,000 b/d

- Qatar has over $8 billion in GTL projects proposed between 2004 and 2008.
  - SASOL / Chevron Approx 120,000 b/d
  - ConocoPhillips 160,000 b/d in two phases.
  - Shell-QP – 140,000 b/d (2008-2009)
  - ExxonMobil – QP – Over 100,000 b/d
  - Ivanhoe Energy – QP – 180,000 b/d (2008)
  - Marathon / Syntroleum – QP – 91,000 b/d (2008)

Alaska GTL Plant Assumptions

- Plant Size: 100,000 b/d
- Conversion: 8 Mcf/bbl
- Feed Gas: 800 MMcf/d
- Gas used in process: 30% (240 MMcf/d)
- Feed gas required 1,040 MMcf/d
- Total Capital Cost: $2.5 Billion
- Operating Cost: $220 Million /year
- Capital Cost per Barrel: $25,000
- Operating Cost per Barrel: $6.00
- Market: U.S. West Coast low sulfur diesel market
- Shipping cost: $1.40/Bbl ($0.24 / MMBtu)

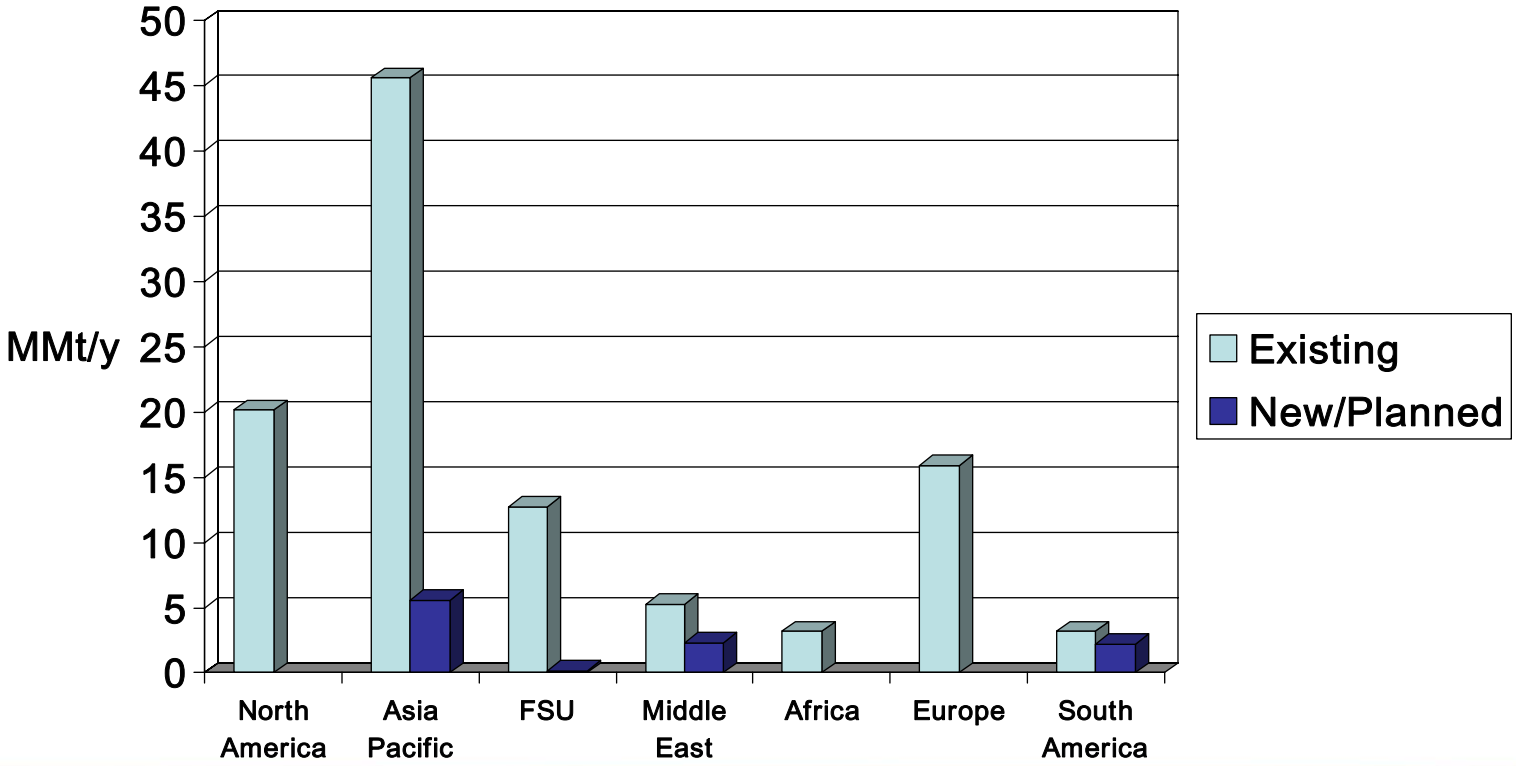
GTL: West Coast Low Sulfur Diesel Netbacks

- Assumes low sulfur diesel price of $9.78/MMBtu in California market (2015-2025)

Benefit / Cost		
Average Incremental Benefit (Before Tax)	$	10.07
Average Incremental Benefit (After Tax)	$	6.75
Average Incremental Cost (Conversion)		$3.16
Average Incremental Cost (Shipping)		$0.24
Total Cost		$3.40
Netback	$	3.34

Ammonia
Existing & New Capacity for Ammonia

- Approximately 106 million tons of ammonia capacity worldwide.
- 10 million tons of projects in planning, engineering, or under construction in 2005.
- Over 50% located in Asia.

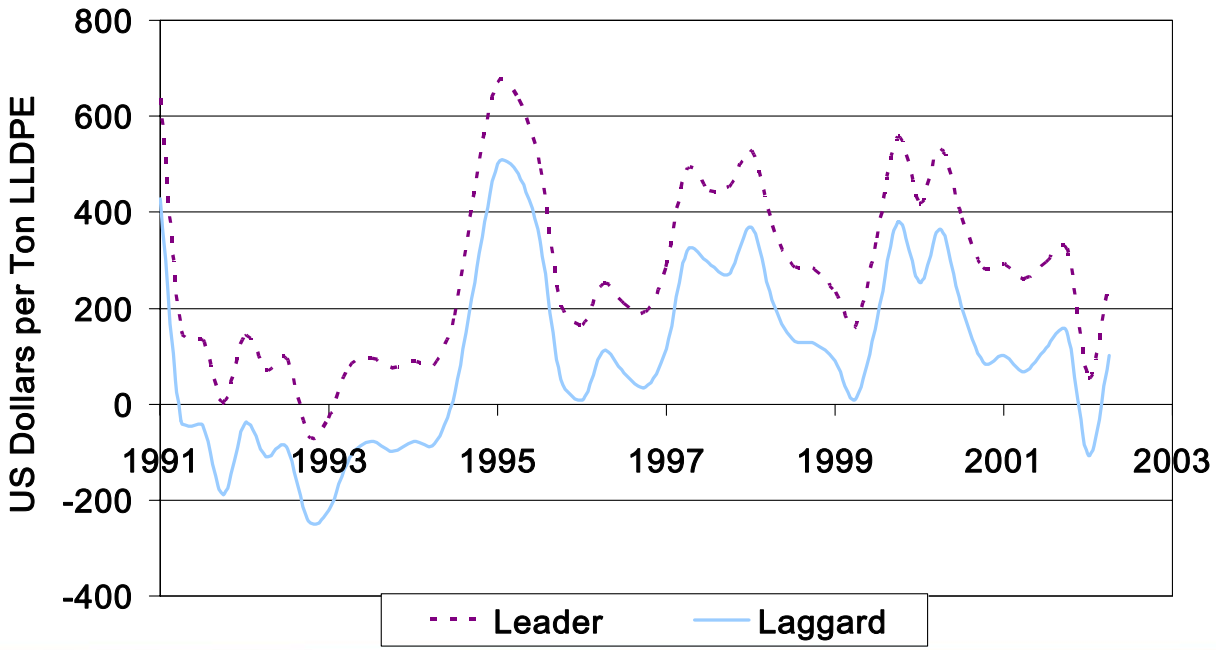


Petrochemical Plant Analysis

- Define scenario for greenfield plant
  - Determine product mix and their markets
  - Scale to a world class competitively sized plant
- Estimate greenfield plant gas demand for feedstock and energy use
- Determine petrochemical plant feasibility:
  - Estimate a netback price of ethylene, polyethylene
  - Determine a **REQUIRED cost** of ethane from an NGL plant

