

SCOMM

146:13

At this time we will call the meeting to order.

Let the record reflect the time is 2 pm on Saturday, April 05, 2008.

Let the record show that

- ☐ Representative Gatto
- ☐ Representative Lynn
- ☐ Representative Kohring
- ☐ Representative Johansen
- ☐ Representative Doll
- ☐ Representative Doogan
- ☐ And myself Representative Neuman

and that we have a quorum.

(Let the record also reflect that _____ has been excused from the committee meeting today.)

Today we will be hearing an **Overview of Alaska's Gas Needs and a Market Assessment.**

Presentation by: **Alaska Natural Gas Development Authority (ANGDA) & Science Applications International Corporation (SAIC).**

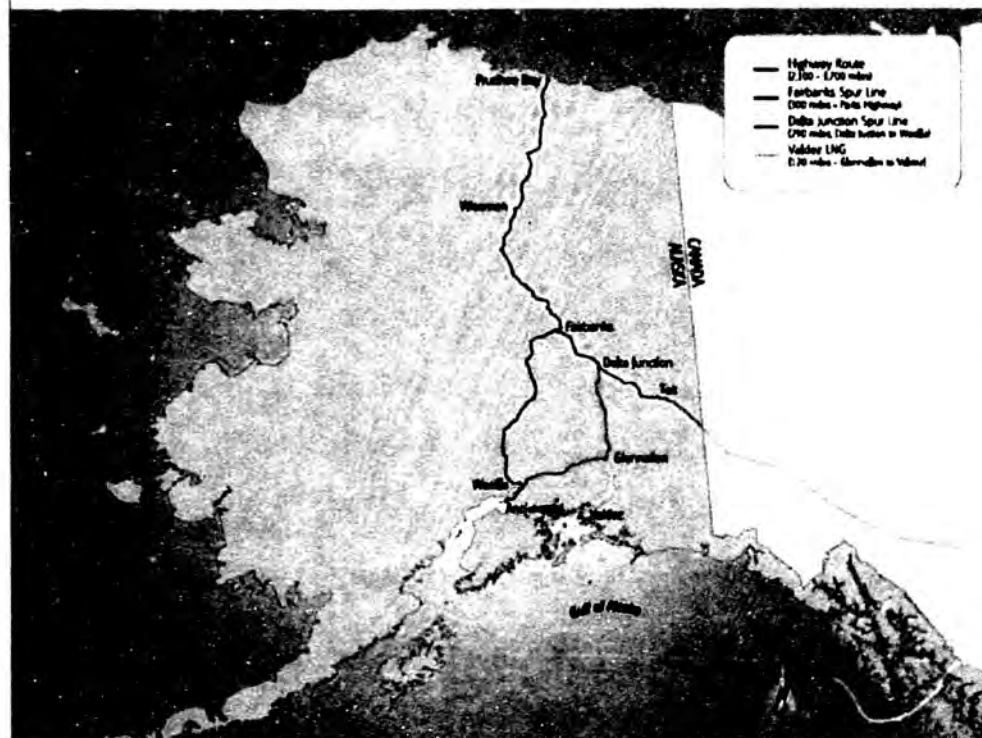
Harold Hinze, Christopher Ellsworth, Charles Thomas.

Before you start please, state your name for the record.

Does the committee have any questions?

Thank You.

This committee is adjourned



Alaska Natural Gas Needs & Market Assessment

Draft Update Presentation

Chris Ellsworth
ellsworthc@saic.com

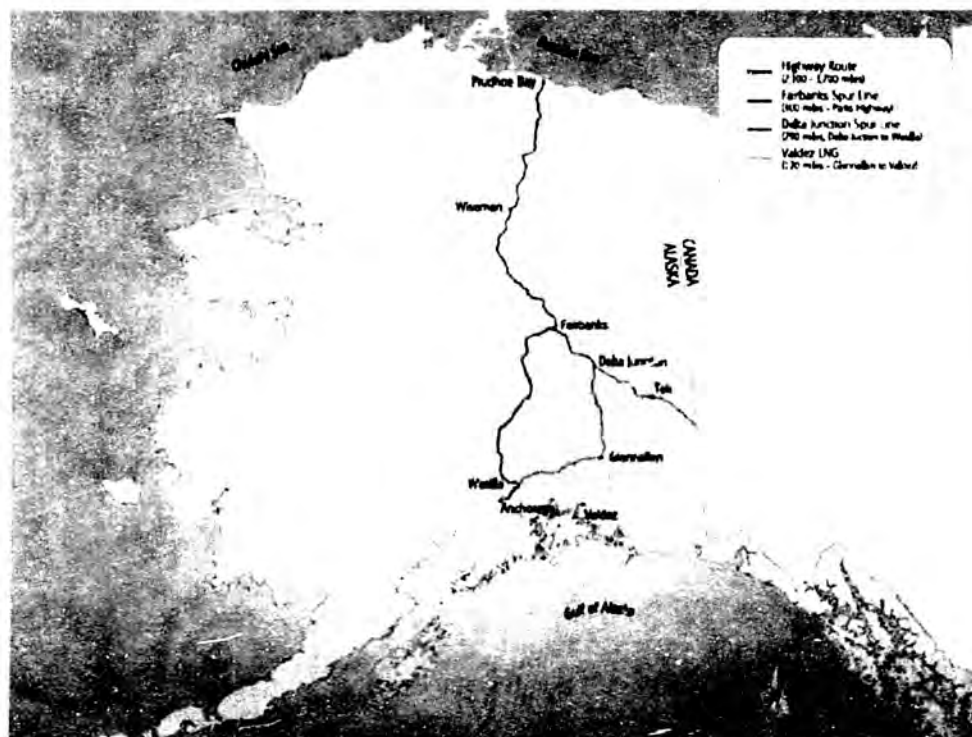
April 5, 2008

Agenda

1. **Background**
2. **Study Assumptions & Methodology**
3. **Study Conclusions**
4. **Study Update**
5. **Summary**

2006 Study Overall Objectives

- ◆ The 2006 spur pipeline feasibility study evaluated:
 - level of sustainable dry gas & NGL demand in South Central Alaska.
 - Residential
 - Commercial
 - Industry
 - Power
 - maximum feasible price of natural gas by sector in S.C. Alaska
 - spur pipeline size, costs, and market storage requirements.
 - Cook inlet gas supply
- ◆ This assessment updates the industrial sector analysis



2006 Study Advisory Group

- Assisted DOE and SAIC in understanding and framing the issues
- Assisted in obtaining current and complete data
- Provided 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

2006 Study Methodology

- (1) A Bottom-up Approach** to determine sustainable NG demand
 - Current Uses
 - New Uses (Blue Sky)

- (2) Integrated Market Analysis** to show the impact of an 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.

- (3) In summary** – Current and potential users of gas (and NG liquids)?
What products? In what Quantity? At what price?

2006 Study Sectors Studied

◆ Industry

- LNG
- GTL
- Ammonia / Urea
- Other
- Petrochemicals
- Propane

DRY GAS

NGLs

◆ Power Generation

DRY GAS

◆ Residential / Commercial

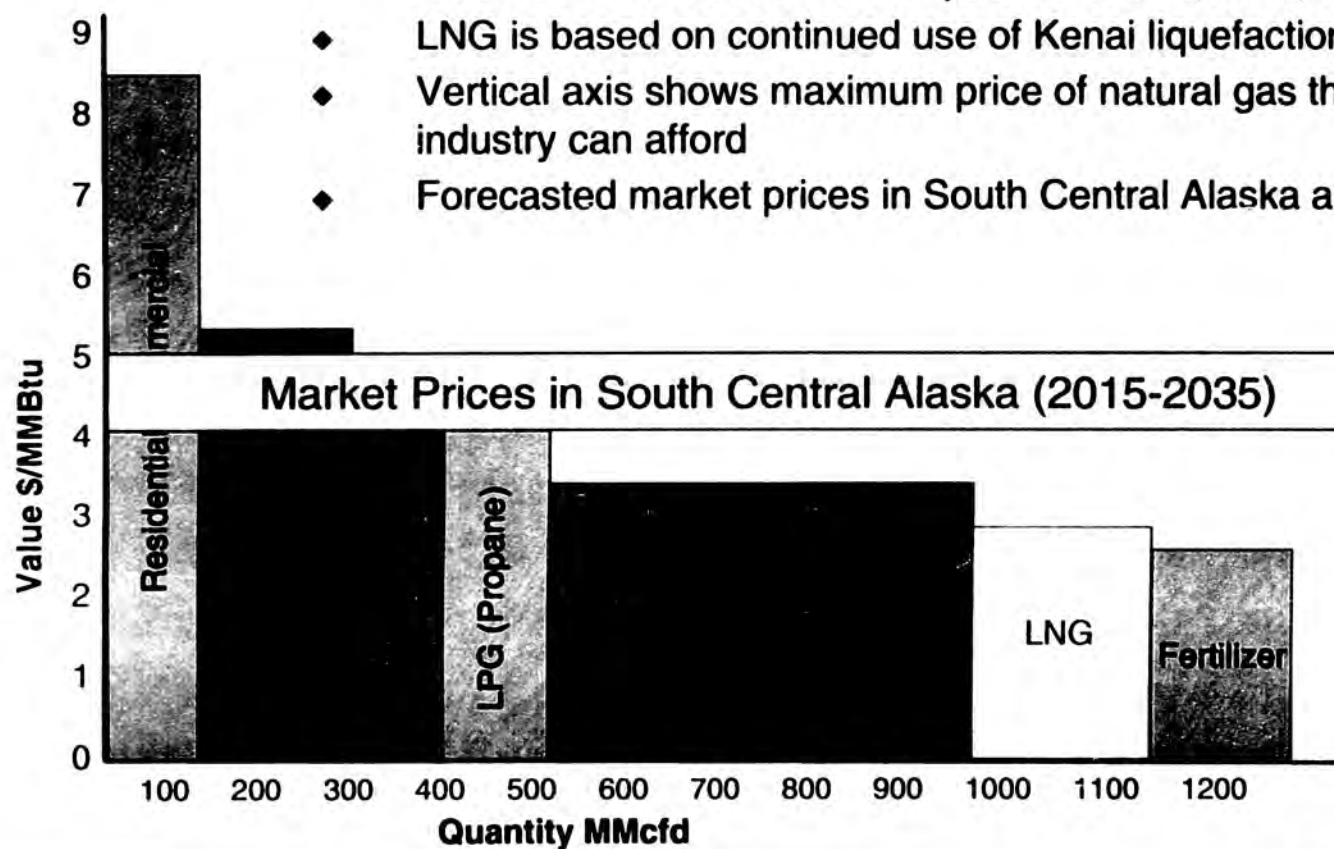
Industrial Capacity and Gas Requirements

Industry	Capacity	Gas Requirement MMcfd
GTL	50,000 bpd low sulfur diesel	480
LNG	1.7 MMTPA	212
Fertilizer	1.25 MMTPA ammonia 1 MMTPA Urea	185
LPG	54,000 bpd propane	84 (propane)
Petrochemicals	1.27 MMTPA ethylene	119 (equivalent) ethane

2006 Study Conclusions

Base Price Scenario (2025 Snapshot)

- ◆ Horizontal axis shows potential gas demand for each industry based on world class size for petrochemical, LPG, and GTL
- ◆ LNG is based on continued use of Kenai liquefaction facility
- ◆ Vertical axis shows maximum price of natural gas that each industry can afford
- ◆ Forecasted market prices in South Central Alaska are overlaid



2008 Update Preliminary Findings

2008 Update Study Sectors Studied

◆ Industry

- LNG
- GTL
- Ammonia / Urea
- Petrochemicals
- Propane

} DRY GAS

} NGLs

◆ Petrochemical Feedstocks

} GAS

◆ Residential / Commercial

2008 Updated Assumptions

◆ Industry assumptions updated for:

- capital costs
- operating costs
- product prices
- natural gas feedstock prices
- gas composition
- updates reflect current markets using 2007\$

◆ Two price scenarios using rich stream

- Low Case (Natural gas and oil prices updated for forecasts produced by EIA and published in AEO2008 Reference Case)
- High Case (Natural gas and oil prices based on futures strip as of March 2008)

2008 Update

Average Fuel Prices (2015 – 2030)

	2006 Study	2008 Update Reference Case*	2008 Update High Case**
Henry Hub (2007\$ /MMBtu)	\$5.60	\$6.27	\$8.54
South Central AK (2007\$ /MMBtu)	\$4.81	\$4.06	\$6.18
Oil Price (2007\$ /Bbl)	\$47.83	\$53.65	\$72.97
Competing Feedstock Prices			
Middle East		\$0.31	
West Africa		\$0.33	
Trinidad		\$0.55	

