the ENERGY lab

PROGRAM FACTS

Strategic Center for Natural Gas & Oil

Arctic Energy Office

Alaska's fossil energy resources will likely play a greater role in meeting the nation's energy needs in the future. Alaska holds about one-fifth of America's remaining proved oil reserves, large accumulations of associated natural gas awaiting a means to reach a market, and over half of its coal resources. When stranded North Slope natural gas and unconventional oil and gas resources such as viscous oil, coal bed natural gas, and methane hydrates are factored in, the energy resources found in Alaska are astounding. Despite Alaska's energy wealth, producing and delivering those resources to the rest of the United States, as well as providing affordable power to Alaska's rural villages, continues to be a challenge. NETL's Arctic Energy Office is coordinating with industry, academia, and other Government agencies to demonstrate the value of Alaska's fossil fuel resources to the Nation and Alaska's rural community while maintaining the pristine environment in which it is contained.

Harvesting Snow to Augment Water Supplies

Environment

Arctic Energy Office objectives include a strong emphasis on environmental issues concerning development of Alaska's resources, such as fragile tundra, permafrost, and wildlife protection. Preserving the unspoiled nature of Alaska is a major consideration of the program. The Arctic Energy Office coordinates with state agencies and academia to deliver research that will address environmental issues limiting oil, gas, and coal development in Alaska.

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U.S. DEPARTMENT OF ENERGY

PROJECT SUMMARY

- **North Slope Decision Support for Water Resource Planning and Management**

  Ice roads and ice pads provide a cost effective means of oil and gas exploration on Alaska's North Slope with minimal impact to the sensitive underlying tundra. This research is developing tools that support stakeholders' needs while meeting regulatory requirements. Key components include information system technology, Arctic hydrology and climatology, water resources management, and decision support through modeling.

  http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/EP/ArcticResources/05683_WaterManagement.html

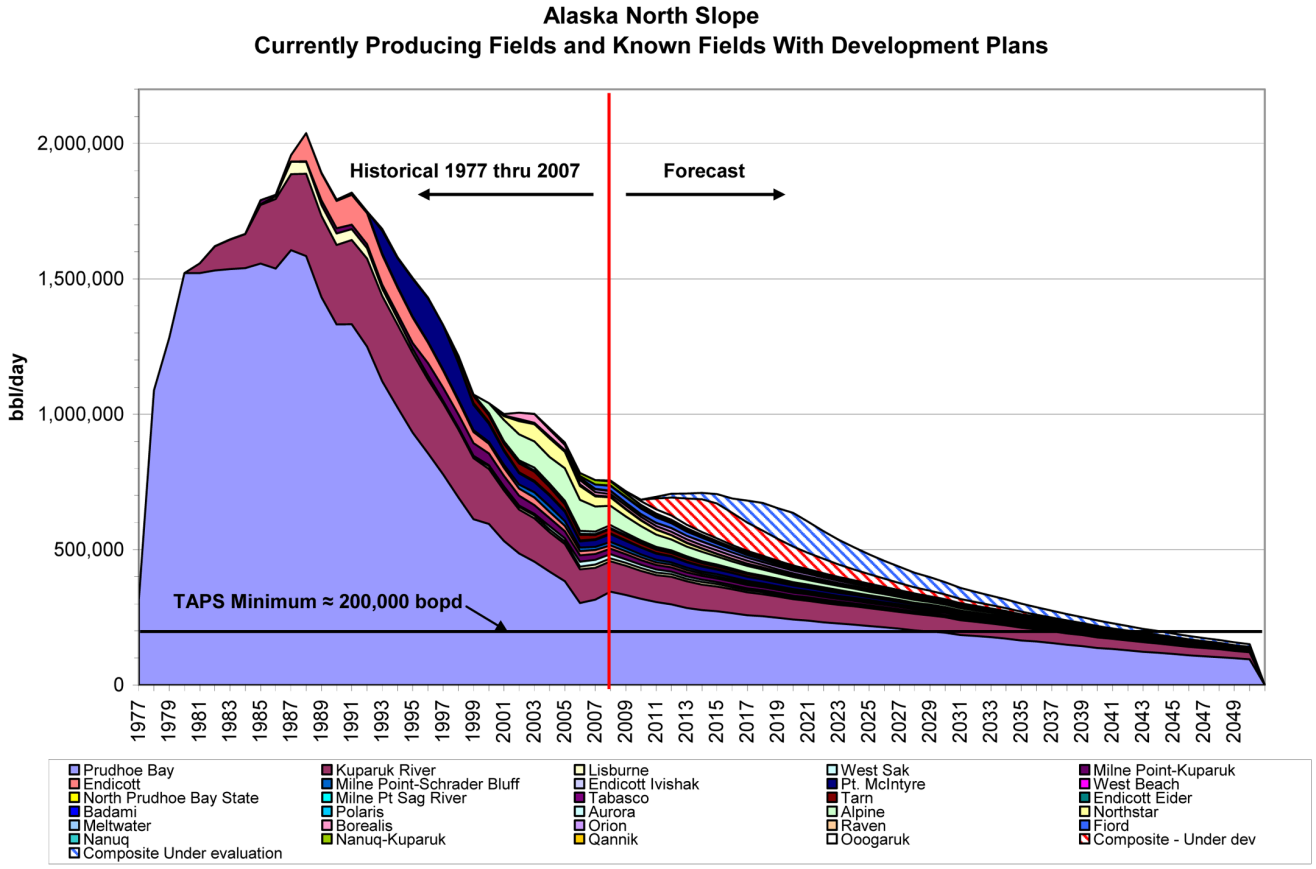
- **Using Artificial Barriers (Snow Fences) to Augment Fresh Water Supply**