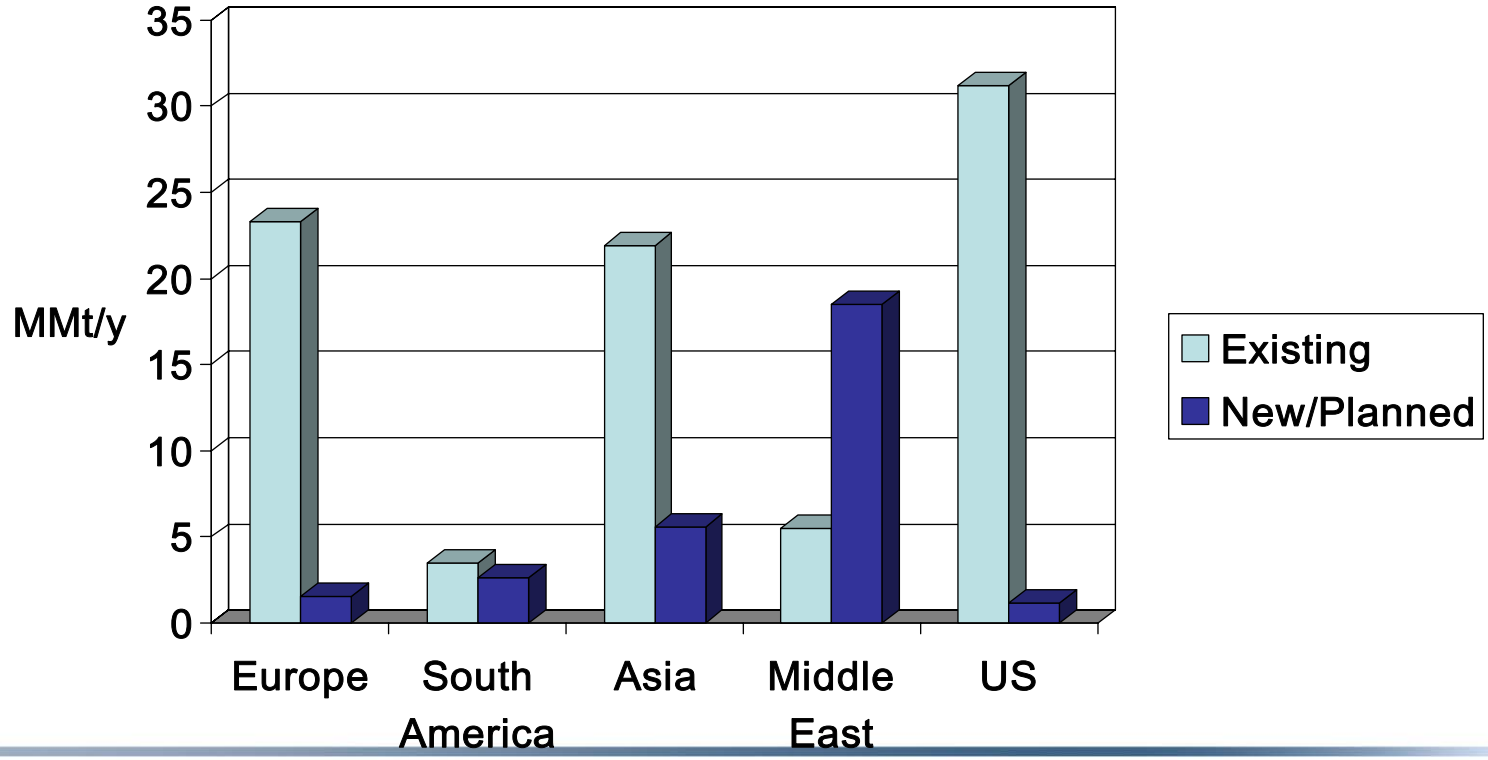
Petrochemicals Outlook
Ethylene & Derivatives

- Market prices and margins are cyclical
  - Prices are cyclical with GDP
  - Recent polyethylene prices delivered to China range around $520/ton from the Middle East to over $700/ton delivered from the U.S.
  - Korea, and some Alberta producers also serve the Chinese market
  - Ethylene glycol spot price: ~$320/ton.



Existing & New Capacity for Ethylene and Ethylene Glycol

- Approximately 91 million tons of ethylene capacity worldwide.
- 29 million tons of projects in planning, engineering, or under construction in in 2005.
- 63% located in Middle East.
- The US is the high cost producer with declining world market share



Alaska Petrochemicals Plant Assumptions (Preliminary)

- Quality of feedstock is critical factor in investment decision
  - Almost pure ethane is preferred, resulting in minimal unwanted by-products.
- Production capacity: 1.36 MM tons/yr ethylene
  - Further processed into polyethylene (PE) and ethylene glycol.
- Ethane for Feedstock: 90,000 bbl/d.
- Methane for Energy (Steam, Power): 146 MMcf/d
- Capital Cost: $1.5 Billion
- Operating Cost: [TBD]
- Shipping Cost: [TBD]
  - Destination China & Pacific Rim countries
  - PE shipped as pellets, no special handling requirements
  - Ethylene glycol shipped as liquid

Propane/LPG Analysis

- Estimate demand for gas from a greenfield LPG plant for in-state distribution and export.
- Determine LPG Feasibility:
  - Define financial arrangement for NGL fractionation facility
  - Estimate a netback price of LPG at terminal
  - Based on the capital, operating, and shipping costs, determine a **REQUIRED cost** of propane from the fractionation plant.

Alaska LPG Plant Assumptions

- Plant Size: 50,000 bbl/d propane.
- Export Volume: 40,000+ bbl/d*
- In-State Market: 7,500 bbl/d by 2015*
  - 500 b/d imports + 500 b/d from Tesoro makes up total in-state demand today of 1,000 b/d
- Natural gas required [TBD]
- Total Capital Cost: $283 Million*
  - Reflects upgrades to Port MacKenzie facility for LPG export
  - Does not include fractionation plant, which may be incurred by or cost-shared with petrochemical company
- Operating & Shipping Costs: [TBD]
- Market: China and other Pacific Rim countries

*Based on PND Incorporated, August 2005.

Other Industrials:
Insulated Wallboard

- Structural insulated panels for building construction
- Expanded polystyrene foam
  - Made from loose foam beads
  - Mixed with a blowing agent (air, CO_2, gases)
  - Molded into shapes

Properties	Value
Density (lbs/cu ft)	1.35-1.80
R-value per inch	4.17-4.35
Tensile strength	18-27 psi
Retail cost	$0.17/bd ft

Source: http://www.forms.org/product_info/brief_foam.html

- Studs from recycled steel can slide into foam panels
- Alaska Innovative Housing Authority and U.S. Military interest
- Product dimensions facilitate shipping in empty containers to other Alaska and Asia ports
- Complement petrochemical and NGL industries
- Will investigate further

Other Industrials:
Rolled Steel/Pipe Forming

- Steel products are essential for Alaska's spur pipeline and construction industries
- Propose shipping of unfinished steel to Alaska for forming and finishing into products for local demand
- Accumulated scrap metal in Alaska can be processed
- Contribution to new industrial demand for Spur (hot rolling)
- Will investigate further

Processes	Energy Use/Ton
Reheat Furnace Avg	1.6 MMBtu
Modern Furnace	1.4 MMBtu
Hot Rolling	0.8 MMBtu
Acid Pickling	1.2 MMBtu
Cold Rolling	0.7 MMBtu
Cleaning/Annealing	1.0 MMBtu

Source: Energetics 2000.