*Based on Energy Information Administration's Annual Energy Outlook 2008

** Based on recent futures strip

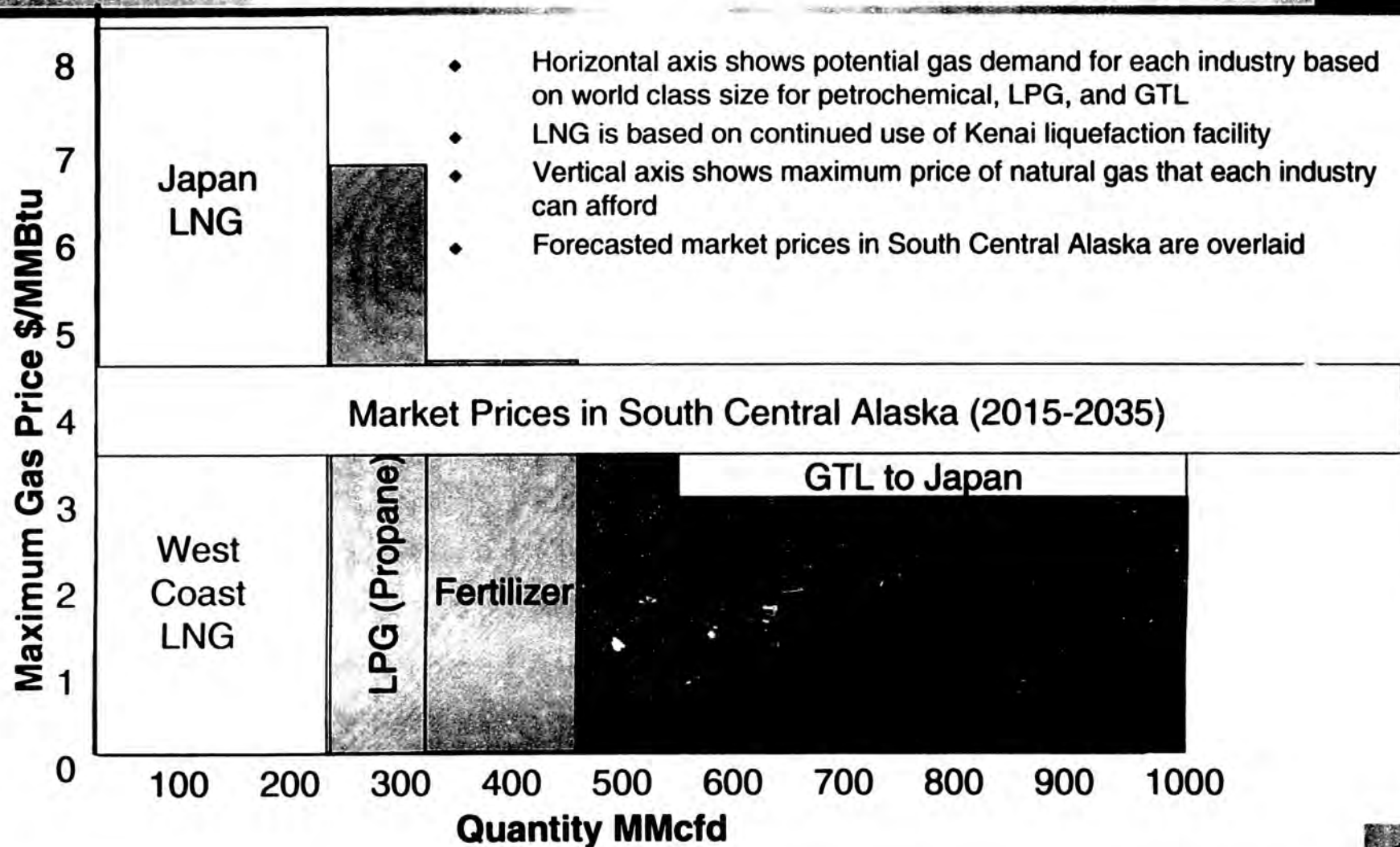
2008 Update Average Product Price (2015 – 2030)

Product	2006 Study	2008 Update Low Case	2008 Update High Case
LPG	\$383/ton	\$639/ton	\$834/ton
Japan Distillate ²	\$9.46/MMBtu	\$11.37/MMBtu	\$15.47/MMBtu
California LNG	\$5.07	\$6.01	\$8.28
Japan LNG	\$6.10	\$6.71	\$8.61*
Ammonia	\$224/ton	\$314/ton	\$380/ton
Polyethylene	\$1,065/ton	\$1,071/ton	\$1,264/ton

**Recent Japanese LNG contracts have been reported at > \$16 /MMBtu*

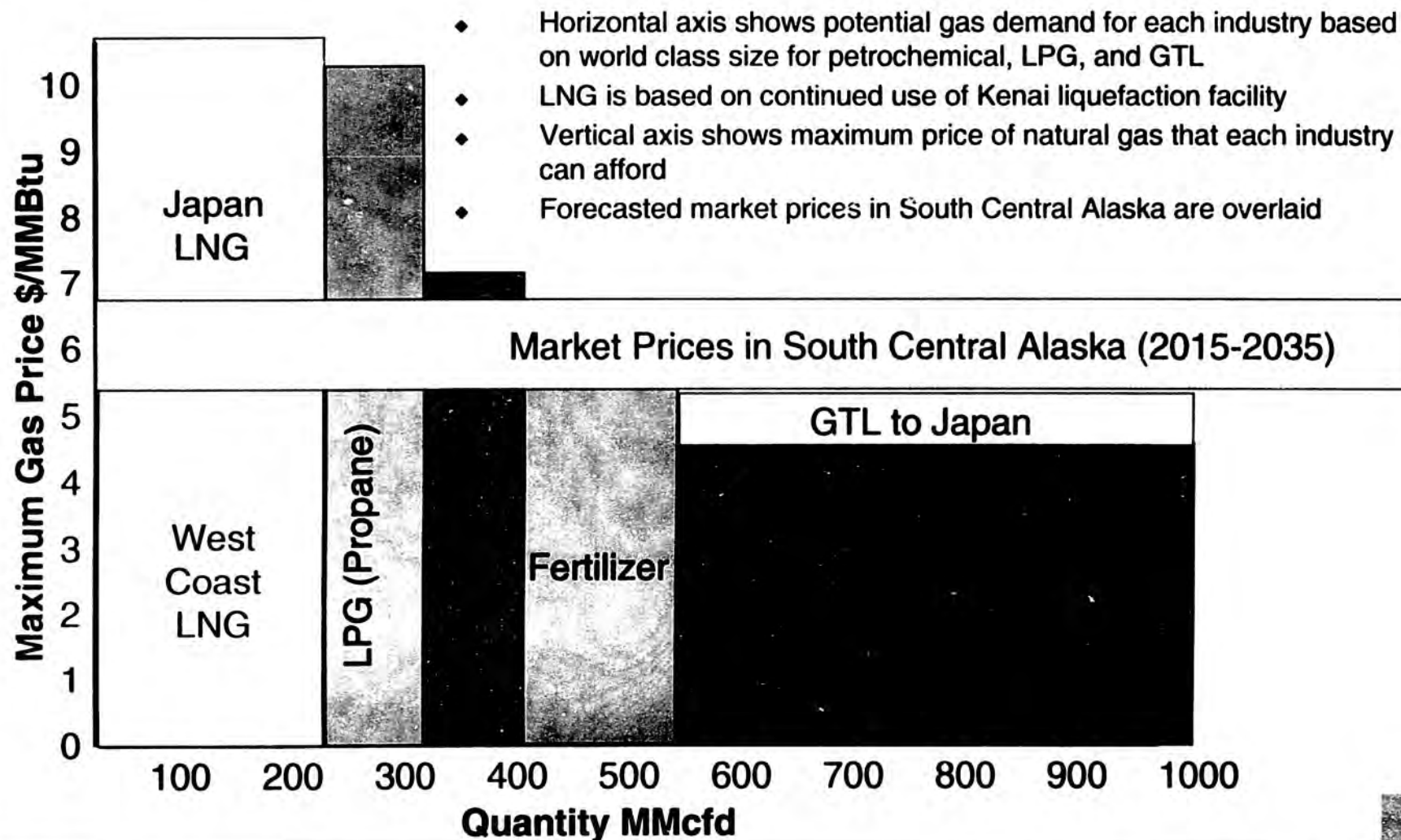
Preliminary Findings

Low Price Scenario (2025 Snapshot)



Preliminary Findings

High Price Scenario (2025 Snapshot)



Markets for Products

The potential market places with the highest projected demand growth and highest prices were selected as the modeled marketplace.

	Modeled Marketplaces
LNG	British Colombia, US / Mexico West Coast, China, Japan, Korea
GTL (ULSD)*	US West Coast, BC
Ammonia	US West Coast, China, Japan
Petrochemicals (PE and MEG)	US Gulf, Korea, China
LPG	US West Coast, China, Japan

* Ultra Low Sulfur Diesel

Revenue Forecast

Gross Revenues in Millions of Dollars per Year, 2015-2035 (2007\$)

	Updated Low Case	Updated High Case
LPG	\$869	\$1,134
GTL	\$1,148	\$1,562
LNG	\$954	\$1,132
Ammonia	\$439	\$531
Petrochemicals	\$1,332	\$1,568
Possible Total	\$4,742	\$5,927

Summary of Preliminary Findings

- ◆ Increases in prices have changed the feasibility of industrial options for natural gas use.
- ◆ These increases suggest that LNG and fertilizer projects are now feasible.
- ◆ High and uncertain capital costs and technology make GTL the most questionable.
- ◆ Higher energy and product prices enhance the feasibility of gas intensive industries in South Central Alaska.
- ◆ The investment climate for these industries will remain highly uncertain given ongoing volatility in energy and product prices.

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✓ Charles Thomas

(907) 301-8054

David Friedman

SCOTT HEYWORTH



SAIC's Technical and Cost Proposal

Update to Economic Modeling Performed for the "Alaska Gas Needs and Market Assessment" and Presentation Preparation

Submitted To:

Corrie Young

Alaska Natural Gas Development Authority (ANGDA)

411 W. 4TH Avenue

Anchorage, AK 99501

Submitted By:

Science Applications International Corporation

20201 Century Blvd., Suite 300

Germantown, MD 20874

March 13, 2008

These data, furnished in connection with referenced RFP, shall not be disclosed outside of The San Diego Foundation and shall not be duplicated, used, or disclosed in whole or in part for any purpose other than to evaluate this proposal. This restriction does not limit the customer's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in pages of the attached files. In addition, the information contained herein may include technical data, the export of which is restricted by the U.S. Arms Export Control Act (AECA) (Title 22, U.S.C. Sec 2751, et seq.) or the Export Administration Act of 1979, as amended (Title 50, U.S.C., App.2401, et seq.).



Update to Economic Modeling Performed for the "Alaska Gas Needs and Market Assessment" and Presentation Preparation

I. Introduction

Science Applications International Corporation (SAIC), a leading systems solutions and technical services company, is pleased to present this proposal to the Alaska Natural Gas Development Authority (ANGDA) to update the "Alaska Gas Needs and Market Assessment" (the Study) prepared for the U.S. Department of Energy, National Energy Technology Laboratory in the Spring of 2006, and to prepare and present a report based on the update.

The objective of the Study was to estimate the potential demand for natural gas in South Central Alaska and other areas of Alaska directly associated with a potential spur pipeline connecting the proposed Alaska North Slope gas pipeline to the Cook Inlet pipeline infrastructure. The assessment was intended to provide an independent estimate of in-state natural gas demand and supply options for the years 2015 through 2035.

To develop an estimate of the potential requirement for natural gas in South Central (Anchorage/Wasilla/Kenai area) and Central Alaska (Fairbanks area), the Study modeled the following demand sectors: residential/commercial; electric power generation; and various natural-gas-intensive industries including petrochemicals, ammonia and urea, liquefied petroleum gas (LPG), natural gas to liquids (GTL), and liquefied natural gas (LNG). Financial modeling provided the primary methodology to estimate the economically viable demand. Natural gas consumption from the power sector was determined using a commercial-grade power dispatch and capacity-build model.

II. Scope of Work

Representative Mark Neuman of the Alaska State Legislature has requested that ANGDA provide a report on potential value added industries that could utilize gas from Alaska's North Slope. To prepare this report, SAIC proposes to update some of the industrial models used in the original Study, recalculate the added value of each industry, and update sections of the report and executive summary. The main drivers for the new valuation will be updated oil price, gas prices, and product prices. This new added value will be reported in the report. In addition, the report will address topics such as:

- The gas composition and volume available under various AGIA proposals
- Potential products that can be made with these volumes
- A basic description of the physical plant necessary to process these volumes, including capacity.
- The range of market prices paid for feedstocks in other jurisdictions
- The major markets for these products
- Possible location of processing plants in Alaska



- Gross revenues generated from the sales of these products based on expected output and prevailing market prices.
- Potential favorable backhaul shipping rates from current Alaskan shippers and vessels on the great circle

SAIC will also present any other information that SAIC considers pertinent to the scope of the Legislature's request.