  Current Arctic energy production is situated in a "Polar Desert." Total annual precipitation averages a mere 6"–10". With water available only 12 weeks of the year, difficulties with storing and distributing water in Arctic conditions, and high operation cost, water is a precious resource. This project evaluates the use of snow management and snow fences to augment lake water supplies. Finding an optimum location for creating snow drifts could increase the probability that this snow will effectively recharge a lake through most of the summer.

  http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/EP/ArcticResources/05684ArcticLakes.html

Alaska North Slope Resources

Additional oil production from known resources as well as new discoveries are essential for keeping the Trans Alaska Pipeline System (TAPS) operating both technically and economically. The lower limit of effective operation for TAPS is in the range of 200,000 barrels per day. Current production rates are about 700,000 barrels per day down from a maximum of over 2 million barrels per day in 1988. The economic limit of TAPS will depend on world oil prices and operating costs, but as oil production rates continue to decline, the tariffs can be expected to increase, affecting the economic viability of all North Slope production. With currently producing and identified development, the TAPS minimum flow rate could be reached as early as 2045 and strand over a billion barrels of oil currently booked as reserves (economically producible). Maintaining the viability of the TAPS pipeline is essential for maintaining access to undiscovered North Slope resources and requires access in a timely manner to the most promising areas for exploration and development, such as all of National Petroleum Reserve Alaska, and the Outer Continental Shelf.



(Source: Alaska North Slope Oil and Gas: A Promising Future or An Area in Decline?)

Unconventional Sources

Development of advanced enhanced oil recovery technologies, especially for "heavy oil," to increase the recovery from known fields is critical for maintaining TAPS trough-put. Heavy oil is a dense, viscous type of crude oil with an API gravity between 10° and 20°. Generally, this oil has a viscosity between 100 and 10,000 centipoise, and does not flow readily in the reservoir without dilution and/or the introduction of heat. Particular emphasis needs to be placed on evaluating technologies that could help recover more of this underdeveloped heavy oil resource in Alaska. Advanced oil recovery technologies, such as miscibility enhanced CO_2-EOR will be essential for recovering more from the largely undeveloped heavy oil resource.