Other Industrials:
Pebble Copper-Gold-Molybdenum Mine

- Status: Proposed large-scale open pit mine
  - Estimated resource: 27 MM oz gold and 16.5 Bill lb copper
  - Feasibility study due 2006
  - Earliest construction: 2009 on mine itself
- Location: Remote
  - AK Peninsula, north side of Cook Inlet, ~50 miles inland near Iliamna
  - Far from transportation and electric power infrastructure
- Energy Needs: 300 MW electric power
  - Multiple options under consideration for generating power
  - Preferred option to connect to Railbelt by building new underwater/overland cable
- Will be added to power load

Other Industrials:
Internet Server Farm

- Existing Internet Server Farm in Anchorage (old ATT Alascom bldg). DOD/NNSA contract; business will expand
- In South-Central Alaska, the Internet Server Farm intends to purchase electricity (primary energy requirement), unlike the North Slope proposal that included on-site gas-fired cogeneration.
- No demand for natural gas anticipated; no contribution to new industrial demand for Spur Pipeline
- Will be added to power load

Market Variables	Today	2010
Capacity (# servers)	50	20,000
Electricity Demand	3.75 kW	1.5 MW
Server investment	$75,000	$30 MM

Sources: Sequestered Solutions, Netricity, LBNL.

Other Industrials:
Seafood Processing

- Seafood continues to drive international export growth in Alaska, accounting for 53% of all exports
- Governor Murkowski's $50 million fish revitalization strategy,
  - Direct aid to fishing communities / fisherman
  - Funding for seafood development projects throughout coastal Alaska
  - Aggressive salmon marketing campaign
- Highly seasonal in most of Alaska: June-August
- Most canneries shut down
- Buyers freeze local fish and ship it south
- No contribution to new industrial demand for Spur Pipeline
- Will NOT be modeled

Source: U.S. Census Bureau, Origin of Movement Series

Other Industrials:
Chipboard/Fiberboard

- Value-added wood products proposed
- New timber-based projects have been thwarted by:
  - International competition
  - Environmental limits on logging
  - Lack of major sawmills (raw materials)
  - Beetle infestations and other diseases
  - Transportation hurdles (roads, rails, port facilities)
- Mitsubishi had a birch and spruce wood chipping facility in Beluga. Rarely broke even.
- Kenai opportunity at Ninilchik, closer to trees, Homer port
- A developer built own sawmill on Kenai; treat and dry lumber
- Unlikely to use gas if cogeneration built; more likely to use wood waste
- No contribution to new industrial demand for Spur Pipeline
- Will NOT be modeled

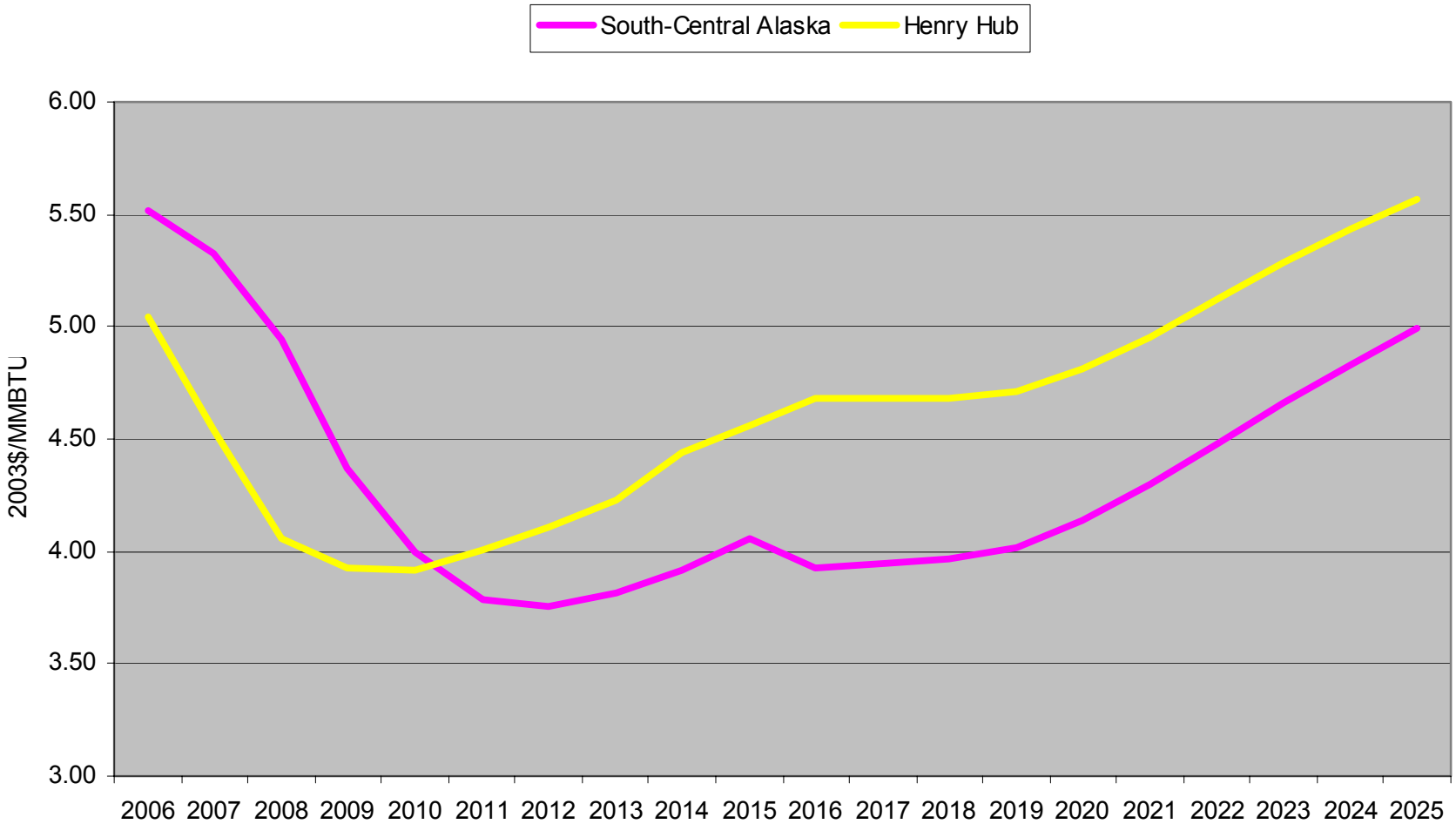
Power - Approach

- Our goal is to estimate natural gas demand for the power sector if the spur pipeline is constructed.
- We will simulate the dispatch of the electric power system.
- An electric generation expansion plan will be developed.
- Several studies have been performed in the past that have provided some guidance and are a source of assumptions for our analysis.
  - Chugach IRP (2004)
  - Railbelt Energy Study (2004)

Power - Assumptions

- The following activities were used to develop the assumptions behind the power market analysis.
  - SAIC was provided the R.W. Beck Studies for general guidance on assumptions.
  - Meetings with ML&P and Chugach.
  - Natural gas and other fuel prices developed internally by SAIC to reflect the prices we'd anticipate to face with and without the spur pipeline and also reflecting more recent information on long-run natural gas markets.
- Although existing contracts for natural gas exists that may differ from our price forecast the price forecast is assumed to reflect regional market prices and all dispatch decisions would occur at market price.

Natural Gas Price Forecasts



Remaining Issues With Fuel Price Forecasts

- Other fuels such as diesel, naphtha, HAGO are pegged to AEO projections.
- Coal prices will remain unchanged.

Assumptions – New Generation Units

New generation units added in the analysis generally adopted those in the R.W. Beck studies with the following changes:

- The 7F technologies were excluded due to size.
- The new GE LMS100 was added.
- A smaller fluidized-bed coal unit was added.
- The stoker coal-fired unit was excluded.

Assumptions – Existing Generation Portfolio

- Existing generation characteristics were generally adopted from the R.W. Beck studies
- Economic idling of a unit is allowed if that unit cannot generate revenues to cover avoidable costs.