SAIC brings years of modeling, market analysis, and commercial energy industry experience to this project. We have supported the US EIA and US Department of Energy since the mid 1980s in the development of energy models and analysis. The SAIC team will work closely with ANGDA staff to successfully write and present the work. The following key people ensure that SAIC can help ANGDA accomplish this work:

The proposed SAIC project manager will be Mr. Christopher Ellsworth, project manager on the original Study. Mr. David Friedman will be the primary financial analyst, a role which he played on the previous Study. Ms. Delma Bratvold, who also worked on the original Study, will be the primary industry analyst. She will be assisted by Ms. Christina Waldron-Davies and Mr. Matt Cleaver, both of whom contributed to the original Study. Quality control will be provided by Mr. Charles Thomas of SAIC's Alaska office.

III. Deliverables and Schedule

- Task 1- Written report addressing at least the topics detailed in the Scope of Work - April 7

Upon delivering the report, ANGDA will have one week for review and comment. Any comments received within one week will be incorporated as applicable into a final submission of the report which will be deemed accepted upon delivery.

- Task 2- Oral presentation to the Alaska Legislature - two days budgeted for travel and one day for oral delivery.

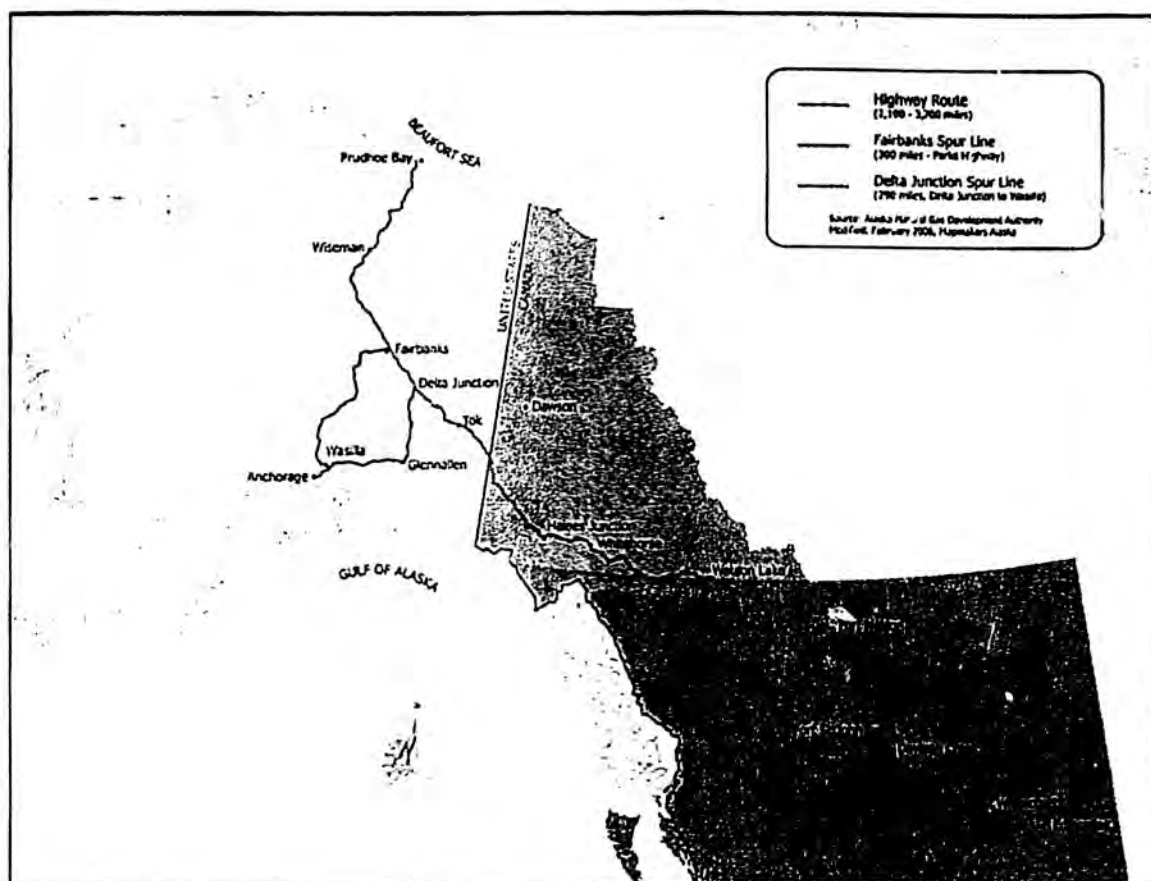
IV. Cost

The level of effort required for this work is estimated at a fixed price of \$80,200. This includes two days of travel to and from Juneau and one day to deliver the oral report. If additional time is required in Juneau to deliver the oral report this would be billed out at \$172 per hour plus any additional travel expenses.

V. Payment Schedule

- \$75,000 shall be paid upon delivery of the Written Report
- \$5,200 shall be paid upon completion of the Oral Presentation

Alaska Natural Gas Needs and Market Assessment



National Energy Technology Laboratory



U.S. Department of Energy
Strategic Center for Natural Gas & Oil
June 2006



Contributors and Acknowledgements

This work was funded by the U.S. Department of Energy's National Energy Technology Laboratory (U.S. DOE-NETL). The authors acknowledge the significant role played by U.S. DOE-NETL in providing programmatic guidance and review of this report. We especially want to thank Brent Sheets and James Hemsath of the NETL Arctic Energy Office in Fairbanks, Alaska and Richard Baker of NETL, Morgantown, West Virginia for their contributions to the study and the final report.

The analytical portion of this study was conducted over a four month period beginning in August 2005. Assistance and support was received from many agencies and industry. Specifically, the authors thank members of the Advisory Committee for input and guidance, and for providing assistance in obtaining publicly available data in a timely and efficient manner.

Advisory Committee

An Advisory Committee was formed to review the scope of work, monitor progress, and make suggestions for further work. The primary function of the committee was to make sure the most critical issues were addressed and to assist in obtaining critical data. The Advisory Committee met on September 28, 2005 and November 9, 2005. The committee members are listed below.

- Alaska Industrial Development and Export Authority: Ron Miller, Executive Director
- Alaska Governors Office: Michael Menge, Energy Advisor, Office of the Governor
- Alaska Natural Gas Development Authority: Harold Heinze, CEO
- Anchorage ML&P: James Posey, General Manager
- ASRC Constructors, Inc.: Marvin Swink, Sr. Vice President
- 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

In addition to their participation in the Advisory Committee, several members were interviewed by phone and in person, in some cases multiple times, regarding select opportunities. They graciously shared materials and estimates, and directed us to visit web sites and interview other agencies and developers involved in the industrial opportunities. SAIC is indebted to the assistance of the Advisory Group, in particular:

- Alaska Industrial Development and Export Authority
- Alaska Natural Gas Development Authority
- Chugach Electric Association
- ENSTAR
- Fairbanks Natural Gas
- Kenai Peninsula Borough

Technical Contributors - SAIC

Charles P. Thomas: Project Manager, Anchorage, Alaska.

Chris Ellsworth: Project Manager, McLean, VA

Christina Davies Waldron

David Friedman

Ralph Zarumba

Mindi Farber-Deanda

Delma Bratvold

Steve Messner

Adam Kreczko

David D. Faulder

Kevin Bloomfield

Abstract

Study Objectives

The objective of the Alaska Natural Gas Needs and market Assessment is to estimate the potential demand for natural gas in South Central and other areas of Alaska directly associated with a potential spur pipeline connecting the proposed Alaska North Slope gas pipeline to the Cook Inlet pipeline infrastructure. This assessment is intended to provide an independent estimate of in-state natural gas demand and supply options for the years 2015 through 2035. Although other gas transportation projects have been proposed, this study assumes the gas pipeline from the North slope will roughly follow the oil pipeline right-of-way past Fairbanks to Delta Junction before following the Alaska Highway route into Canada.

Study Methodology

To develop an estimate of the potential requirement for natural gas in South Central (Anchorage/Wasilla/Kenai area) and Central Alaska (Fairbanks area), this study modeled the following demand sectors: residential/commercial; electric power generation; and various natural-gas-intensive industries including petrochemicals, ammonia and urea, liquefied petroleum gas (LPG), natural gas to liquids (GTL), and liquefied natural gas (LNG). Financial modeling provided the primary methodology to estimate the economically viable demand. Natural gas consumption from the power sector was determined using a commercial-grade power dispatch and capacity-build model. Residential/commercial demand was modeled using a combination of financial and econometric modeling. Smaller demand points such as the Yukon River crossing and along the spur pipeline routes were not modeled.

This study assumes a dense-phase line (capable of transporting methane with significant NGLs maintaining a gaseous phase), with a capacity of at least 4.5 billion cubic feet per day (Bcf/d), will be operating in 2015 to deliver North Slope natural gas to the lower-48 states (Lower 48); and that the majority of Alaska's demand will be supplied by a spur pipeline delivering natural gas to South Central Alaska with an off-take facility in Central Alaska to serve the Fairbanks area. With the exception of future supply from currently producing Cook Inlet gas fields, the study did not model any potential future production from drilling programs in the Cook Inlet, Nenana or Copper River Basins.

Natural gas prices are based on the DOE Energy Information Administration forecast for Lower 48 prices. North Slope wellhead prices are assumed to be Lower 48 prices less the estimated tariff for delivery to the Lower 48. The prices in Central and South Central Alaska are North Slope wellhead prices plus tariff to the takeoff point plus the estimated spur pipeline tariff.

Study Conclusions

The South Central Alaska yearly-average demand for residential/commercial and electric power generation is estimated to be 260 million cubic feet per day (MMcf/d) in 2015, increasing to 265 MMcf/d in 2025, and to 290 MMcf/d by 2035. Peak gas consumption in the winter season will be about 350 MMcf/d in 2015, 400 MMcf/d in 2025, and 430 MMcf/d by 2035. The residential/commercial and power generation demand in Central Alaska is estimated to increase from a yearly average of about 18 MMcf/d in 2015, to about 65 MMcf/d in 2025, and 75 MMcf/d in 2035. Hence, the total estimate for these two regions in Alaska, which will account

Name:	
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Address: 8301 Greensboro Drive, McLean, VA 22102	
Telephone Number: (703) 676-8808	
Points of Contact: Christopher Ellsworth	
Dates Employed	Duties Performed
Science Applications International Corporation (SAIC) Director, Energy Markets and Forecasting March 2004 - Present	• Christopher Ellsworth is Director of Natural Gas and LNG Services at SAIC, with over 25 years of energy industry experience as an economist and exploration geologist. Using fundamental and financial energy models Mr. Ellsworth has provided long term energy market forecasts, market analysis, and due diligence support to numerous commercial gas and power projects in the US and globally. He has worked on fuel market assessments, price forecasts, and valuations for LNG terminal developers, natural gas pipelines, power projects, and natural gas producers. He also provides energy modeling solutions involving EIA's NEMS and NRCAN's MAPLE-C models. He has extensive experience in the design and development of domestic and international energy models. Over the years, Chris has worked on many components of NEMS design, upgrade and maintenance as well. Specifically, he has experience working the Oil and Gas Supply Model (OGSM) and the Natural Gas Transmission and Distribution Model (NGTDM) of NEMS. • Mr. Ellsworth has published articles in the Oil and Gas Journal and Public Utilities Fortnightly, and coauthored a book on natural gas hedging strategies, published by Risk Publications. He has an MA in economics from the University of Houston and a BS in Geology from King's College, London. • Project manager on Alaska gas market assessment for a gas spur pipeline to satisfy FERC filing requirements for the Alaska Natural Gas Transmission System. The study included an assessment of LNG, GTL, propane, petrochemical and fertilizer export potential as well as domestic Alaska gas demand from the residential, commercial, industrial, and power sectors. • Brass LNG. Managed a project to assess labor availability and terms and conditions for Brass LNG in Nigeria. The work included in-country field work in major industrial centers and cities in Nigeria. • Global LNG Trade Model (GLNG). Project manager on the development of the model. GLNG captures all important steps in the LNG value chain, from production, liquefaction, shipping, and regasification to markets. Costs, technologies, and policies impacting each stage of the value chain are comprehensively modeled. GLNG is composed of a comprehensive database and a linear programming model that solves for the optimal flows of LNG and prices. The database contains worldwide current and announced LNG projects on a project by project basis, their capacities and costs, contracted quantities, shipping capacity and distances, and LNG qualities and Btu content. • Implementing a Uniform Analytical Framework for Pending Climate Change Legislation – managed analysis of the McCain Lieberman bill using NEMS. The analysis looked at the impact of proposed GHG legislation on all sectors of the energy economy, with particular emphasis on natural gas, electricity, and transportation. • Rwanda-Burundi Pipeline Capacity Market Analysis. Project manager on feasibility to establish the feasibility of extending an oil pipeline from Kampala, Uganda to Kigali, Rwanda and Bujumbura, Burundi. The project focuses on a market analysis of oil products in Rwanda and Burundi and includes an assessment of the required size of the pipeline extension. • Serves as project manager on National Energy Modeling System (NEMS), providing modeling and analytic support to the US Energy Information Administration (EIA) and commercial clients. NEMS uses information on energy production and utilization, together with market and price data to forecast the mix of fuels, energy technologies, and energy prices over a 20 year horizon under various scenarios. • Serves as project manager for MAPLE-C: a Canadian version of NEMS used by the Canadian government (NRCAN) to model compliance strategies for the Kyoto Protocol. • Provide natural gas market analysis, price forecasts, and gas market modeling to government and commercial clients. • Provided gas price forecasts and market commentary for New York MTA to support negotiations with New York Power Authority. • Provided oil price forecasts to Brazilian mine operation in support of fuel purchase and equipment upgrade strategy. • Worked on security and quality control issues for the US Energy Information Administration on their Weekly and Monthly petroleum surveys. • Looked at options for procuring and using backup fuel, including environmental regulations in the Northeast.