API 10° crude

API 19° crude

Initial steps are being taken to produce a portion of the in-place oil resource from two large heavy oil reservoirs on the Alaska North Slope. The Schrader Bluff Formation in the Milne Point Unit has experienced a steady growth in heavy oil production, reaching 19,000 barrels per day in 2003, from a few thousand barrels per day in the 1990s. It is now producing about 12,000 barrels per day. The West Sak Formation in the Kuparuk River Unit, after years of experimentation and delay, produced 18,100 barrels of heavy oil per day in 2007. The Unit operator has submitted plans to the Department of Natural Resources, Alaska to conduct an aggressive program of horizontal well drilling and water injection to increase West Sak heavy oil production to a peak 26,000 barrels per day in 2015.

ALASKA'S POTENTIAL FROM UNCONVENTIONAL SOURCES:

- The Alaska heavy oil resource is large, on the order of 45 billion barrels of original oil in place.
- The West Sak PA is believed to contain between 15 and 20 billion barrels of oil (BBO) with variable oil gravity from 10 to 22°API.
- West Sak development is restricted to a core area of about 2 BBO of which only 1.2 BBO is considered to be economical to develop.
- The Schrader Bluff PA is believed to contain between 15 and 20 BBO of 17°API oil.
- Schrader Bluff development is restricted to a core area of about 2 BBO of which only 1.3 BBO is considered to be economical to develop.
- Other heavy oil producing formations are Ugnu, Tabasco, Orion, and Polaris.

Further advances in heavy oil recovery technology, adapted particularly to the special geological, reservoir, environmental, and operational situations in Alaska, will be essential for increasing oil recovery from Alaska's large heavy oil endowment. Current research supported by the NETL's Arctic Energy Office includes:

- ***Use of Polymers to Recover Viscous Oil***
  Alaska's North Slope contains a very large unconventional oil resource—over 45 billion barrels of heavy/viscous oil. Production has been limited to pools in the core area that flow with thermal or miscible gas injection/water-alternating-gas, but the majority of the oil is stranded. The project will be valuable in establishing the most cost-effective path forward to develop Alaska heavy oil resources, studying both existing and new viscoelastic polymers to change the viscosity, new methods for improved injectivity during polymer injection, sweep efficiency enhancements, and effects of induced fracturing and formation parting.

  http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/EP/ImprovedRec/06555_Polymers.html

- ***Fluid and Rock Property Controls on Production and Seismic Monitoring Alaska Heavy Oils***
  A prime factor limiting the efficiency of heavy oil recovery is the heterogeneity of the system. Variability includes the heavy oil with varying resin and asphaltene contents and the rock matrices' with different porosities, permeability, connectivity, and mineral content. Using seismic data, this study is attempting to characterize the reservoir fluid and rock properties such that a geophysical monitoring program can potentially be used to enhance heavy oil recovery.

  http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/EP/ArcticResources/05663_AlaskaHeavyOil.html

- ***Phase 2–Drilling and Production Testing the Methane Hydrate Resource Potential Associated with the Barrow Gas Fields***
  Previous research efforts funded by the DOE, supported the hypothesis that methane hydrates exist within the Barrow gas fields. Based on detailed reservoir modeling and other favorable conditions (i.e., formation gas composition, formation water chemistry, and reservoir pressure), it is believed that these accumulations may be interacting with the free gas reservoirs, providing pressure support through dissociation of the hydrates. During Phase 2 of the project, a production test well will be designed, drilled, logged, and cored, and a continuous reservoir surveillance and monitoring program will be implemented to prove the commercial potential of producing methane hydrate through depressurization dissociation from the gas zone underlying the hydrates.

  http://www.netl.doe.gov/technologies/oil-gas/FutureSupply/MethaneHydrates/projects/DOEProjects/MH_42962BarrowGasP2.html

ARCTIC ENERGY RESOURCES

- Early estimates of natural gas entrapped under the Arctic permafrost in gas hydrates was 590 trillion cubic feet.
- USGS revised the amount of technically recoverable natural gas in methane hydrates to a median estimate of 85.4 trillion cubic feet.
- 187 billion short tons of coal are identified in Alaska. (This is over 50 percent of the U.S. Domestic total of demonstrated reserves.)
- 1.4 million short tons of coal are produced annually in Alaska.
- 5.6 trillion short tons of hypothetical coal reserves are thought to exist throughout Alaska.