Residential / Commercial

- Preliminary demand forecast prepared in two ways
- S Central Alaska – very good historic data
  - Uses existing Enstar data on growth projections and expansion areas
  - Netback benefit/cost screening used to confirm existing growth projections
  - Model prepared that adjusts per unit consumption based on weather and efficiency
- Fairbanks area – limited data sets
  - Existing market penetration very low
  - Demand forecast uses residential, commercial growth assumptions and analogous consumption rates
  - Also relies on netback benefit/cost screening to estimate penetration potential

Case 1 - Fairbanks - North Pole Area Heating Unit Burner Conversion

- Assumes current heating oil price = $2.52/gallon (October market survey)
- Heating oil calorific value = 132,000 Btu/gallon (Fairbanks NG web site)
- Natural gas calorific value = 1.035 MMBtu/MCF
- Residential unit consumption = 190 MCF/yr (Fairbanks NG correspondence)
- System O&M costs from review of Enstar records and regulatory filings
- Conversion and replacement costs from discussions with Enstar
- Distribution line unit costs from Enstar correspondence and regulatory filings
- Distribution line lengths from Fairbanks NG data on expansion areas

Benefit / Cost	
Average Incremental Benefit (Heating oil price $/MMBtu)	$19.09
Average Incremental Benefit (Heating oil price ($/MCF)	$19.76
Conversion cost	$1400.00
Conversion cost amortized over 5 years - 190 MCF/year use	$1.47
Distribution line - $8.80/ft installed (Fairbanks NG data for avg. distance)	$1681.00
Distribution cost amortized over 5 years - 190 MCF/year use	$1.77
System O&M costs	$1.64
Total costs	$4.88
Netback price at delivery point ($/MCF)	$14.88

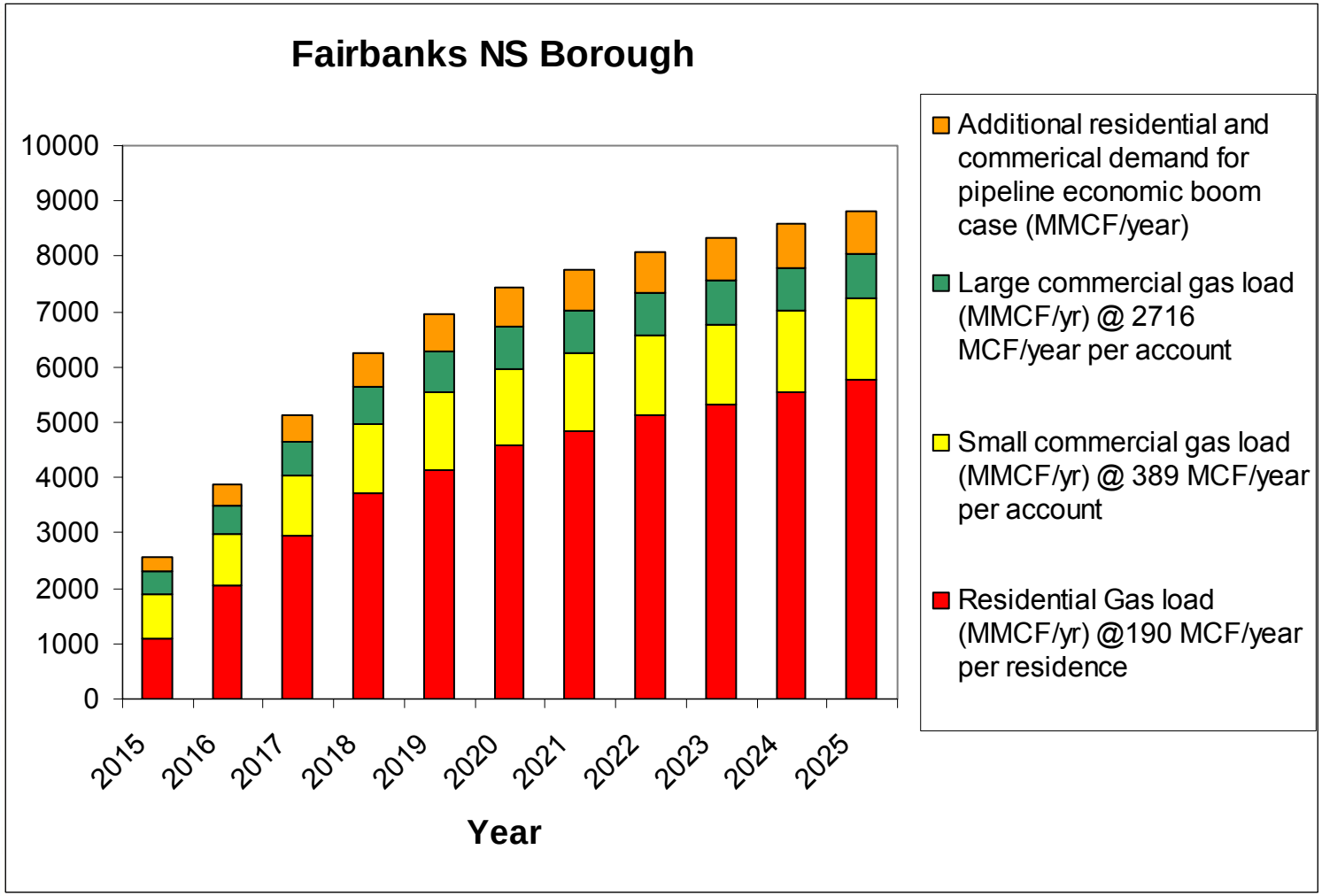
Case 2 - Fairbanks NS Borough Outlying Community - Heating Unit Replacement

Benefit / Cost	
Average Incremental Benefit (Heating oil price $ / MMBtu)	$19.09
Average Incremental Benefit (Heating oil price $ / MCF)	$19.76
Replacement cost	$3000.00
Replacement cost amortized over 5 years - 190 MCF/year use	$3.16
Distribution line (distance extrapolated from Fairbanks NG data)	$4000.00
Distribution cost amortized over 5 years - 190 MCF/year use	$4.21
System O&M costs	$1.64
Total costs	$9.01
Netback price at delivery point ($/MCF)	$10.75

Conclusions based on favorable net back price and SC Alaska historic data:

- 70% residential penetration assumed for Fairbanks North Star Borough in 10 years after North Slope gas available, 80% in 20
- 90% commercial penetration assumed for Fairbanks North Star Borough in 5 years after North Slope gas available

Residential / Commercial Demand - Fairbanks



Assumptions:

- Residential growth rate = 1%
- Commercial gas consumption from Enstar data
- Number of commercial gas accounts from percentages seen in SC Alaska - 9% of total residences for small commercial and 0.7% for large commercial
- Estimates of new residents (10,400) for pipeline mini-boom case from BP, Conoco-Phillips, Exxon socioeconomic study (November 2004)