*Pace Global Energy Services Inc.
March 2000 – February 2004
Chief Economist*

- Seminars and Workshops. Conducted a seminar on the North American natural gas market for Atlantic LNG out of Trinidad. Also conducted a seminar on South American gas markets for the Gas Technology Institute in Santiago, Chile.
- South Africa Natural Gas Feasibility Study. Project manager on USTDA funded project to provide Petro South Africa with a natural gas utilization investment strategy. The project included a global LNG market overview, an economic analysis of LNG utilization in South Africa, and forecasts of LNG pricing from various supply sources. The assessment also covered LNG regasification terminal siting, LNG business practices and contracts, and LNG liquefaction, shipping, and regasification technology.
- Mexico LNG Development Strategy for a Major Gas Company. Market and regulatory due diligence to support client plans for the export of LNG to the Mexican market. Evaluated the potential for LNG terminal development at various sites on the Pacific coast, quantified long-term market demand, and assessed alternative LNG supply sources (incorporating analysis of inlet gas, pipeline transportation, liquefaction, and shipping costs).
- Gas Market Assessment for an LNG Developer in Southern California. Assessed the impact of LNG terminal development in Baja Mexico and Southern California on the Southern California gas market. Used a proprietary gas flow model to look at the impact of LNG terminal development on regional gas flows and prices.
- Conference Presentations to industry and government on US and global LNG, including
 - Presentation to Stanford University (Energy Modeling Forum) on The Outlook for U.S. LNG terminal Development: The Impact on Regional Gas Markets, January 29, 2004.
 - Presentation at Calgary LNG Conference on "The Economics of the LNG Value Chain," December 3, 2003.
 - Atlantic Basin LNG and Its Impact on Asian Markets, Presentation at Baker Institute Energy Forum Workshop, New Energy Technologies in the Natural Gas Sector: A Policy Framework for Japan, April 2-3, 2001.
- Financing Support for Lake Charles LNG Terminal. Authored an independent market review in support of the financing of the Lake Charles, LA LNG receiving terminal. The report focused on the role of LNG in the North American natural gas market, North American LNG receiving terminals, global availability of LNG, and a review of British Gas' global gas strategy.
- Florida LNG Regasification Terminal Development. Directed and managed upstream due diligence task for a proposed LNG terminal to serve the Florida gas market.
- Barents Sea LNG. Managed a project to assess the viability of shipping LNG from the Barents Sea to markets in the U.S. and Europe.
- Atlantic Basin LNG and Its Impact on Asian Markets. Managed a project to assess the impact of the growth in Atlantic LNG trade on LNG flows and prices in the Asian market.
- Turkey Gas Pipeline Tariff Design. Deputy project director on a USTDA funded project to develop a cost based tariff for Botas, Turkey's gas pipeline.
- NTG Pipeline Market Assessment. Directed and managed the market assessment of the North Transgas Pipeline, originating in Baltic Russia to serve markets in Germany, the Netherlands, and the UK.
- Market Assessments and Fuel Forecasts. Provided fuel market assessments and price forecasts for the U.S. natural gas and oil markets to support project feasibility studies, fuel due diligence, power market analysis, risk management, contract negotiation support, expert witness testimony, and energy management. Natural gas and oil price forecasts were provided for over eighty regional points, monthly for thirty years. The market assessments provided regional forecasts of gas demand for the residential, commercial, industrial, and power sectors, regional gas supplies, forecasts of inter-regional transmission and storage, and pricing and liquidity at key market centers. The analysis was performed using proprietary models of gas supply, gas transmission, and U.S. power markets.
- Independent Fuel Consultant Report for a \$105 Million Bond Offering. The report was produced as part of an offering memorandum for a roll up financing of ten power plants located in the WSCC. The fuel consultant's report opined on the availability and cost of fuel for the plants and was used as part of a power market study.
- Independent Fuel Consultant Report for the financing of a greenfield power project in the U.S. Southwest. Led the fuel due diligence for a 2,145 MW plant located in Gila Bend Arizona. The study assessed fuel requirements, fuel management, and gas supply and transportation options for the plant. The study also opined on supply and transportation contracts and proforma fuel pricing.
- Expert Witness. Provided expert witness testimony before the Commonwealth of Virginia Public Utility Regulatory Commission concerning the siting of a gas fire power plant in Fluvanna County, VA. The testimony opined on adequacy of gas supplies and

	transportation, the impact of the use of backup fuel oil on local road use, and the impact of the plant's gas use on the local gas market. • Expert Witness. Provided expert witness testimony before the Indiana Utility Regulatory Commission in support of an 1,800 MW combined cycle power plant in Pike County Indiana. The testimony opined on the impact of the plant's gas consumption on natural gas reliability and pricing to other consumers in Indiana, and considered factors such as natural gas supply, available pipeline capacity, and commercial arrangements for securing natural gas. • Millennium and Volunteer Gas Pipelines. Managed a project to provide market assessments of the Northeast and Southeast power and gas markets for a major pipeline company considering serving the two regions. Provided the client with power market assumptions, gas market assumptions and competitive analysis of alternative pipelines. The analysis included assessments of power requirements, load growth, and power and fuel price forecasts. The analysis also provided estimates of spark-spread values to determine opportunities for IPPs, and a listing of proposed power projects in the vicinity of the proposed pipeline routes. • Gulfstream Pipeline. Evaluated the gas and power markets relevant to a Florida natural gas pipeline development project. Assessed natural gas supply availability from the Onshore Gulf coast and the Gulf of Mexico. Also opined on the revenue aspects of the pro forma financial model inputs to ensure that the financial targets were accurately reflected and achievable. • Kern River Pipeline. Evaluated Western gas and power markets, with a special focus on Nevada and Southern California in support of the financing of the 2003 Kern River pipeline expansion. • Wyoming Pipeline Study. Managed the market analysis and pipeline flow modeling for a proposed pipeline to serve the Midwest, originating in the Rocky Mountain region of the U.S. • Comprehensive North American Gas Supply, Demand, and Price Forecast for a Major Oil and Gas Company. Managed a project to assess the North American gas market and prospects for LNG imports. The analysis used a suite of models, including an econometric basin-level supply model in combination with a classical nonlinear gas transmission model, and a power dispatch model.
<i>Energy Security Analysis Inc. July 1997 – March 2000 Manager of Natural Gas Practice.</i>	• Edit monthly and weekly ESI publications, including the North American Natural Gas Stockwatch and the Natural Gas FundWatch. • Provide natural gas market and price forecasts. • Developed a new natural gas forecasting product for ESI. • Developed several new clients during first eighteen months. • Conducted World Bank sponsored workshops on assessing new natural gas markets to Sichuan Petroleum Administration, Chengdu, China. • Provided European gas market analysis for a report on the Commoditization of Europe's Power and Natural Gas Markets. • Co-authored a report to the Maine Public Utilities Commission on Estimates and Forecast of the Cost Consequences of Implementation by the State of Maine of the Act to Restructure the State's Electric Industry. • Co-authored a client report on the oil and gas infrastructure of Iran, Libya, and Syria. • Co-authored a client report on "Electricity and Climate Change – Estimating the Effects of Compliance with the Kyoto Treaty." • Co-authored book on "Natural Gas Hedging: Benchmarking Price Protection Strategies" for Risk Publications. Mr. Ellsworth drew on his experience producing short and long term natural gas price forecasts based on physical and paper market fundamentals. Using an extensive database of historical options and futures prices the book looked at the efficacy of various hedging strategies using futures, plain options, and exotics. The results were published by Risk Publications, London.
<i>Science Applications International Corporation August 1989- July 1997 Senior Economist and Project Manager</i>	• Manage projects to provide analysis of issues and trends in the natural gas and oil industry. • Manage projects to develop economic models for the U.S. Department of Energy. • Author technical reports for publication by the U.S. Department of Energy. • Manage teams of professional, including economists, OR analysts, and programmers. • Market and prepare responses to Request for Proposals. • Managed more than \$1 million of tasks to develop the Department of Energy's Oil and Gas Supply Model. • Market analysis of the potential for natural gas in the Eastern Mediterranean countries

	- for a major oil and gas company. • Analysis of niche refining opportunities for a major oil and gas company. • Assessment of oil demand in the new Central Asian Republics for a major oil and gas company. • Authored industry regulation chapter of Energy Policy Act Transportation Study (Energy Information Administration, Washington, D.C., 1995). • Authored financial chapter of Natural Gas: Issues and Trends (Energy Information Administration, Washington, D.C., 1995).
<i>Texas State Comptroller (Austin, Texas)</i> June 1986 - July 1989 Economist/Revenue Analyst	• Forecast state revenues from oil severance and motor fuel taxes. • Analyze the fiscal impact of proposed state and federal legislation. • Develop economic models for the State of Texas. • Provide analysis of the U.S. and international oil and gas industry. • Represent the Comptroller's office at meetings with industry, other government agencies, the legislature, and the public. • Prepared fiscal impact statements of the effects of tax proposals for the State legislature.
<i>The Hunt Corporation (Dallas, Texas)</i> Feb. 1982 - July 1985 Geophysicist/Geologist	• Geophysicist/Geologist involved in domestic U.S. oil & gas exploration. • Interpret seismic and geologic information and supervise contractors. • Generated oil and gas prospects in Western Oklahoma and South Central Oklahoma. • Coordinated and supported the personal and mainframe computing needs of the oil and gas exploration department.
<i>Geophysical Services INC. (Saudi Arabia)</i> Nov. 1979 - Nov. 1981	• Geologist - initial experience in oil and gas exploration (two year assignment with the Arabian American Oil Company).
Availability/Existing Commitments:	• 100% available
Credentials (Education, Training, and Certifications):	
• University of Houston, Master of Arts, Economics, 1988 • King's College, University of London, Bachelor of Science (Honors), Geology, 1979	
Security Clearance	Employment Status
None	Employed by SAIC
Job Duties to Be Performed	
Economist	

Name: DAVID M. FRIEDMAN

Company Name: Science Applications International Corporation

Address: 8301 Greensboro Drive, McLean, VA 22102

Telephone Number: (703) 676-4559

Points of Contact: Christopher Ellsworth (703) 676-8808

Dates Employed

Duties Performed

*Science Applications
International Corporation
(SAIC) April 1984 - Present
Director Transportation and
Fuels 1995 - Present*

- Financial Analyst on Alaska gas market assessment for a gas spur pipeline to satisfy FERC filing requirements for the Alaska Natural Gas Transmission System. The study included an assessment of LNG, GTL, propane, petrochemical and fertilizer export potential as well as domestic Alaska gas demand from the residential, commercial, industrial, and power sectors.
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- For the US AID and for the Department of Energy of the Czech Republic, Mr. Friedman was the Assistant Manager on a project to identify alternative emission control measures for two central heating plants – Holesovice in Praha and Tonaso in Nestsvece (Usti). Mr. Friedman was responsible for establishing and managing project relationships with the local subcontractor – Energoprojekt, Praha.
- For the Environmental Protection Agency, conducted an assessment of the impact of environmental regulations on the small business section of 10 key U.S. industries. This study examined a variety of economic and financial criteria to determine the impact of environmental regulations.
- Developed an assessment of energy-related factors in the aluminum industry for the Office of Industrial Programs of the Department of Energy. This study addressed key issues that could influence the industry's future energy conservation.
- Program Manager and Principal Investigator on a task for the National Academy of Sciences / Transportation Research Board (NAS/TRB) to develop a guide for ferry-system operators to use in evaluating security measures to meet their security and operational goals. As part of this assignment, led seven tasks. These included: Characterization of the US ferry System; Identification of common threats; Identify preventive measures to address ferry-system security threats; Development of a menu of security measures; Evaluation of measures; and the Development of a user-friendly Guide.
- Prepared an analysis of textile recovery processes and their applicability to textile manufacturing for the Office of Industrial Applications and Commercialization of DOE. Mr. Friedman was responsible for identifying and assessing the impact of new textile technologies on textile materials recovery processes and the potential application of textile recovery technologies to energy conservation in the textile industry.
- Principal investigator on a task, to determine the status of electrical power generation in Eastern Europe and in countries with centrally planned economies (CPE).
- Mr. Friedman managed the support services contract with the NEPA Affairs Division of the Office of the Assistant Secretary for Environmental and Emergency Preparedness. This major contract was designed to provide assistance to the division in evaluating the environmental impacts of renewable energy and conservation programs directed by DOE.
- For a major gas research organization, Mr. Friedman conducted a comparative

	impact assessment for the role of natural gas in decentralized and centralized electricity generation market and end-use service markets. Future trends in each technology were analyzed in significant detail, with specific emphasis on: end-use efficiency, life-cycle economics, potential for cost reduction, sensitivity to electric peak requirements, and anticipated future technological advances. • Subtask leader in evaluating the environmental impact of evolving fossil energy technologies. Mr. Friedman was responsible for characterizing the technological processes for enhanced oil recovery and identifying the environmental consequences of specific enhanced oil recovery processes. The effluent stream at each stage, for each technology option, was assessed and the findings were presented to the Office Oil, Gas, Shale and Coal Liquids, ASFE. • Project management on a task assessing the environmental impact resulting from changes in DOE's Industrial Energy Conservation Program. The study identified the key environmental issues and defined the conservation impact of alternative program options. The resultant environmental differences of the alternative energy conservation levels were also identified.
Booz, Allen and Hamilton Bethesda, Maryland 1978 - 1981	• Mr. Friedman was employed as a senior consultant in the Energy and Environment Division of Booz, Allen and Hamilton. While there, Mr. Friedman participated in a large number of assignments, including those in the following technical and functional fields: fossil energy; electric power generation; regulatory impact analyses; solar, wind, photovoltaics, and biomass energy; industry-related impact; and energy technology-related market studies.
	•
Availability/Existing Commitments:	• 50% available
Credentials (Education, Training, and Certifications):	
• B.A. Economics, Hunter College, CUNY, 1973 • M.B.A. Baruch College of Business Administration, CUNY, 1981 • Reads, writes, and speaks: Slovak, Hungarian, and Czech. Some command of Russian.	
Security Clearance	Employment Status
• None	• SAIC
Job Duties to Be Performed	
Financial Analysis	

DELMA BRATVOLD, Ph.D.