- ***Producing Light Oil from a Frozen Reservoir: Reservoir and Fluid Characterization of Umiat Field, National Petroleum Reserve, Alaska***
  The Umiat oil field contains light oil in a shallow, frozen reservoir and may be typical of an abundant supply across the Arctic permafrost. Most prior efforts researching how to produce in these strata of rock/ice/light oil system at low pressures has been focused upon techniques for heavy oil in unconsolidated but unfrozen sands or on gas hydrates. This research project is developing a robust reservoir model to test possible production methods for Umiat and similar frozen reservoirs that do not use steam or a liquid that will freeze.

  http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/Arctic_Energy/5641_FrozenReservoirs.html

Challenges

Natural gas in the Arctic, until recently, has been largely overlooked. Little is known about the possible breadth of the Arctic storehouse of natural gas apart from the resource associated with the currently producing oil fields In the Alaskan North Slope area, about 36 trillion cubic feet (Tcf) of natural gas awaits construction of a pipeline to the Lower 48 states, and it is estimated that another 137 Tcf of technically recoverable natural gas will be discovered. While this amounts to a little less than 10 percent of the Nation's supply, it is significant in that much of the Arctic is still unexplored. This number does not include methane produced from hydrates which may add an estimated 85 Tcf.

Alaska's identified coal resource is an estimated 187 billion tons, roughly half of the U.S. total. However, this resource is undeveloped as a result of the challenges imposed by the Arctic's protected status, remoteness, higher exploration and development cost. The USGS estimates that as much as 5 trillion metric tons of coal could remain undiscovered in Alaska, 70 percent of which lies in Alaska's North Slope Region. Alaskan coal has a low sulfur content compared to coal in the contiguous United States.

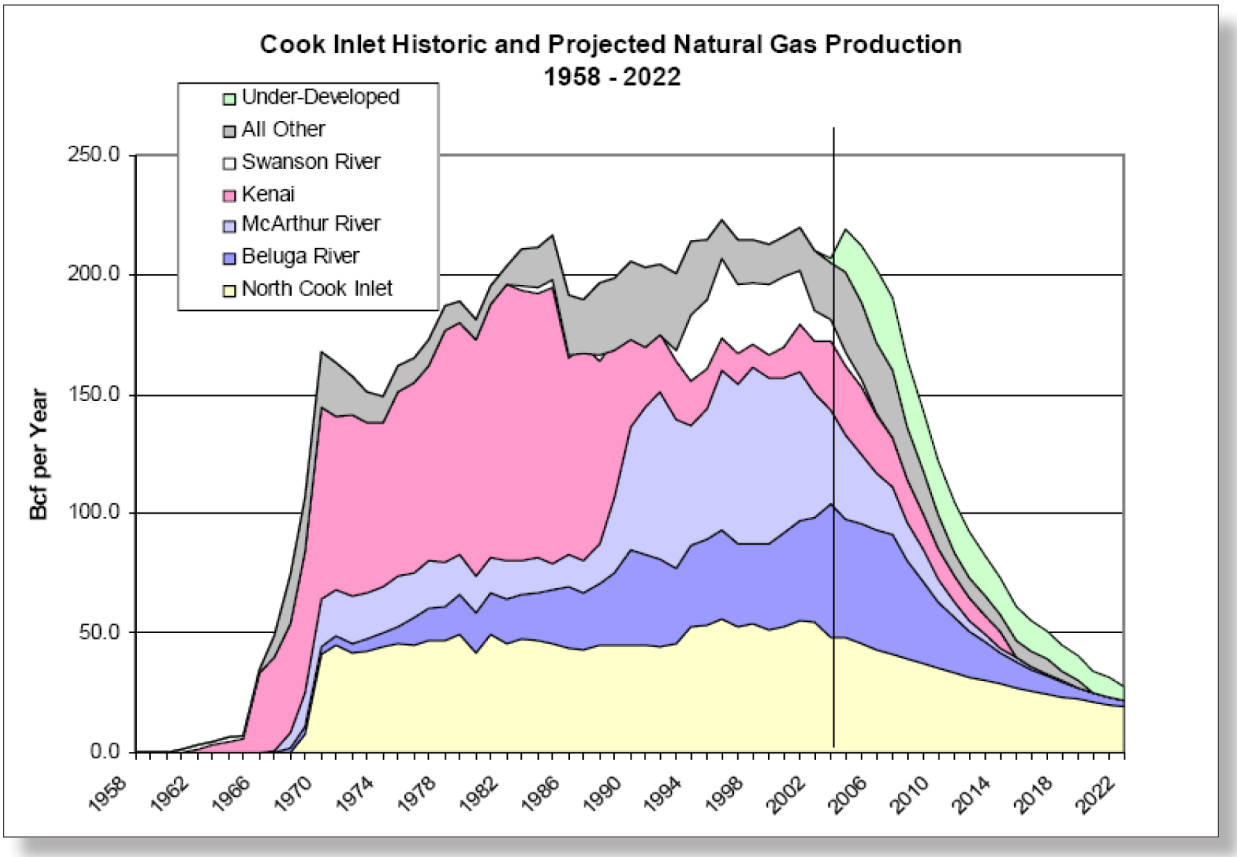
On a more regional level, over forty communities are sited near potential coal resources, yet they do not make use of the coal for electrical power generation and space heating. Given that Alaskans use 1112 Mmbtu/capita versus the United States average of 333 Mmbtu/capita, producing the Arctic's energy resources is a challenge and a priority. Additional research is required to meet the existing and future challenges of finding, producing, and transporting these Arctic resources to market.