Case 3 – S Central Alaska Outlying Community - Heating Unit Replacement

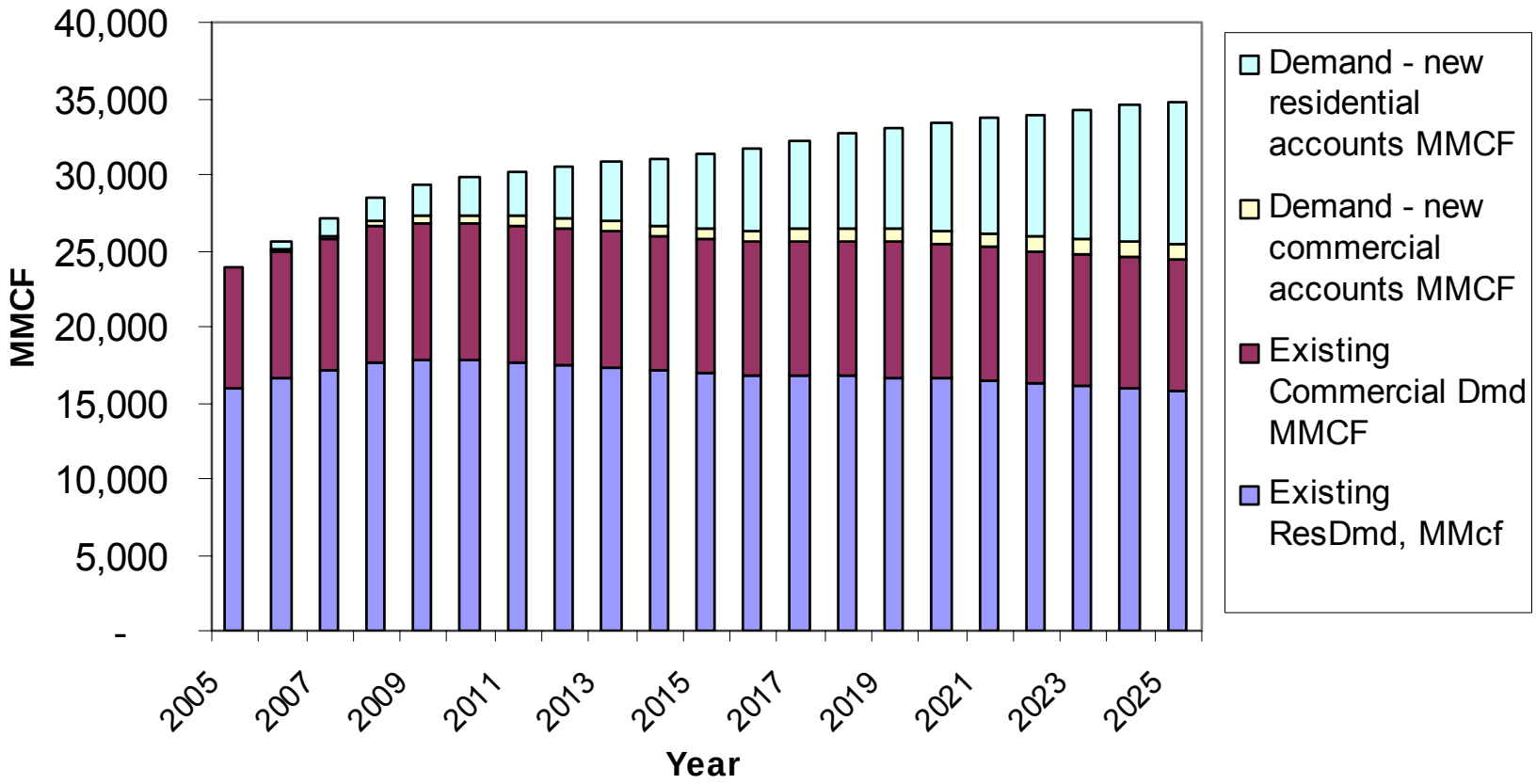
Benefit / Cost	
Average Incremental Benefit (Heating oil price $ / MMBtu)	$18.26
Average Incremental Benefit (Heating oil price $ / MCF)	$18.90
Replacement cost	$3000.00
Replacement cost amortized over 5 years - 175 MCF/year use	$3.43
Distribution line	$4000.00
Distribution cost amortized over 5 years - 175 MCF/year use	$4.57
System O&M costs	$1.64
Total costs	$9.64
Netback price at delivery point ($/MCF)	$9.26

Assumption changes:

- Heating oil calorific value = 138,000 Btu/gallon
- Residential unit consumption = 175 MCF/yr (Enstar data)

Conclusion: Favorable net back price confirms future growth potential in existing market

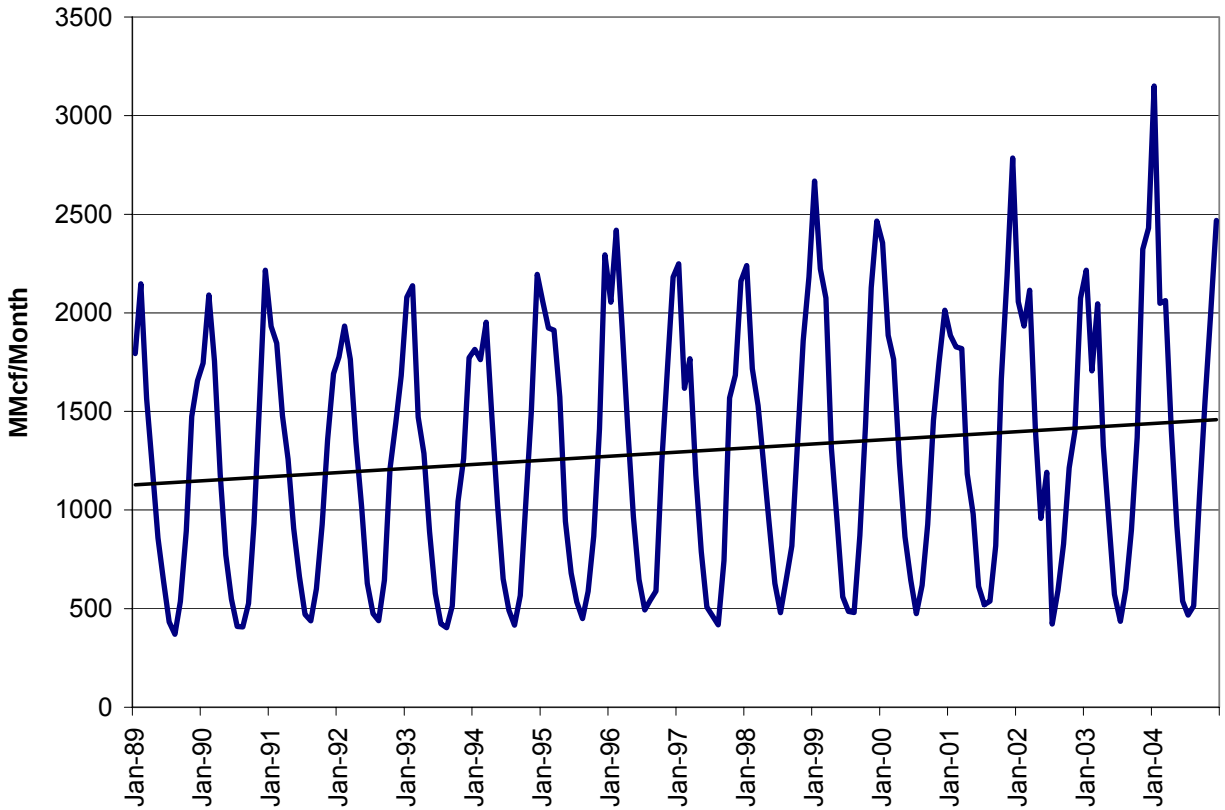
Residential / Commercial Demand – S Central Alaska (Preliminary)



- New residential and commercial account numbers and unit consumption rates from Enstar projections.
- Assumes Residential growth rate = 2%