EDUCATION:

B.A. Biology, Monmouth College, 1984

M.S. Biology, George Mason University, 1993

Ph.D. Environmental Science and Public Policy, George Mason University, 1995

WORK SUMMARY:

Dr. Bratvold has over 20 years of combined experience in consulting, academic research, teaching, and publication. Her work in the field of energy and environmental policy has included natural gas, coal, nuclear, solar, and wind power. She has developed and contributed to economic models on a variety of topics ranging from gas pipelines to intermittent power sources and energy storage. She has conducted analyses of the impacts of regulations issued under DOE, EPA, DOT, and OSHA.

PROFESSIONAL EXPERIENCE:

Science Applications International Corporation (SAIC), 1987 to 1996, and 2004 to Present

Dr. Bratvold has been a primary researcher in projects dealing with energy and transportation. Some of these projects are briefly described below:

- **Project Contributor** on the 2006 report for DOE – NREL to assess the feasibility of an Alaskan natural gas “spur” pipeline. Alaskan demand and economic feasibility of both dry and wet gas lines were assessed.
- **Project Co-Investigator** on a current project to develop a user-friendly economic modeling tool to assist transit bus operators in assessments of alternative-fueled buses with consideration of external costs (i.e., values of energy security and emissions reductions).
- **Project Investigator** on a current project to assess the status of wireless communications in the transit industry, with a follow-on project to develop a strategic plan for transit industry wireless communications during ongoing FCC spectrum changes.
- **Project Investigator** on a project developing a model of the incremental economic feasibility of storage capacity and retrofits for wind power generators.
- **Project Investigator** on a project to assess the effects of environmental regulations on the adoption of new and alternative energy technologies for NREL.
- **Project Investigator** on a project for NREL to assess the effect of current Federal and State environmental regulations on the use of back-up fossil fuel generators.
- **Project Investigator** on a project for DOE to assess regulations regarding natural gas curtailment, and provide analysis of gaps in these regulations and their implementation under emergency conditions.

- **Project Investigator** on various transportation projects which have components that require analysis of DOT, DOE, and OSHA regulations regarding safety and environmental compliance.
- **Project Investigator** on a project for GRI to assess the current carbon monoxide regulations and their sufficiency based on recent toxicity research.
- **Project Investigator** on a project for the National Academy of Sciences / Transportation Research Board to assess threats and responses to the transportation system with emphasis on radiological, chemical, and biological threats.
- **Project Investigator** on a project for the National Academy of Sciences / Transportation Research Board to provide guidance on the selection of security technologies for ferry operators.

University of Georgia, 2003 to 2005.

Project Manager of a water quality study of aquaculture effluent and tidal creek receiving waters conducted under a grant from the NOAA S-K Program. A second grant from NOAA – South Carolina Sea Grant was for monitoring and modeling tidal creek water column nutrients, chlorophyll, and physical-chemical parameters in response to land-use change.

South Carolina Department of Natural Resources, 1996 to 2003

Principal Investigator on a series of projects for USDA examining methods to increase aquaculture production through microbial ecological control of water quality and biosecure management. A project for NOAA-Sea Grant monitored tidal creek water quality throughout tidal cycles. Methodologies developed by Dr. Bratvold ranged from disinfection and biosecure production, to measurements of aquatic system metabolism and benthic production.

Academic publications co-authored by Dr. Bratvold include:

- Tidwell, J.H., **Bratvold, D.**, (2005). Utility of added substrates in shrimp culture, pp 247-286. In: M.E. Azim, M.C.J. Verdegen, A.A. van Dam, and M.C.M. Beveridge (Eds), *Periphyton: Ecology, Exploitation and Management*. CAB International, Oxfordshire, UK, 319 pp.
- Calle Delgado, P., Avnimelech, Y., McNeil, R., **Bratvold, D.**, Browdy, CL, Sandifer, P.A., 2003. Physical, chemical and biological characteristics of distinctive regions in paddlewheel aerated shrimp ponds. *Aquaculture*, 217:235-248.
- Bratvold, D.**, and Browdy, C.L. 2001. Effects of sand sediment and vertical surfaces (AquaMats™) on production, water quality, and microbial ecology in an intensive *Litopenaeus vannamei* culture system. *Aquaculture* 195:81-94.
- Browdy, C.L., **Bratvold, D.**, Hopkins, J.S., Stokes, A.D., Sandifer, P.A., 2001. Emerging technologies for mitigation of environmental impacts associated with shrimp aquaculture pond effluents. *Asian Fisheries Science*, 14:255-267.
- Browdy, C.L., **Bratvold, D.**, Stokes, A.D., and R.P. McIntosh, 2001. Perspectives on the application of closed shrimp culture systems. In: C.L. Browdy and D.E. Jory, Eds,

- The New Wave: Proceedings of the Special Session on Sustainable Shrimp Farming. World Aquaculture Society, Baton Rouge, LA, 375 pp.
- Bratvold, D.**, Sreenc, F., and Taub, S.R. 2000. Analysis of the distribution of ingested bacteria in nanoflagellates and estimation of grazing rates with flow cytometry. *Aquatic Microbial Ecology*, 21:1-12.
- Browdy, C.L., **Bratvold, D.**, Hopkins, S., and A.D. Stokes. 2000. Estrategias progresivas en el manejo de estanques para mejorar la produccion sostenible de cameron. *Panorama Acuicola* 5(2)10-11.
- Bratvold, D.**, Lu, J., and Browdy, C.L. 1999. Disinfection, microbial community establishment and shrimp production in a prototype biosecure pond. *Journal of the World Aquaculture Society*, 30:422-432.
- Browdy, C.L. and **Bratvold, D.** 1998. Preliminary development of a biosecure shrimp production system. In S.M. Moss (ed.). *Proceedings of the US Marine Shrimp Farming Program Biosecurity Workshop*.
- Pileblad, E., Slivka, A., **Bratvold, D.**, and Cohen, G. 1988. Studies on the autoxidation of dopamine: interaction with ascorbate. *Arch. Biochem., Biophys.* 263(2):447-452.

CHARLES P. THOMAS

WORK SUMMARY:

35 years of broad-based research, engineering, and management experience in the oil and gas industry.

Experience includes 20 years with a major oil company (Phillips Petroleum Company), the U.S. Department of Energy's (DOE) Idaho National Laboratory (INL), director of a university research division (New Mexico Institute of Mining and Technology), an energy-consulting firm, and Science Applications International Corporation (SAIC).

Scientific specialties include fundamentals of fluid flow in porous media, reservoir characterization and management, and improved oil recovery (IOR) research and applications.

Developed and led interdisciplinary R&D programs for IOR research, environmental remediation, oil and gas resource evaluation, oil and gas processing technology, and CO₂ sequestration.

Project manager and leader in a series of Alaska oil and gas resource evaluation projects for the DOE.

Society of Petroleum Engineers Distinguished Lecturer for the 2001-2002 season; subject "Methane Hydrates: Major Energy Source for the Future or Wishful Thinking?"

PROFESSIONAL EXPERIENCE:

February 2002 to present: SAIC Alaska Energy Branch, Energy Solutions Group, Anchorage, Alaska

Responsibilities include technical consulting and support to the DOE National Energy Technology Laboratory's (NETL) Arctic Energy Office for fossil energy and rural energy systems, management of professional staff (scientists, engineers, economists), and business development for SAIC's oil and gas and geothermal geoscience consulting practice. We provide technical expertise for energy and environmental engineering and research for the Alaska oil and gas industry, state of Alaska, and federal resource agencies. Recent projects include a regional natural gas supply and demand study for South Central Alaska (June 2004), South Central Alaska Natural Gas Needs Assessment (February 2006), a comprehensive review of Alaska North Slope Oil and Gas Resources (August 2007), and an analysis of gas storage options for Cook Inlet Alaska (December 2007).

July 1999 – February 2002: Science & Engineering Fellow, Idaho National Laboratory, Idaho Falls, Idaho

Responsibilities included program management and technical leadership for Research, Development, and Demonstration Projects for the Fossil Energy Technology program. The reservoir and environmental group projects totaled \$3.5 million per year. Projects involved research and development for IOR, geoscience, oil and gas resource evaluation, oil and gas processing, CO₂ sequestration, environmental remediation programs, and methane hydrates

research. He was the INL representative to the Natural Gas and Oil Technology National Laboratory Partnership and was responsible for leading the Drilling, Completion, and Stimulation section of the partnership. Responsibilities also included providing input to the laboratory's direction through review and participation in development of the Institutional Plan and the Laboratory Directed R&D program.

1998 – July 1999: Principal, The Brashear Group LLC, Tulsa, Oklahoma

Officer of The Brashear Group LLC, an International Energy Management Consulting Firm based in Potomac, Maryland serving public and private sector clients. Responsibilities included managing the Firm's Tulsa office, assisting in general management of the Firm, marketing to public and private sector clients, and providing technical leadership and input to projects. The principal client was the DOE National Petroleum Technology Office that managed the Fossil Energy Oil Program.

1997: Director, New Mexico Institute of Mining and Technology, Petroleum Recovery Research Center, Socorro, NM

Director of the New Mexico Petroleum Recovery Research Center (PRRC), a state chartered division of the New Mexico Institute of Mining and Technology that has been in operation since 1977. The PRRC had over 30 full-time professional employees and employed 20 to 25 students. PRRC funding was about \$3.5 million per year. PRRC research objectives include laboratory and field-based projects to develop and assist industry in applying improved oil recovery processes in a cost-effective and environmentally sensitive manner to oil and gas resources throughout the world. PRRC researchers were involved in the development of advanced computational techniques such as neural networks, artificial intelligence and geostatistics for application in conventional, fractured, and heterogeneous reservoirs. The director's responsibilities included developing proposals, providing technical guidance to research projects, and integrating the results of multi-disciplinary research teams consisting of geologists, geophysicists, petroleum engineers, petrophysicists, and reservoir simulation engineers for field application.

1989-1996: Science and Engineering Fellow, Idaho National Laboratory, Idaho Falls, ID

Responsibilities included program management and technical leadership for Research, Development, and Demonstration Projects for the Fossil Energy Technology program. During this period the INL Fossil Energy Program grew from a single IOR project to a broad based research, development, and demonstration program encompassing upstream exploration and production technologies as well as refining and transportation technologies and increased to over a \$7 million per year diversified research and development program.

During this period he was project manager and technical lead for Alaska North Slope projects at the special request of the Office of Fossil Energy (DOE-FE):

- Alaska Oil and Gas - Energy Wealth or Vanishing Opportunity? DOE/ID/01570-H1,

January 1991. Primary source document for the National Energy Strategy concerning oil and gas resources on the North Slope of Alaska and potential legislation for opening of the Alaska National Wildlife Refuge (ANWR) for exploration.

- North Slope Natural Gas Review, September 1991. Analysis of effects of selling natural gas from the Prudhoe Bay Unit on oil recovery.
- Alaska North Slope National Energy Strategy - Analysis of Five Undeveloped Fields, DOE/ID/01570-T164, May 1993. An analysis of the technical, economic, environmental, and regulatory barriers to development of five undeveloped North Slope Alaska fields.
- Economics of Alaska North Slope Gas Utilization Options, August 1996. A technical and economic evaluation of options for using North Slope natural gas and the viability of gas-to-liquids conversion technology for the development of the large, remote, and currently unmarketable Alaska North Slope natural gas resource, INEL-96/0322.