Shortages

Anchorage and the rest of South-Central Alaska have been blessed with a relatively inexpensive and abundant source of natural gas from Cook Inlet. Since the 1960s, natural gas from the Cook Inlet Basin has supplied most of South-Central's heating and electricity generation. Until recent years, natural gas finds were merely a byproduct of the search for oil. With no pipeline to transport it, the natural gas was stranded from Lower 48 or Canadian markets and their supply-and-demand based prices. This resulted in low prices for ratepayers and the localized industry on the Kenai Peninsula being built to take advantage of the then-abundant stranded gas.

FACTS/ISSUES

- Average South-Central natural gas consumption in 2005 was:
  - 13.9% gas utility
  - 20.0% power generation
  - 54.3% industrial-LNG sales, oil refining, and fertilizer manufacturing
  - 7.2% field operations
  - 4.6% other
- Due to a lack of natural gas deliverability, the Cook Inlet fertilizer plant terminated operations in May 2008.
- LNG sales are increasingly curtailed during cold weather due to peak demand shortages. The LNG export license is up for renewal in 2011.
- Exploration must find new reserves on the order of 500 Bcf, and that will only solve the natural gas shortage until approximately 2019.



The era of inexpensive natural gas is nearing an end. Gas production from the major Cook Inlet fields is in decline and known reserves are not sufficient to meet current demand—residential, commercial, and industrial—beyond 2012, at best. Natural gas prices have already risen, and even in the best scenario, this upward trend will continue. The more critical question is where future energy supplies will come from and at what price. No easy answers are available. NETL's AEO office has been working closely with the utilities and state agencies to better understand and address the issues.

Alaska's remote population has many different energy issues from the Lower 48. Many residents live in remote villages, beyond the end of the road, and off the grid. Therefore, diesel electric generators provide electrical power for virtually all of Alaska's rural residents. Furthermore, as a result of having to ship diesel by barge or plane long distances and store the fuel on site, fuel costs are very high. Alaska's rural residents pay the highest prices in the nation for electricity. In 2009, the EIA reports the national average for electricity was 9.83 cents/kW. The Regulatory Commission of Alaska reports average urban Alaska's rate at 14.64 cents/kW and the average rate in rural Alaska is 61.46 cents/kW (and as high as $1.16/kW in some villages).