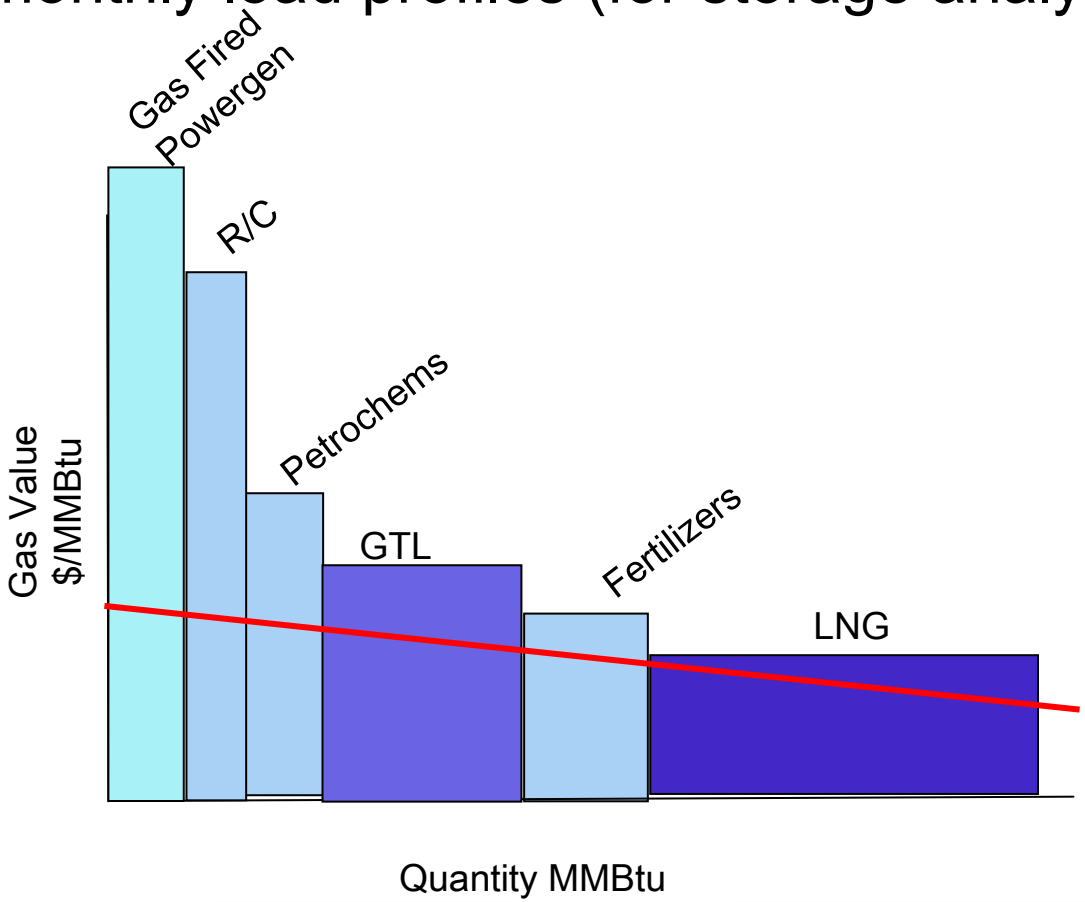
Seasonal Residential Consumption

- Monthly residential consumption oscillates by a factor of six over a year
- Peak day consumption oscillates by a factor of ?????
- Seasonal consumption patterns will determine overall storage requirement



5. Preliminary Results
Calculation of Netback Prices

- Build gas demand curves based on current consumption, future possibilities, and alternative fuels
- Determine monthly load profiles (for storage analysis)



Summary Gas Demand and Netback Values: 2020

SECTOR	GAS DEMAND	NETBACK VALUE
Residential / Commercial	115 MMcf/d	$6 – 9
LNG	2,000 MMcf/d	$2.45
GTL	1,040 MMcf/d	$3.34
Petrochemical Plant	146 MMcf/d	TBD
LPG		TBD
Ammonia / Urea	160-165 MMcf/d	TBD
Power Sector		

Cook Inlet Natural Gas Supply

- Updated analysis of production data
  - See no change in EUR from prior Cook Inlet natural gas study for Beluga River, Kenai, McArthur River, North Cook Inlet
  - **Total Cook Inlet production 201.76 Bscf in 2004**
  - Production during 2004
    - Cannery Loop, 14.35 Bscf
    - Ninilchik, 12.37 Bscf
    - Beaver Creek, 7.72 Bscf

Beluga River	57.62
Kenai	24.22
McArthur River	33.16
North Cook Inlet	41.01
2004 TOTAL	**156.01 Bscf**

Cook Inlet Gas Market Dynamics

Demand

LNG – Phillips/Marathon (70%/30%) - 78 Bcf/yr

Urea – Agrium - 52 Bcf/yr

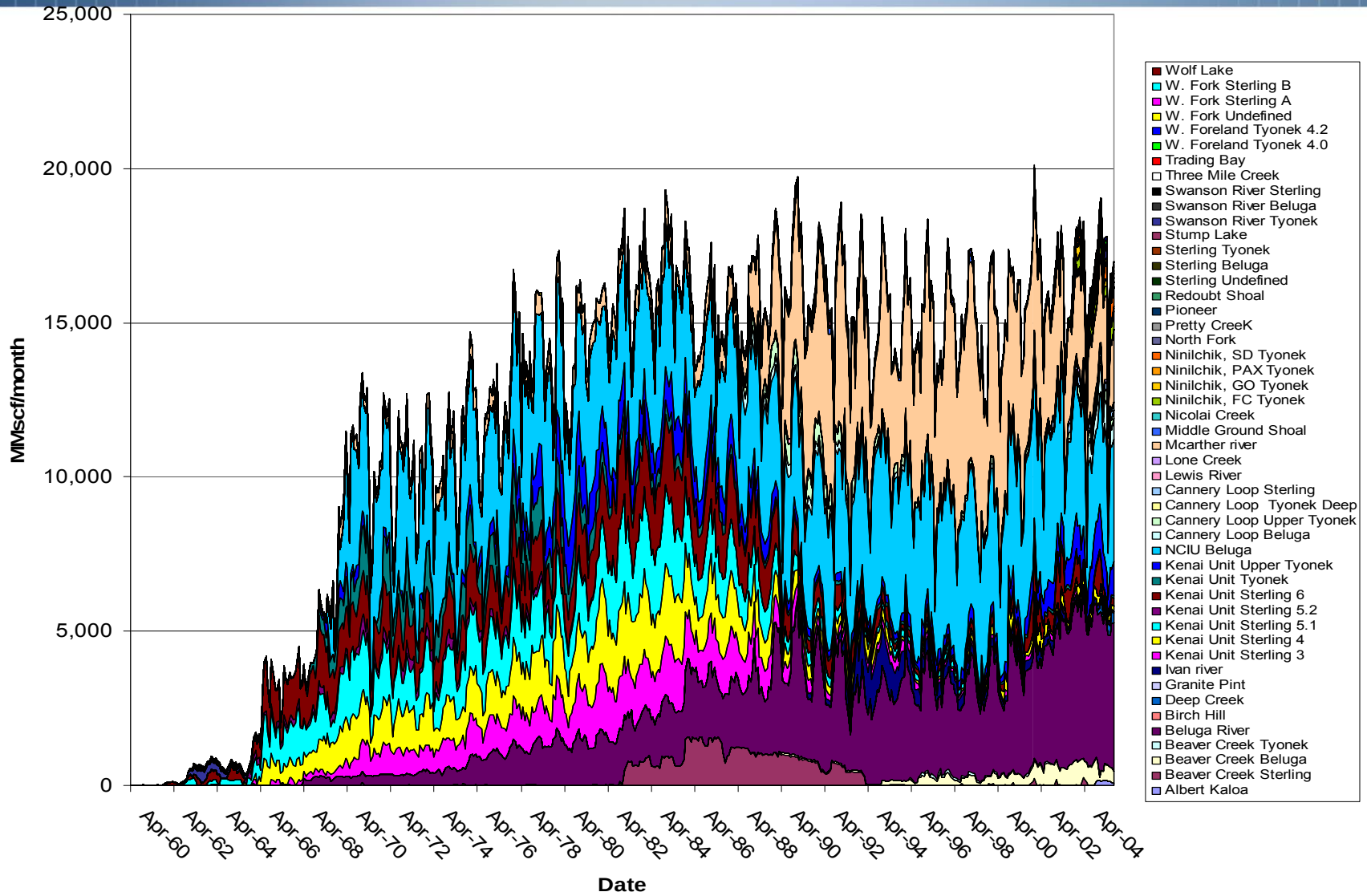
Power Generation – ML&P/Chugach - 35 Bcf/yr