1985-1988: Manager, Reservoir Engineering, Phillips Petroleum Company, Bartlesville, OK

Manager of reservoir engineering for Western Division based in Denver, CO; this division was responsible for the Western United States, including Alaska and offshore California. Responsibilities included field development studies for primary and enhanced oil recovery, formation of secondary units, evaluation of properties for acquisition and sale, oil and gas reserves estimates, production and expense forecasts, and capital and expense budgets.

Manager of reservoir engineering for Eastern Division (1985-1986), which included Permian Basin and Gulf Coast Regions and offshore Gulf Coast. Responsibilities were the same as above.

1979-1985: Equity Manager, Prudhoe Bay Field, Western Division E&P, Phillips Petroleum Company, Denver, CO

Responsibilities included Joint Interest Operations for the Prudhoe Bay Unit (PBU) and representative to PBU Owners Committee and Equity Subcommittee, manager of a multi-disciplinary technical group in determination of final equity and arbitration of the ownership of the Prudhoe Bay Unit, North Slope, Alaska. The group consisted of reservoir engineers, mathematicians, research scientists, geologists, petrophysicists, computer mapping technologists, and attorneys. Arbitration responsibilities included preparation of technical data, arbitration strategy, presentation of evidence as an expert witness in reservoir fundamentals, cross examination of technical witnesses before the Arbitration Board, and coordination of efforts with partners (Chevron and Mobil).

1971 to 1978: Senior Research Engineer, Production Research Branch, Phillips Research Center, Phillips Petroleum Company, Bartlesville, OK

Responsible for fundamental investigation of EOR processes including miscible and immiscible gas flooding, polymer flooding, and surfactant flooding. Studies

included experimental and theoretical investigations of process fundamentals, fundamentals of fluid flow in porous media, and mathematical modeling of chemical flooding processes; Project Supervisor responsible for research, project design, and field testing for gas flooding projects (CO₂ and nitrogen), foam diversion systems, surfactant and polymer flooding.

1968-1971: Theoretical Research Physicist, Phillips Research Center, Phillips Petroleum Company, Bartlesville, OK

Polymer physics research on the relationship of molecular structure of polymers to engineering flow properties and rheology of complex fluids.

1963-1968: Graduate Teacher and Research Assistant, Georgia Institute of Technology, Atlanta, GA

Worked for Department of Engineering Mechanics. Teaching Experience - Engineering Graphics, Statics, Strength of Materials, and Fluid Dynamics.

EDUCATION:

Ph.D. Engineering Mechanics and Applied Mathematics, Georgia Institute of Technology, 1968

M.S. Engineering Mechanics, Georgia Institute of Technology, 1965

B.S. Mechanical Engineering, Auburn University, 1963

Miscellaneous:

Professional Society: Society of Petroleum Engineers (SPE)

Special Recognition:

- January 1991 Alaska study listed as one of the "Top Ten" accomplishments of the INEL for 1990.
- Commendation from Assistant Secretary of Fossil Energy for the September 1991 North Slope Alaska gas study.
- Significant Accomplishment Award, Science & Technology Department, EG&G Idaho, Inc., 1990 and 1991.
- Nominated by the INEL for the 1995 U.S. Department Energy's Energy Science and Technology (Lowery Award). The Lowery Award is the most prestigious DOE Fossil Energy award and recognizes scientific and technical achievement in the development of fossil fuel resources.
- Excellence Award from Lockheed Martin Idaho Technologies in March 1996 for contributions to the Alaska North Slope Gas Utilization Study.
- Selected by the Society of Petroleum Engineers to serve as a Distinguished Lecturer for the 2001- 2002 season; subject "Methane Hydrates: Major Energy Source for the Future or Wishful Thinking?"

Special Accomplishments:

President and founding partner of an Idaho National Engineering Laboratory

spin-off company formed in November 1993 to commercialize soil remediation technology for removing organic contaminants from solid materials. Company was dissolved in 1997.

Patents:

- Well Treatment Method, Patent No. 4,231,438, 11/4/80.
- Method for Plugging and Subsequent Treatment of Subterranean Formations, Patent No. 4,495,995, 1/29/85.
- Method for Removing Hydrocarbon Contaminants From Solid Materials, Patent No. 5,454,878, 10/03/95.
- Apparatus for Removing Hydrocarbon Contaminants From Solid Materials, Patent No. 5,490,531, 02/13/96

Technical Publications:

Thomas, C.P.: "A Study of Anomalous Stress Effects in Slightly Viscoelastic Fluids," Ph.D. Thesis, Georgia Institute of Technology, June, 1968.

Thomas, C.P.: "The Mechanism of Reduction of Water Mobility by Polymers in Glass Capillary Arrays," Society of Petroleum Engineers Journal, June, 1976, pp. 130 136.

Slattery, J.C., Chen, J., Thomas, C.P., and Flemming, P.D. III, "Spinning Drop Interfacial Viscometer," Journal of Colloid and Interface Science, February 1980, Vol. 73, No. 2.

Arnett, R.L. and Thomas, C.P.: "Zero Shear Viscosity of Some Ethyl Branched Paraffinic Model Polymers," Journal of Physical Chemistry, Vol. 84, No. 6, 1980.

Flemming, P.D. III, Thomas, C.P., and Winter, W.K.: "Formulation of General Multiphase, Multicomponent Chemical Flood Model," Society of Petroleum Engineers Journal, February 1981, pp. 63 76.

Thomas, C.P., Winter, W.K., and Flemming, P.D. III: "A Ternary Two Phase, Mathematical Model of Oil Recovery with Surfactant Systems," Society of Petroleum Engineers Journal, December 1984, pp. 606 616.

Thomas, C.P., Doughty, T.C., Faulder, D.D., Harrison, W.E., Irving, J.R., Jamison, H.C., White, G.J.: "Alaska Oil and Gas: Energy Wealth or Vanishing Opportunity?," U.S. Department of Energy, DOE/ID/01570-H1, January 1991.

Thomas, C.P., Bala, G.A., and Duvall, M.L.: "Microbial Enhanced Oil Recovery and Wettability Research Program, 1990 Annual Report," U.S. Department of Energy, DOE/ID-10326 (DE91002248), July 1991.

Thomas, C.P., Doughty, T.C., Faulder, D.D., Irving, J.R., Jamison, H.C., Robertson, E.P.: "Alaska North Slope Natural Gas Review," U.S. Department of Energy, September, 1991.

Thomas, C.P., Bala, G.A., and Duvall, M.L.: "Surfactant Based Enhanced Oil Recovery Mediated by Naturally Occurring Microorganisms," Society of Petroleum Engineers (SPE) Reservoir Engineering, November 1993, pp. 285-291.

Bala, G.A., Duvall M.L., Barrett, K.B., Robertson, E.P., Pfister, R.M., and Thomas, C.P.: "Surfactant Based Microbial Enhanced Oil Recovery (MEOR)," in Minerals Bioprocessing, R.W. Smith and M. Misra (eds.), The Minerals, Metals, & Materials Society, 1991, pp. 121-132.

Bala, G.A., Herd, M.D., Robertson, E.P., Duvall, M.L., and Thomas, C.P.: "Surfactant Mediated Microbial EOR of Medium to Heavy Crude Oils," 1991 Eastern Oil Shale Symposium, Lexington, KY, November 12 to 15, 1991, pp. 158-166.

Herd, M.D., Lassahn, G.D., Thomas, C.P., Bala, G.A., Eastman, S.L., "Interfacial Tensions of Microbial Surfactants Determined by Real-Time Video Imaging of Pendant Drops," SPE/DOE 24206 presented at the SPE/DOE Eighth Symposium on Enhanced Oil Recovery, Tulsa, OK, April 22-24, 1992.

Herd, M.D., Thomas, C.P., Bala, G.A., Lassahn, G.D., "Measurement of Interfacial Tensions by Use of Pendant Drop Video Techniques," Topical Report, U.S. Department of Energy, DOE ID/01570-T170 (DE93000168), September 1993.

Robertson, E.P., Bala, G.A., Thomas, C.P., "Laboratory Methods for Enhanced Oil Recovery Core Floods," Topical Report, U.S. Department of Energy, DOE/ID/01570-T171 (DE94000117), March 1994.

Thomas, C.P., R.B. Allaire, T.C. Doughty, D.D. Faulder, J.R. Irving, H.C. Jamison, G.J. White, "Alaska North Slope National Energy Strategy Initiative: An Analysis of Five Undeveloped Fields," U.S. Department of Energy, DOE/ID/01570-T164 (DE93000142), May 1993.

Fox, S.L., Brehm, M.A., Robertson, E.P., Jackson, J.D., Thomas, C.P., Bala, G.A., "Comparative Analysis of Microbially Mediated Recovery by Surfactants Produced by *Bacillus licheniformis* and *Bacillus subtilis*," Microbial Enhancement of Oil Recovery - Recent Advances, Proceedings of the 1992 International Conference on Microbial Enhanced Oil Recovery, Developments in Petroleum Science, 39, E. Premuzic and A. Woodhead, (eds), Elsevier, 1993, pp. 143-150.

Mahmood, S.A., D.K. Olsen, C.P. Thomas, "Heavy Oil Production From Alaska," presented at the Sixth UNITAR International Conference on Heavy Crude and Tar Sands, February 12-17, 1995, Houston, Texas.

Avellanet, R.A., Thomas, C.P., and Robertson, E.P.: "Options for Alaska North Slope Natural Gas Utilization," SPE 35702, Society of Petroleum Engineers Western Regional Meeting, Anchorage, AK (May 22-24, 1996).

Thomas, C.P., Doughty, T.C., Hackworth, J.H., North, W.B., Robertson, E.P.: "Economics of Alaska North Slope Gas Utilization Options," prepared for the U.S. Department of Energy by Idaho National Engineering Laboratory, Advanced

Engineering Development Laboratory, Lockheed Martin Idaho Technologies Company, Idaho Falls, Idaho, 83415, INEL-96/0322, August 1996.

Robertson, E.P., Bala, G.A., Fox, S.L., Jackson, J.D., Thomas, C.P.: "An Overview of Field-Specific Designs for Microbial EOR," presented at The Fifth International Conference on Microbial Enhanced Oil Recovery and Related Biotechnology for Solving Environmental Problems, September 11-17, 1995, Plano, Texas, 1995 Conference Proceedings, CONF-9509173 (DE96001220), pp 469-489.

Robertson, E.P., Thomas, C.P.: "Economics of Alaska North Slope Gas Utilization Options," presented at the U.S. Department of Energy Natural Gas Conference, March 1997, Houston, Texas.

Buckley, J.S., Wang, J.X., Wu, Y., Thomas, C.P.: "Wettability and Waterflooding of the Sulimar Queen Reservoir," presented at the 18Th International Energy Agency Workshop and Symposium on EOR, Copenhagen, Denmark. August 31-September 3, 1997.

Thomas, C.P.: "Methane Hydrates: Major Energy Source for the Future or Wishful Thinking?," SPE 71452, presented at the 2001 SPE Annual Technical Conference and Exhibition, New Orleans, 30 September 3, October, 2001.

Robertson, E.P., Thomas, C.P.; Zhang, Y; Morrow, N.R.: "Improved Waterflooding through Injection-Brine Modification," Idaho National Engineering and Environmental Laboratory, Bechtel BWXT Idaho, LLC, Idaho Falls, Idaho 83415, INEEL/EXT-02-01591, December 2002.

Thomas, C.P., T.C. Doughty, D.D. Faulder, D.M. Hite: "South-Central Alaska Natural Gas Study," U.S. Department of Energy, Arctic Energy Office, National Energy Technology Laboratory, June 2004.

Thomas, C.P., C.L. Ellsworth, C. Davies-Waldron, D. Friedman, R. Zarumba, M. Farber-Deanda, D. Bratvold, S. Messner, A. Kreczko, D.D. Faulder, K. Bloomfield: "Alaska Natural Gas Needs and Market Assessment," U.S. Department of Energy National Energy Technology Laboratory, May 2006.

Thomas, C.P., T.C. Doughty, D.D. Faulder, D.M. Hite, G.J. White: "Alaska North Slope Oil and Gas Resources - A Promising Future or an Area in Decline?" U.S. Department of Energy, National Energy Technology Laboratory, DOE/NETL-2007/1279 & 1280, August 2007.

Thomas, C.P., K. Bloomfield, T.C. Doughty, D.M. Hite: "Cook Inlet Natural Gas Reservoir and Storage," for the Alaska Natural Gas Development Authority, Alaska Department of Revenue, December 2007.

Christina Davies Waldron

Education:

MS, Civil and Infrastructure Engineering, George Mason University. Concentration in Transportation, 2006.

BS, Integrated Science and Technology, James Madison University.
Concentrations in Energy and Environment, 1998.