Alaska is just beginning to explore for coal bed methane and shallow gas for local use except for the North Slope and Cook Inlet Regions. A small amount of seismic data and a few exploration wells have been drilled in interior Alaska over the years but no major discoveries have been found. Fossil energy resources, particularly the huge coal deposits, are well documented around Alaska. However, few local markets are large enough to justify the necessary capital cost to develop these resources, and the lack of infrastructure and remoteness from larger markets makes market-driven development unlikely. For example, coal bed methane is likely to exist under some villages, but current costs for drilling make this resource too expensive. Reducing the cost of exploiting nearby coal and natural gas resources is a necessary step in making these projects cost effective, and NETL's Arctic Energy Office has been sponsoring research to discover how such energy resources might be economically utilized. Completed activities include:

Rural Alaska Coalbed Methane—Local Energy Supply in Rural Alaska.

A light weight drill rig was used for the first time to drill a slimhole well through the coals, gravels, and permafrost necessary to produce natural gas from coal bed seams in a remote area. The research was used to develop an economic model to establish if coalbed methane can be used as replacement for diesel fuel in the generation of electricity, thus lowering the costs of producing electricity for Alaskan villages such as Fort Yukon where the well was drilled.

http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/EP/AdvDrilling/41248_2_03_2.htm

Alaska Coalbed Methane Water Disposal Methods—A Review of Available Coalbed Methane Information and Disposal and Treatment Options for Alaska.

An important issue to resolve for coalbed methane production is water disposal or treatment methods. In the frozen Arctic, water problems are magnified both in quantity and quality. The research produced data about coalbed methane formations, available water-quality, community systems which could be used for water treatment systems, and other water use and general information for each community needed for evaluating coalbed methane water management issues.

http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/Environmental/Produced_Water/FWPFEAB112CBNG.html

Galena Electric Power—A Situational Analysis.

Remote villages need power for basic survival. The power system in Galena was studied as a model case. Options included enhancement of the current diesel generation system, opening a small nearby coal seam and installing a coal-fired power plant, and installing a modular small-scale nuclear reactor (Toshiba 4S – 10 MW). Of these three options, the installation of the 10-MW nuclear reactor was the most economical.

http://www.netl.doe.gov/technologies/oil-gas/AEO/RemotePower/RemotePower.html

Solid Oxide Fuel Cell (SOFC) System for Remote Power Generation.

Large scale SOFC (200 kW) has been demonstrated to be the most efficient and reliable of the current fuel cell technologies. However, many applications in Alaska require smaller loads. This unit, the first 5-kW SOFC to operate in the United States, was demonstrated in a year-long test run. The year of trouble free operation demonstrated that this technology can be competitive with diesel generators.

http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/EP/ArcticResources/41248_2_04_01DieselReformer.html

Diesel-fueled Solid Oxide Fuel Cell System for Remote Power Generation.

Solid oxide fuel cells have been demonstrated to generate electrical power at high efficiency at the 5kW range when operated on natural gas. However, natural gas is not a readily available fuel in remote locations where the value of electrical power is very high, making operation of these fuel cells on liquid fuels, preferably diesel fuel, critical to the use of fuel cells in remote locations. This program tested a SOFC on hydrogen from reformed diesel.

http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/Environmental/Petroleum_Refining/FEW4661_06.htm

Nome Region Energy Assessment

Many remote Alaskan communities have installed diesel-powered plants for electrical generation in an era when the fuel was at a lower cost. Not only has fuel increased in cost but transportation of fuel has supplied a multiplier effect. The study provided planning and decision-making capability about coal as compared to alternatives including wind, geothermal, and gas.

http://www.netl.doe.gov/technologies/oil-gas/publications/AEO/NomeEnergyAssessment_March2008.pdf