Utility – Enstar - 31 Bcf/yr

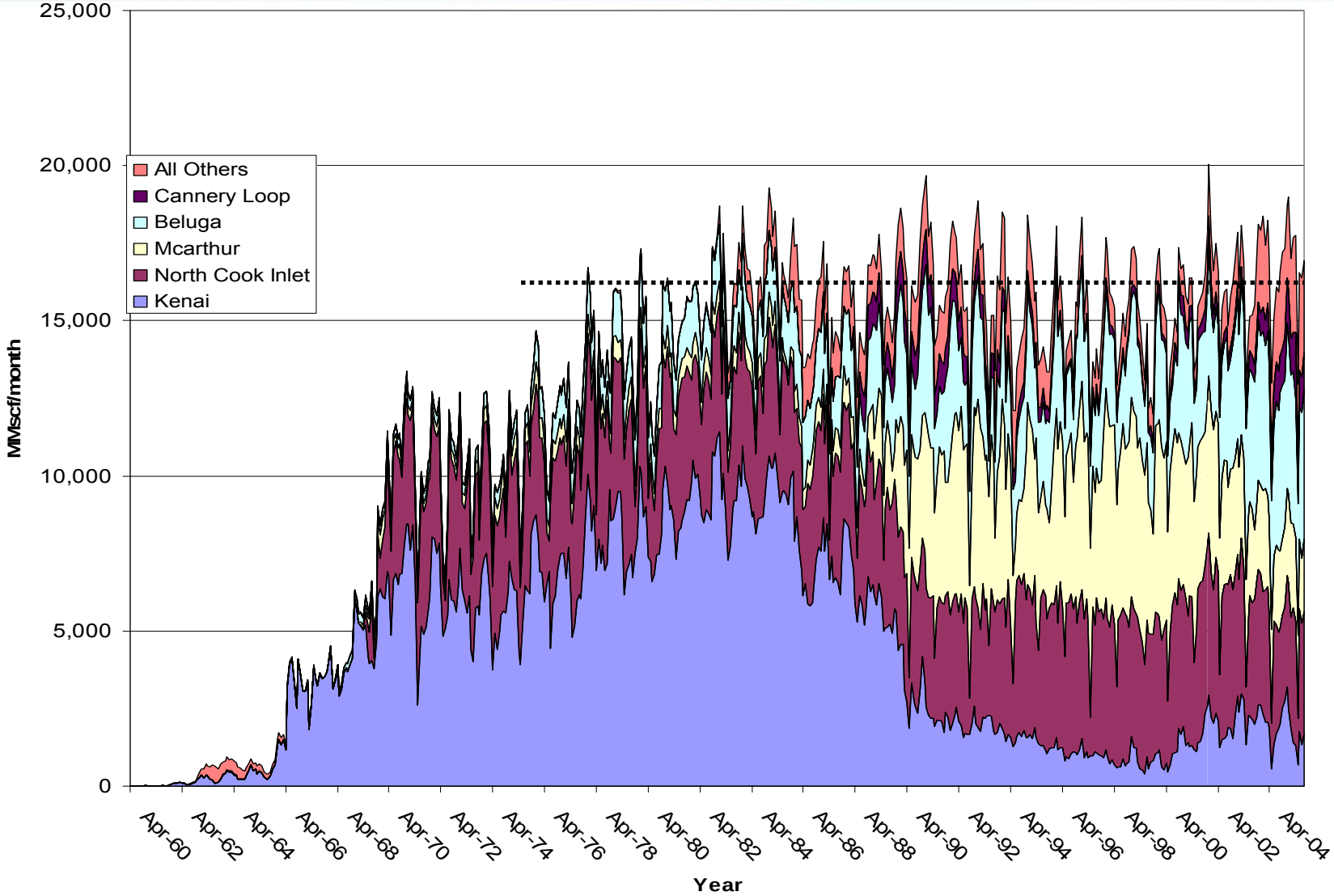
Supply, Bcf/yr

Field	2003	2004	Ownership
Beluga $2.77/Mcf	54	57.6	Phillips/Chevron/ML&P
Kenai $1.50 Mcf	27	24.2	Marathon
McArthur $1.20/Mcf	37	33.2	Marathon /Unocal
N. Cook Inlet $1.50/Mcf	46	41.0	Phillips
Other Prevailing Value $2.83/Mcf	31	45.8	

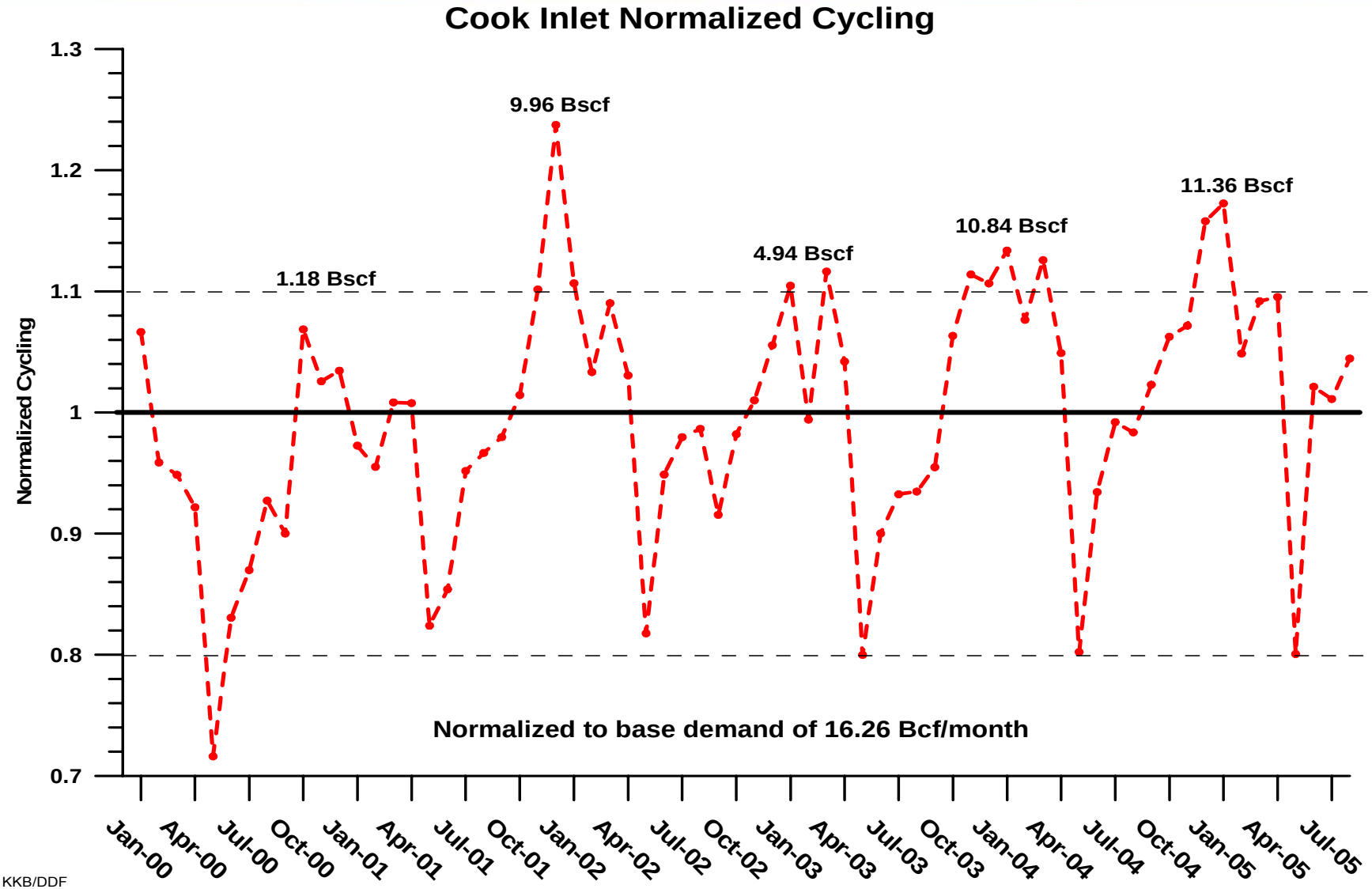
Historical Monthly Production of All Reservoirs