Work Summary:

Christina Davies Waldron is an engineer and policy analyst for SAIC. Ms. Waldron has ten years of experience in climate change, transportation, and energy research, science and policy analysis, program development, and project management. She specializes in the assessment of energy, power generation, and transportation policies, technologies, and fuels for reducing greenhouse gas emissions. Ms. Waldron has experience in emissions accounting, inventories, offset projects, and emissions reporting guidance development. Her recent experience includes the development of a entity-wide corporate GHG inventory for the Nebraska Public Power District, the co-authoring of a comprehensive Climate Change Response and Strategic Planning consultant report for the Sacramento Metropolitan Utility District (SMUD), and the review and assessment of a GHG offset project for the Bank of America. Ms. Waldron served as a Lead Author for the 2006 Intergovernmental Panel on Climate Change (IPCC) *National Greenhouse Gas Inventories Guidelines*, and along with other contributors to this and other IPCC publications she was acknowledged as a Nobel Laureate by the IPCC Chairman Pachauri for the 2007 Nobel Peace Prize. Ms. Waldron has been named to the UNFCCC Roster of Experts on greenhouse gas emissions inventory preparation.

1.1 Professional Experience:

October 2002-present: SAIC, McLean VA, Energy and Climate Change Specialist.

Recent work assignments include:

- During 2004, Ms. Waldron was selected by the Intergovernmental Panel on Climate Change (IPCC) and the National Greenhouse Gas Inventories Programme to be a Lead Author for the 2006 IPCC *National Greenhouse Gas Inventories Guidelines*. Ms. Waldron participated in Authors Experts meetings in Arusha Tanzania (September 2004), Manila (January 2005), Philippines, and Moscow, Russian Federation (July 2005). For her participation as a lead author of this IPCC publication, Ms. Waldron was acknowledged as a Nobel Laureate, along with other IPCC participants, by the IPCC Chairman Pachauri for the Nobel Peace Prize 2007. http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_3_Ch3_Mobile_Combustion.pdf
- Lead analyst for NETL study: Scrutiny and Assessment of Approaches for Calculating Net Energy Yield for Cellulosic Ethanol from Switchgrass (February 2008 - ongoing). Ms. Waldron assessed the methodology, data, and assumptions used to determine estimated net energy yield for production and conversion of switchgrass to ethanol as described in the literature. Ms. Waldron performed this assessment for each stage of the process required to produce ethanol from switchgrass (e.g., planting, crop cultivation, harvesting, conversion, transportation, etc.) reported in the literature. She identified calculations based on data and those based on assumptions. She differentiated between assumptions that are supportable based on known facts (with reasonable extrapolation) and those that are purely aspirational.

In subsequent phases, she will evaluate the range of values that would be achieved for net energy yield based on varying degrees of success or failure of the aspirational assumptions.

- Co-Author for a comprehensive Climate Change Response and Strategic Planning consultant report for the Sacramento Metropolitan Utility District (SMUD), a mid-size California utility. The Plan covered a regional climate science analysis and established seven future climate scenarios, taking into account physical and demographic changes in the environment as well as anticipated changes under California law (AB 32) and Federal law (proposed bills like Warner Lieberman). This plan prioritized actions that SMUD should consider, looking at renewable energy, demand side measures (DSM), carbon capture and storage (CCS), distributed generation, and cogeneration. The study also looked closely at the opportunities and challenges for SMUD associated with a significant expansion in the use of plug-in hybrid vehicles (PHEV). Ms. Waldron led the analysis of the physical risks of climate change that would impact SMUD. The study examined regional climate science analyses and assessed and summarized for utility decision makers the relevant extreme high temperature impacts, precipitation, river flow, and water resource changes, hydroelectricity impacts, and risks of flooding (2007).
- For the Nebraska Public Power District, Ms. Waldron co-lead the development of a corporate entity-wide GHG inventory. The effort involved a requirements gathering phase to determine the purpose of the inventory, which is to document their emissions, determine their risks and potential liabilities, and identify energy and emission-reducing opportunities. In addition to these benefits, the inventory was prepared following EPA Climate Leaders, EIA's 1605(b), and the California Climate Action Registry program guidelines, to allow NPPD to participate in these programs if they so choose. Ms. Waldron identified, analyzed, and summarized the relevant costs and benefits to NPPD of potentially participating in the many programs in which NPPD is eligible. She summarized the scope of the most relevant U.S. GHG programs that may benefit NPPD, and provided detailed information describing each of these programs. Next, Ms. Waldron and the team described for NPPD and provided recommendations on the key elements of the inventory. Key elements and issues included: selecting a base period of emissions; selecting years to be included in the inventory; establishing entity boundaries; setting organizational boundaries; setting operational boundaries; GHG data management; data collection methods; data quality assurance; calculating emissions; assessing uncertainty; verification of emissions; and reporting of emissions. Ms. Waldron documented the technical requirements and level of effort for inventory preparation required based on the variables of the various GHG programs. The second phase of the inventory preparation involved a site-visit for data collection and cleansing, inventory review and processing, quality assurance and quality control (QA/QC). Ms. Waldron oversaw the development of the custom GHG inventory tool, which the SAIC team built from scratch to store data, calculate emissions, generate reports, and analyze trends (2007).
- Primary technical lead and deputy project manager for support to the California Energy Commission (CEC) on Transportation Metrics to Measure Petroleum Reduction (since April 2006). Ms. Waldron leads the technical effort to develop a tracking tool or model that has the ability to track petroleum use, non-petroleum fuels use, and petroleum saved as a result changes in California's vehicle fleet fuel efficiency. SAIC is establishing metrics to evaluate the progress of the State of California toward the CEC & CARB goals pursuant to AB 2076 (to reduce petroleum consumption use by 15 percent below 2003 demand levels by the year 2020, and increase non-petroleum fuel use by 20 percent of on-road fuel consumption by 2020, and 30 percent by 2030). In addition, recent policy and legislative initiatives, including the Low Carbon Fuel Standard (LCFS) will also be addressed by the tracking methodologies and tool that SAIC is developing. Steps of the project include identifying the relevant data to be tracked, determining the availability of sources of those data, and assessing the completeness and accuracy of potential data sets (2006 - present).

- For the Bank of America during 2007, Ms. Waldron reviewed a climate change offset project for robustness and provided recommendations and reservations regarding purchasing associated CER credits. She reviewed a project description and supporting documentation on a Mexico HFC destruction project and confirmed through the CDM website that the project has been registered and verified, and that Certified Emission Reductions have been issued. Additionally, Ms. Waldron prepared easily understandable definitions for a list of commonly used, technical climate change terms to explain to a broad, non-technical audience.
- For NETL, co-authored a report on the state of knowledge on general trends in adaptation research, and climate change vulnerability and adaptation specifically associated with the energy sector. The available literature includes relatively limited discussions of potential climate change impacts, vulnerabilities, or adaptation research, and few real-world examples of adaptation measures, specific to the energy sector. Ms. Waldron addressed the following energy-specific vulnerability and adaptation issues: Reduced water availability for hydropower; Increased end-use demand for interior heating and cooling; Decreased availability of cooling water resources for electricity generation; Oil and gas development impacts and adaptation measures; Higher temperature impacts on electrical transmission lines; and Adaptation in the context of long-term energy infrastructure planning (2006).
- For NETL, co-authored a technical report on "The Impact of Existing Legal and Regulatory Structures on the Ability to Apply Climate Change Mitigation and Adaptation Efforts." (2007)
- Conducted industrial energy demand / natural gas market needs assessment of South Central Alaska for the State of Alaska on behalf of NETL; served as contributing author on *Alaska Natural Gas Needs and Market Assessment*. Ms. Davies researched and analyzed industrial energy demand and industrial business developments in the South Central region provided forecasts total future industrial natural gas demand and price threshold for an integrated analysis. Specifically, Ms. Davies provided forecasts of future natural gas consumption from existing natural gas markets (fertilizer), and potential consumption from new markets and industries (petrochemicals, gold and mineral mining, and other minor industries) through 2035. After completing interviews and a literature review, Ms. Waldron conducted a detailed feasibility, cost, and market analysis of the construction, operation, and energy use of proposed ammonia, urea, and petrochemical industrial facilities in Kenai, Alaska. The study included a global market assessment of the commodities ammonia, urea, polyethylene, and ethylene glycol, manufactured from dry natural gas (methane) and natural gas liquids (NGLs) (propane, butane, ethane) (Aug 2005 - Feb 2006) www.netl.doe.gov/technologies/oil-gas/publications/AEO/AlaskaGasNeeds-MarketStudy.pdf
- In support of the U.S. EPA, developed a new methodology for GHG offsets project involving large industrial boilers, which was presented at the EPA National Climate Leaders Partners Conference in January 2006. In addition, Ms. Davies developed a standardized methodology for estimating a baseline and establishing a performance standard for a transit bus fuel-switching project. Prepared a life-cycle cost estimate and uncertainty analysis of monitoring options applicable to a transportation fuel-, efficiency-, or technology-focused emission reduction projects (July 2004-Feb. 2005). In a follow-on task, Ms. Davies supported EPA in the compilation of baseline and monitoring methodologies for the following greenhouse gas offset project types: boilers, landfills, iron and steel manufacturing, transit buses, cement manufacturing, coal mine methane, manure management, SF₆, and terrestrial carbon sequestration. The baseline and monitoring methodology papers that have been independently developed for each project type were compiled into a single document that outlines offset methodologies for the specific projects. Ms. Davies analyzed the baseline and monitoring methodologies and ensured that each step of the baseline methodology is treated consistently across project types, as well as ensuring similar structures and content among the monitoring discussions. Methodological steps include: including developing the boundary, determining

eligibility, developing the baseline, estimating reductions, monitoring, and accounting for leakage [2005].

- Worked with State and local government personnel to establish a Capital Region Consortium for Climate Protection and a plan, schedule, and budget for a Climate Action Project [2005 -].
- Support to U.S. DOE's National Energy Technology Lab (NETL) on "Advanced Energy Technology Options for Power Generation: Case Studies in China, India, Kazakhstan, Poland, and South Africa" [2002-]. Developed revised methodology, conducted country-specific research, data analysis, and spreadsheet modeling to identify and quantify options to reduce fuel use and emissions from fossil power plants in China, India, South Africa, Poland, and Kazakhstan, and drafted final report on each country. Screened potential in country power sector expert consultants and served as direct communications interface between the consultants and NETL.
- *Capacity Building in Greenhouse Gas Accounting and Project Development for Alternative Fuel Vehicles in India* (July 2004 - July 2005)– As a subcontractor to the National Energy Technology Laboratory (NETL) on a project funded by the U.S. Agency for International Development (USAID), Ms. Waldron and the SAIC Team provided all climate change-related services under a task to promote alternative fuel vehicle (AFV) use in India to reduce GHG emissions and local air pollutants. Under this task, SAIC developed and conducted a training workshop, "the USAID Clean Air/Clean Vehicle Project Workshop" in Mumbai India in June 2005 for Indian business, government, and NGO representatives on the methods and approaches for conducting greenhouse gas (GHG) accounting and developing GHG projects for AFVs, including data collection, estimation methodologies, baseline determination, and project planning and implementation. Ms. Waldron developed and delivered curriculum for the workshop on the methods for estimating and accounting for greenhouse gas emissions and reductions resulting from mitigation or offset projects involving alternative fuel vehicles. For her research in preparation for the workshop, Ms. Waldron analyzed the life-cycle energy and emissions of vehicle fuel switching from conventional petrol to propane or ethanol, using the Argonne National Laboratory Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) Model. She evaluated the underlying assumptions and presented the applicable concepts and conclusions to the Indian stakeholders.
- Managed task and co-authored, "Assessment of the Greenhouse Gas Emission Benefits of Heavy Duty Natural Gas Vehicles in the United States," for the U.S. Department of Transportation, Center for Climate Change and Environmental Forecasting (Sep '04-Sep '05). More accurate emission factors for heavy duty vehicles are necessary as organizations are proactively implementing fuel switching projects and purchasing natural gas vehicle fleets, and claiming GHG benefits. GHG reduction estimates for fuel switching projects are often based on estimates of CO₂ only, without considering increases in CH₄ emissions from natural gas vehicles. To address this knowledge gap, SAIC and WVU extracted previously unpublished data from heavy duty vehicle tests undertaken by WVU and analyzed CO₂ and CH₄ emissions from different fuels, vehicle types, engine technologies, and drive cycles.
- Support to NETL on geologic carbon sequestration program: prepared recommendations for greenhouse gas accounting protocols for geologic sequestration projects; researched and analyzed geologic sequestration policy initiatives; researched current and emerging technologies for separation, capture, transport, and injection of carbon dioxide in sequestration projects and applications including enhanced oil recover (EOR), enhanced gas recovery (EGR), and enhanced coalbed methane recovery (E-CBM), summarized carbon storage capacity in geologic formations, including depleted oil fields, deep, unminable coal seams, and saline aquifers [2002-].