University of Alaska – Fairbanks—Power Plant Upgrade In Progress

The University of Alaska at Fairbanks is a research institution housing the Arctic Energy Technology Development Laboratory. The need for the coal-fired power plant expansion allowed for the opportunity to explore a conceptual design to incorporate research platforms for education and research and development regarding coal gasification, biomass gasification, solid fuel to liquid, CO_2 capture, and other energy related issues.

http://www.netl.doe.gov/technologies/oil-gas/AEO/main.html

Alaska Coal Regional Assessment—In Progress

Despite the large coal resources in the Arctic, Alaska's coal is largely categorized as hypothetical. Research is being conducted to provide a technical basis that would support characterizing more of Alaska's estimated coal resources from hypothetical to demonstrated reserves. Once the data is collected, it will be made available in the hydrocarbon GIS system used by State, Federal, and local sources.

http://www.netl.doe.gov/technologies/oil-gas/AEO/FossilEnergy/AlaskaCoal.html

Beluga Coal Gasification Feasibility Study—Phase I Final Report.

The Beluga Field coal is part of a 1.4 billion short ton measured reserve in the South Central region of Alaska. The study investigated the feasibility of gasification for power generation or export. The study concluded that a sufficient coal existed to supply the needs of a plant, markets existed for product, and local plants could be retrofitted from a technical and economic stand point.

http://www.netl.doe.gov/technologies/coalpower/gasification/pubs/pdf/Beluga%20Coal%20Gasif%20Feasibility%20Study9_15_06.pdf

Alaska Coal Gasification Feasibility Studies—Healy Coal-to-Liquids Plant

The Usibelli Coal Mine in the interior region of Alaska has accounted for most of the 1,500,000 short tons produced on average per year in the Arctic. Combined with a shortage of natural gas to feed a manufacturing plant, gasification was investigated as a means to supply the raw materials. The study concluded that a 14,640 barrel-per-day Fischer-Tropsch liquid using 4 million tons of coal per year was technically and economically feasible.

http://www.netl.doe.gov/technologies/coalpower/gasification/pubs/pdf/FINAL-Healy%20FT%201251%2007062007.pdf

Current Projects	Current Partners and Performers
Use of Polymers to Recover Viscous Oil from Unconventional Reservoirs http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/EP/ImprovedRec/06555_Polymers.html	New Mexico Institute of Mining & Technology
Producing Light Oil from a Frozen Reservoir: Reservoir and Fluid Characterization of Umiat Field, National Petroleum Reserve, Alaska http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/Arctic_Energy/5641_FrozenReservoirs.html	University of Alaska Fairbanks Renaissance Alaska LLC
Fluid and Rock Property Controls on Production and Seismic Monitoring Alaska Heavy Oils http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/EP/ArcticResources/05663_AlaskaHeavyOil.html	Colorado School of Mines University of Houston Earthworks British Petroleum, Alaska
Gas Hydrates Production Trial http://www.netl.doe.gov/technologies/oil-gas/FutureSupply/MethaneHydrates/projects/DOEProjects/MH_06553HydrateProdTrial.html	ConocoPhillips Company
Phase 2- Drilling and Production Testing the Methane Hydrate Resource Potential associated with the Barrow Gas Fields http://www.netl.doe.gov/technologies/oil-gas/FutureSupply/MethaneHydrates/projects/DOEProjects/MH_42962BarrowGasP2.html	North Slope Borough Arctic Slope Consulting Group Petrotechnical Resources of Alaska University of Alaska Fairbanks
North Slope Decision Support for Water Resources Planning and Management http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/EP/ArcticResources/05683_WaterManagement.html	University of Alaska Fairbanks Texas A & M University PBS&J Consulting
Using Artificial Barriers (Snow Fences) to Augment Fresh Water Supply http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/EP/ArcticResources/05684ArcticLakes.html	University of Alaska Fairbanks CRREL Colorado State University
University of Fairbanks, Power Plant Upgrade http://www.netl.doe.gov/technologies/oil-gas/AEO/main.html	Worley Parsons Ohio Coal Development Office Touchstone/Cedar Lane Farms University of Alaska Fairbanks