U.S. Department of Energy • Office of Fossil Energy
National Energy Technology Laboratory

Energy from the High North

Highlights from NETL's Arctic Energy Office

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Alaska Energy – Critical for the Nation's Energy Security

Alaska's fossil energy resources can and 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, a significant portion of its natural gas reserves, and over half of its coal resources. When stranded North Slope natural gas and unconventional oil and gas resources such as viscous oil, coalbed natural gas, and methane hydrates are factored in, the potential is incredible. Despite Alaska's energy wealth, there are many challenges to producing and delivering those resources to the rest of the United States, as well as providing affordable power to Alaska's rural villages. NETL is working with industry, academia, and other Government agencies to maximize and show 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.

Alaska Oil Potential

Alaska produced 17 percent of total domestic oil production, about 860,000 barrels per day, in 2005. It contributed as much as a quarter of daily domestic oil before the decline in production from the North Slope began in 1988. Alaska contains 20 percent of domestic conventional oil reserves. About 15 billion barrels of oil have been produced in Alaska, primarily from the North Slope's Prudhoe Bay Field. Further, the US Geological Survey (USGS) and the Minerals Management Service (MMS) estimate that more than 50 billion barrels of conventional oil remains undiscovered but technically recoverable in the onshore and offshore areas of Alaska. These estimates place about 10 billion of these barrels in each of northern Alaska's two important onshore areas, the National Petroleum Reserve (NPRA) on the western North Slope and the Alaska National Wildlife Refuge (ANWR) on the eastern North Slope. Additionally, large amounts of shallow viscous oil remain to be developed.

In order to reach its full potential, Alaskan oil needs an efficient delivery mechanism to the rest of the US. With operations that began in 1977, the 800-mile Trans Alaska Pipeline System (TAPS) delivers oil from the North Slope fields to the Port of Valdez. Designed for peak production of 2 million barrels per day, throughput has been dropping for the last 18 years and now stands at less than 900,000 barrels/day. It is estimated that the lower limit of effective operation for TAPS is approximately 200,000 to 300,000 barrels per day. Accounting for currently producing fields and identified development projects, this minimum rate could be reached as early as 2020, thus stranding over a billion barrels of currently booked oil reserves.

Natural Gas

Most of the natural gas produced along with North Slope oil is re-injected to maintain oil reservoir pressure. About 36 trillion cubic feet (Tcf) awaits construction of a pipeline to the Lower 48 states, and USGS estimates there is another 127 Tcf of technically recoverable natural gas to be discovered. In addition to the conventional gas resources, other resources include deep gas, methane in coal seams, and the potentially enormous volume of methane held within gas hydrates (>500 Tcf).

Under a cooperative agreement with NETL, BP Exploration, Inc., is working to determine the commercial viability of gas hydrates and associated free gas resources in three areas of the Alaska North Slope: Prudhoe Bay, Kuparuk River and Milne Point. A gas hydrates characterization well will be drilled in BP's Milne Point field as early as the winter of 2006/2007.

Coal

Alaska's identified coal resource is an estimated 154 billion metric tons, roughly half of the U.S. total. However, this resource has not been economic to develop, with the exception of the Usibelli Mine near Healy, Alaska's only operating coal mine. Major untapped coal deposits exist on the North Slope, in Cook Inlet, and to a lesser degree in discrete areas throughout central Alaska. The USGS estimates that as much as 5 trillion metric tons of coal could remain undiscovered in Alaska, 70 percent of which lies in the North Slope. Alaskan coal has a low sulfur content compared to coal in the contiguous United States.

Of particular interest is the undeveloped Beluga field adjacent to Cook Inlet in South Central Alaska, near Anchorage. Natural gas production from the major Cook Inlet fields is declining and proven reserves are not sufficient to meet local demand beyond 2012. NETL is sponsoring a study to determine the economic feasibility of siting a coal based gasification plant in the Cook Inlet region for the co-production of electric power and products (e.g. gas, diesel, ammonia fertilizer) using Beluga coal.

Deploying instrumentation for Tundra Lakes Water Withdrawal Project

NETL in Alaska

There are many technological and economic challenges associated with the development of Alaska's abundant fossil energy resources. These result from the unique geographic, climatic, environmental, and cultural elements that are characteristic of Alaska's Arctic regions. To address these challenges, the Secretary of Energy established, as part of the National Energy Technology Laboratory's Strategic Center for Natural Gas and Oil (SCNGO) the Arctic Energy Office. NETL's AEO office was opened in 2001. AEO's work has been carried out through extensive collaboration with the University of Alaska, the energy industry and state agencies. AEO manages a variety of projects, some of which are presented below.

Arctic Access and Travel

Access to Critical Arctic Tundra Areas

Tundra Travel Impact Testing

North Slope Ice Road

On Alaska's North Slope, the oil industry must travel off-road across the tundra during winter for a variety of reasons: to carry out seismic exploration, to build ice roads for exploratory drilling, to carry out construction activity, or to perform maintenance on remote infrastructure. The length of the winter work season imposes a limit on activity and has shortened over the past 30 years, dropping from over 200 days in 1970 to about 100 days in 2003.