Composite Monthly Historical Cook Inlet Production



Monthly Production Cycling



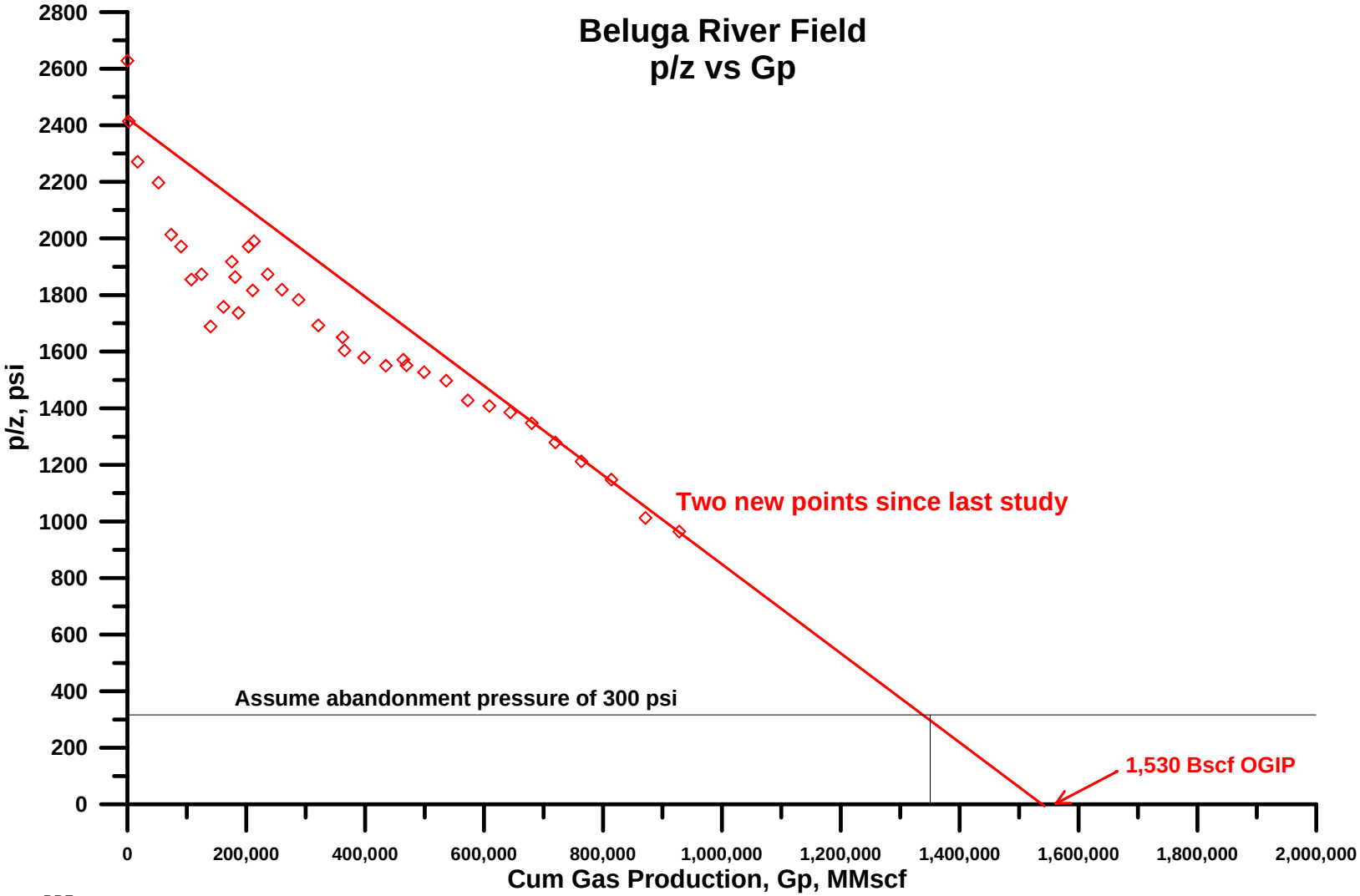
Total Storage Requirements

- Peak demand October through April
- Slack demand May through September
  - Required injection storage of 50 to 60 MMscf/d
- Pretty Creek storage approval by Alaska DNR September 13, 2005
  - One injection well, PCU #4 with storage capacity of 0.7 Bscf
  - Maximum deliverability of 20 MMscf/d
- Pretty Creek has the potential storage capacity, PCU #4 does not have the deliverability

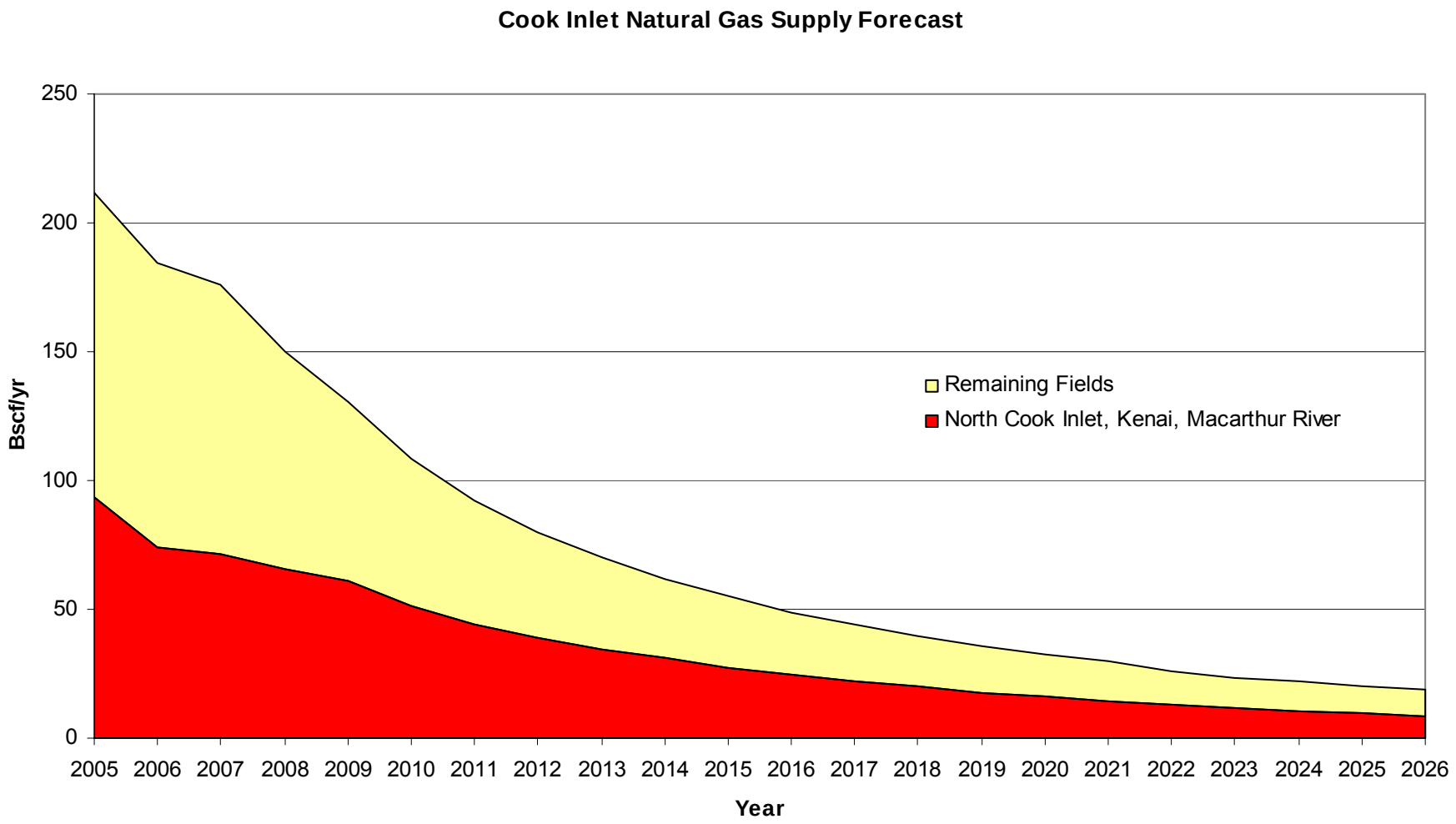
Reservoir Performance

- Performed production forecasting using
  - p/z material balance
  - Empirical decline curve analysis
- Assume Beluga River, Kenia, North Cook Inlet, and McArthur River fields have an abandonment pressure of 300 psi
  - Will require compression in the future
- Examined the economics of these fields using the gas production forecast

Material Balance Performance



2005 Cook Inlet Natural Gas Forecast – prelim.



6. Schedule

DELIVERABLE	DATE
Begin Work	August 1, 2005
Advisory Group Mtg.	September 28, 2005
Summary of Assumptions	October 24, 2005
Second Advisory Group Mtg.	November 9, 2005
Draft Final Report	December 19, 2005
Complete Adv. Grp. Review of Report	January 13, 2006
Final Report	January 30, 2006

7. Discussion