- Support to Energy Information Administration (EIA) Inventory of Emissions of Greenhouse Gases in the United States (1605(a)), and Enhanced Documentation of the Inventory sources and methods, on energy, non-energy use of fossil fuels, and agriculture sections [Annual reporting cycles since 2002]. For the fossil fuels that have non-fuel uses, such as petroleum products used in pharmaceuticals and petrochemicals, Ms. Waldron reviewed and analyzed the lifecycle energy inputs, emissions, and energy stored in products, and calculated the total net annual GHG emissions and carbon stored for each fuel type.
- In support of the Department of Energy, Policy Office on the President Bush Administration initiative, led SAIC's support to U.S. DOE on the development of technical guidelines for the Enhanced 1605(b) Voluntary Reporting of Greenhouse Gases Program and proposed improvements to the current greenhouse gas registry. Guideline preparation included chapters on industrial processes, indirect emissions from electricity, and transportation. Transportation chapter contains detailed guidelines for estimating emissions from use of biogenic fuels, including ethanol (July 2003 – 2006).
- Support to EIA Voluntary Reporting of Greenhouse Gases Program, 1605(b). Prepared text for 1605(b) report for 2001 data reporting year, including chapters on Policy Developments and Energy End-Use from Stationary Sources. Summarized end-use projects and data statistics for reporting entities, including the following industries: cement, energy and electric power generation/utility, automobile manufacturing. Project types included: demand side management (DSM), urban forestry, energy-efficient lighting and appliances [2002].

July 1998 – September 2002: Booz Allen Hamilton, Arlington VA, Senior Consultant, Transportation and Global Climate Change Work Experience

- Task manager for DoD global climate change support task, including technical, financial, and personnel management. Provided technical support to DoD to establish policies that protect U.S. national security interests while fulfilling U.S. obligations under the Framework Convention on Climate Change (UNFCCC). Developed inventory methodology for estimating GHG emissions from DoD international bunker fuels used by aircraft and ships. Developed emissions model and MS Access database for annual DoD inventory of emissions from transportation fuels and international bunker fuels. Collected and analyzed fuel (e.g., diesel, gasoline, jet fuels, ethanol, naval distillate, intermediate, and burner fuels) and operations data (e.g., aircraft flying hours, vessel steaming hours, vehicle fuel efficiency data) from Military Services. Prepared results for publication by EPA in *Inventory of U.S. Greenhouse Gas Emissions* for 1998, 1999, 2000, and 2001 [1999-2002].
- Conducted case study on estimating greenhouse gas emissions from multilateral operations in the Balkans, including emissions from aviation and waterborne navigation. Presented results, on behalf of U.S. DoD, at international conference, "The Importance of Military Organizations in Ozone and Climate Protection" in Brussels, Belgium, February 2001 [2000-2001].
- Advised the Automotive Governors of the World Economic Forum on the historical and projected future climate change impact of the automotive industry. Analyzed worldwide, regional, national, and sectoral fuel consumption trends and energy indices. Surveyed industry-wide (including U.S., European Union (EU), and Japanese companies) existing and developmental technologies, research and development products, and climate-friendly initiatives, and recommended short and long-term options to reduce climate impact [2001].
- Transportation Technology Transfer, Feasibility, Cost, and Lifecycle Analysis-Related Work Experience
- Task manager for technical analyses of small boat engine wet exhaust, serving NAVSEA and U.S. Coast Guard on development of a dual DoD and EPA Federal regulation. Technical

lead for 2⁺ year feasibility analyses of technologies to control marine engine wet exhaust, including alternative fuels (e.g., JP-5, JP-8, F-76, low-sulfur and bio-diesels, reformulated gasoline) and engine designs (e.g., 2-stroke and 4-stroke, spark ignition and compression ignition). Researched and analyzed military fuel standards and specifications, fueling operations and logistical requirements, policies and instructions of the Defense Energy Support Center (DESC), DoD, Navy, and USCG, EPA and California fuel regulations (e.g., diesel sulfur limits, reformulated gasoline regulations), on-road, off-road, and marine compression ignition (CI) and spark ignition (SI) engine rules [1999-2002].

- Managed multidisciplinary team of chemists, biologists, environmental scientists, naval architects, and engineers; coordinated data management and information exchange among characterization, environmental analysis, and feasibility teams each conducting analyses of baseline discharge and technologies to control small boat engine wet exhaust. Used results of cost-benefit analyses to recommend standards to be included in DoD and EPA regulation, Uniform National Discharge Standards (UNDS) for Armed Forces Vessels [1999-2002]. Attended high-level policy meetings, serving as technical lead, to resolve issues between EPA and DoD policy chiefs and legal counsel.
- Prepared and supervised economic cost analysis of environmental and energy technologies for multiple projects (e.g., Navy UNDS development and EPA Region 9 jewelry manufacturing). Conducted comprehensive survey and evaluation of commercial and government-sponsored cost estimating software tools; selected most appropriate tool for each project. Learned ACEIT cost estimating software and trained team members on cost model [1998-2002].
- In support of EPA, served as project manager and technical lead on lifecycle analysis (LCA) of commercial jewelry manufacturing plant; prepared feasibility and cost analysis of pollution prevention and control equipment for jewelry manufacturing industry [2001-2001].
- Prepared recommendations for environmental, safety, and occupational health (ESOH) lifecycle cost (LCC) accounting within weapon system acquisition. Reviewed lifecycle analyses and LCC reports for weapon system programs, recommended improvements to accounting protocols to increase visibility of cost drivers for decision-makers, reduce costs and risk associated with ESOH [2002].
- Prepared Programmatic, Environmental, Safety and Health Evaluation (PESHE) for Navy satellite weapon system program. Analyzed weapon system lifecycle for ESOH impacts, pollution prevention opportunities, and compliance assurance [2002].
- Prepared MS Project plans for FAA ESOH compliance schedules and activities [1998].

Environmental Restoration/Clean-Up-Related Work

- Reviewed Everglades National Park monitoring program and protocols, supported review of and recommendations for Comprehensive Everglades Restoration Program (CERP) [2001-2002]
- Project manager for development of Department of Navy (DON) 5-Year Environmental Restoration Program. [2002]
- Evaluated technologies to treat perchlorate-contaminated soil and groundwater for the Air Force (AFCEE). [2002]

May 1997 – April 1998: Institute for Energy Technology of Malta, Marsaxlokk, Malta, Engineering Assistant.

- Initiated contact between JMU and Institute for Energy Technology (IET) of Malta; proposed collaboration between JMU & IET; and received dual sponsorship for internship abroad [1997].

- Conducted trials of prototype solar water-detoxification system for European Union project [1997].
- Authored thesis, which was delivered to IET director and engineers, titled: "Comparative Analysis of Strategies Encouraging Technology Transfer of Domestic Solar Water Heaters and their Applications for the Republic of Malta" [1997-1998].

Miscellaneous:

Publications:

- *2006 IPCC National Greenhouse Gas Inventories Guidelines*, lead author, Road, Off-Road, and Rail Transportation, Intergovernmental Panel on Climate Change, 2006.
- Alaska Natural Gas Needs and Market Assessment, U.S. Department of Energy, Strategic Center for Natural Gas & Oil, June 2006, Technical Contributor.
www.netl.doe.gov/technologies/oil-gas/publications/AEO/AlaskaGasNeeds-MarketStudy.pdf
- "An alternative vision for a liquid global market in GHG credits based on currency markets: Currency Markets As Analogue," contributing author, submitted by M. Mondshine (lead author) to *Environmental Finance*
- "Fuel and Emissions Impacts of Roundabouts – A Meta Analysis" Thesis report for masters degree, George Mason University, December 2005.
- Christina Davies, Jette Findsen, and Lindolfo Pedraza, "Assessment of the Greenhouse Gas Emission Benefits of Heavy Duty Natural Gas Vehicles in the United States," Final Report, September 22, 2005, prepared for U.S. Department of Transportation (DOT) Center for Climate Change and Environmental Forecasting, Research and Innovative Technology Administration, Washington DC,
<http://climate.dot.gov/publications/docs/natgasvehic092205.pdf>
- Findsen, Jette; Davies, Christina and Forbes, Sarah. 2003. "Estimating and Reporting GHG Emission Reductions from CO2 Capture and Storage Activities." Second Annual Conference on Carbon Sequestration. Alexandria, Virginia. May 5-8, 2003.
- "Comparative Analysis of Strategies Encouraging Technology Transfer of Domestic Solar Water Heaters and their Applications for the Republic of Malta" Christina Davies for the Institute for Energy Technology of Malta, 1998.

Professional Associations and Memberships:

- Society of Women Engineers (SWE) professional member since 2006
- Association of Energy Engineers (AEE) participant, non-member

MATTHEW S. CLEAVER

EDUCATION:

University of South Florida, 1994-1996, B.A. Anthropology
The Catholic University of America, 1992-1994

WORK SUMMARY:

Matthew Cleaver is currently an Energy Analyst at SAIC. Mr. Cleaver has over seven years experience performing analysis, quality assurance, technical writing, research, and project management functions for the Energy Information Administration and other offices within the Department of Energy. He has been involved in every aspect of energy survey data processing including residential, commercial and industrial electricity data collection, quality assurance, data analysis, publication support, and project management. He is experienced managing survey operations support staff, ensuring high quality and on time deliverables and overseeing the budget requirements for multi-year cost plus fixed fee contracts. Mr. Cleaver also assists in the production of the Energy Assurance Daily report for the Infrastructure Security and Energy Restoration Division of the Office of Electricity Delivery and Energy Reliability. Mr. Cleaver has extensive knowledge of the energy industry, with particular strength in the electric power sector. He has taken Project Management training and has completed a Leadership Effectiveness and Development (LEAD) training course. He is skilled with MS Excel, Word, PowerPoint, and Access.

PROFESSIONAL EXPERIENCE:

2/06 - Present, Senior Analyst II, SAIC

Mr. Cleaver currently serves as a Senior Analyst II in support of commercial clients at the Port Authority of New York and New Jersey as well as Natural Gas clients at the Department of Energy. In this role Mr. Cleaver assists commercial clients with the management of energy billing information. He is developing a database application to assist clients with the import, storage, and analysis of billing information from multiple suppliers and commodities. He meets regularly with clients to discuss progress and demonstrate product functionality. Mr. Cleaver also manages the progress of two full time database development staff to ensure requirements are met accurately and on time. Mr. Cleaver produced a detailed requirements specification as well as a user documentation manual for the product.

For the Natural Gas Division of the Department of Energy Mr. Cleaver assisted with the upgrade of the "GasTran" natural gas pipeline mapping and information system from a FoxPro based to MS Access based platform.

Mr. Cleaver assisted with the update of the "Strategic Investment Activities and Worldwide Oil and Gas Equity Access Challenges of Major E&P Companies" report for the Energy Information Administration. This involved updating the current production and reserves values for selected national oil companies as well as researching and

updating the accompanying text to detail any new in-country and overseas strategic investment in equity oil and gas and infrastructure projects.

1/05-1/06, Energy Analyst, SAIC

Mr. Cleaver served as an Energy Analyst supporting clients at the National Energy Technology Laboratory, Office of Integrated Analysis and Forecasting, Office of Fossil Energy, and the Office of Electricity Delivery and Energy Reliability. As part of his support for the NETL he researched and authored two case studies on the impacts of climate change on the electricity sector. These studies focused on the effects of drought on the electricity supply in the Northwest and Southwest United States. He also prepared a literature review for the Office of Fossil Energy on the current science of climate change. Mr. Cleaver assisted with the background research for an assessment paper detailing viable generation alternatives for developing countries by outlining the current coal use and coal waste activities for multiple subject countries. Mr. Cleaver served on the team of analysts that researched and produced the Energy Assurance Daily report for the Office of Electricity Delivery and Energy Reliability. In addition, he assisted with the production of detailed instruction manuals for the staff producing the report and aided in the initial design of the report format. Mr. Cleaver assisted with the research for an assessment paper focusing on the natural gas needs of South Central Alaska associated with potential routes for a spur pipeline from Alaska's North Slope.

1/01-12/04, Energy Analyst/On-Site Resource Manager, SAIC

During his role as Resource Manager Mr. Cleaver supervised a team of contractor employees at the Coal, Nuclear, Electric, and Alternate Fuels Division of the Energy Information Administration, Department of Energy. He coordinated the efforts of a team of eight to ten full time energy analysts and up to ten additional summer interns in the collection and analyses of annual and monthly energy industry data. Mr. Cleaver designed real time data editing applications using MS Access and SQL applications to ensure the highest level of data integrity. He regularly communicated with industry professionals representing major energy providers, State level public utility commissions, and the Federal Energy Regulatory Commission (FERC) in conducting research and collecting data. He prepared final project reports detailing work done for a reporting cycle, solutions to problems encountered, and suggestions for improvement. Mr. Cleaver efficiently managed budget requirements for a three year cost plus fixed fee task and ensured that staff of analysts had the necessary materials and instruction to perform tasks effectively.

COMPUTER PROFICIENCY:

MS Word, MS Excel, MS PowerPoint, MS Access, MapInfo desktop mapping

OTHER TRAINING:

Leadership Effectiveness and Development (LEAD), SAIC, 2006
Project Management I, SAIC, 2005