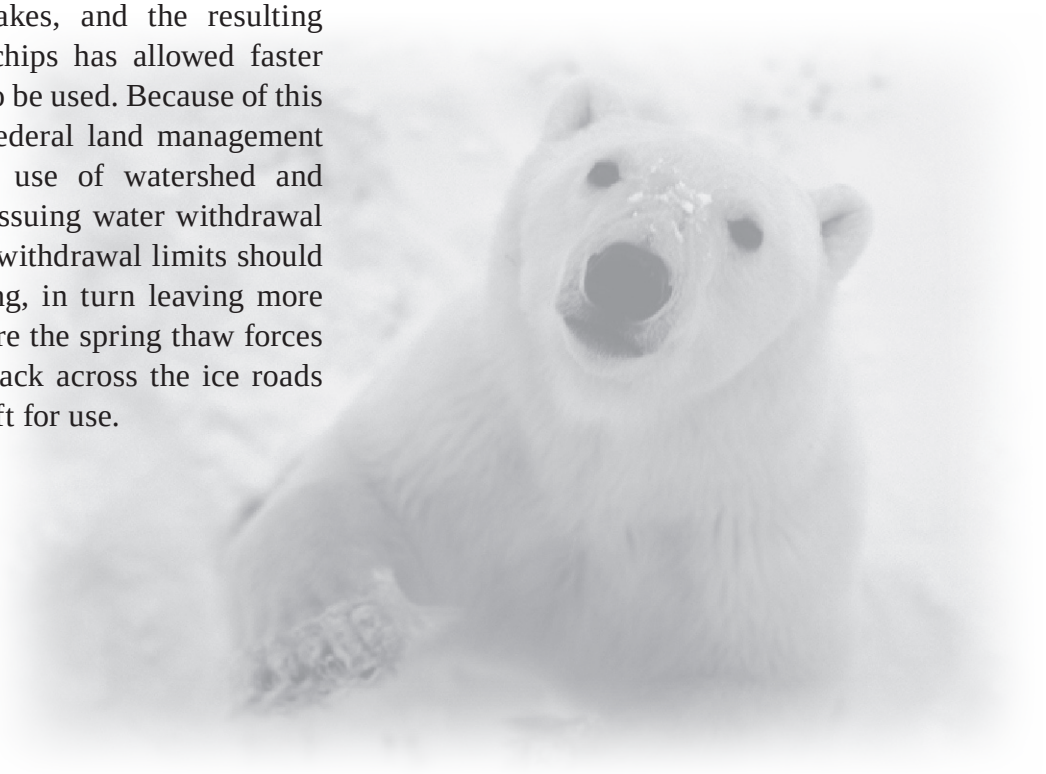
NETL's AEO is working to provide tools that will lead to a longer work season while maintaining or enhancing current levels of environmental protection. Based on the results of the NETL sponsored Tundra Travel Model, Alaska's Department of Natural Resources (DNR) opened the eastern coastal area of the North Slope on December 10, 2004, the earliest opening since 1995 and two weeks earlier than the previous year. Indications are that DNR will continue to rely upon this new tool for determining the opening and closing dates for the exploration season. Lengthening a 3-month exploration season by one month will be a very important change in enabling the continued exploration of Alaska's North Slope. NETL's emphasis on safely increasing the work season may allow companies to complete exploration wells within one season rather than two.

Tundra Lakes Water Withdrawals

The ice roads that are used to safely transport heavy equipment across fragile tundra without harming it require fresh water. This water has historically been extracted from tundra lakes, with a 15 percent volume limitation of the unfrozen water from most lakes. Another NETL project assessed the environmental impact of potentially pumping more than 15 percent of the free water from these lakes in order to support time dependant construction of ice roads in the brief exploration season on the North Slope. The study found that past withdrawal rates have not resulted in measurable adverse impacts in the Kuparuk area and data collected enabled development of lake recharge models that will be used to estimate the maximum quantity of water that might be available without adverse environmental impact.

Water Withdrawal for Ice Road Construction

Due to their interest and participation in this study, the Alaska Department of Fish & Game permitted Lake 9817 - in the NPRA - to have 30 percent water withdrawal instead of 15 percent. In addition, ice-chipping was removed from permit-volume restrictions at selected lakes, and the resulting access to additional ice chips has allowed faster road building techniques to be used. Because of this NETL study, State and Federal land management agencies are considering use of watershed and recharge estimates when issuing water withdrawal permits. Increased water withdrawal limits should lead to faster road building, in turn leaving more time for well drilling before the spring thaw forces oil companies to retreat back across the ice roads before they become too soft for use.



Enhancing Alaska's Ability to Recover and Utilize its Fossil Energy Resources

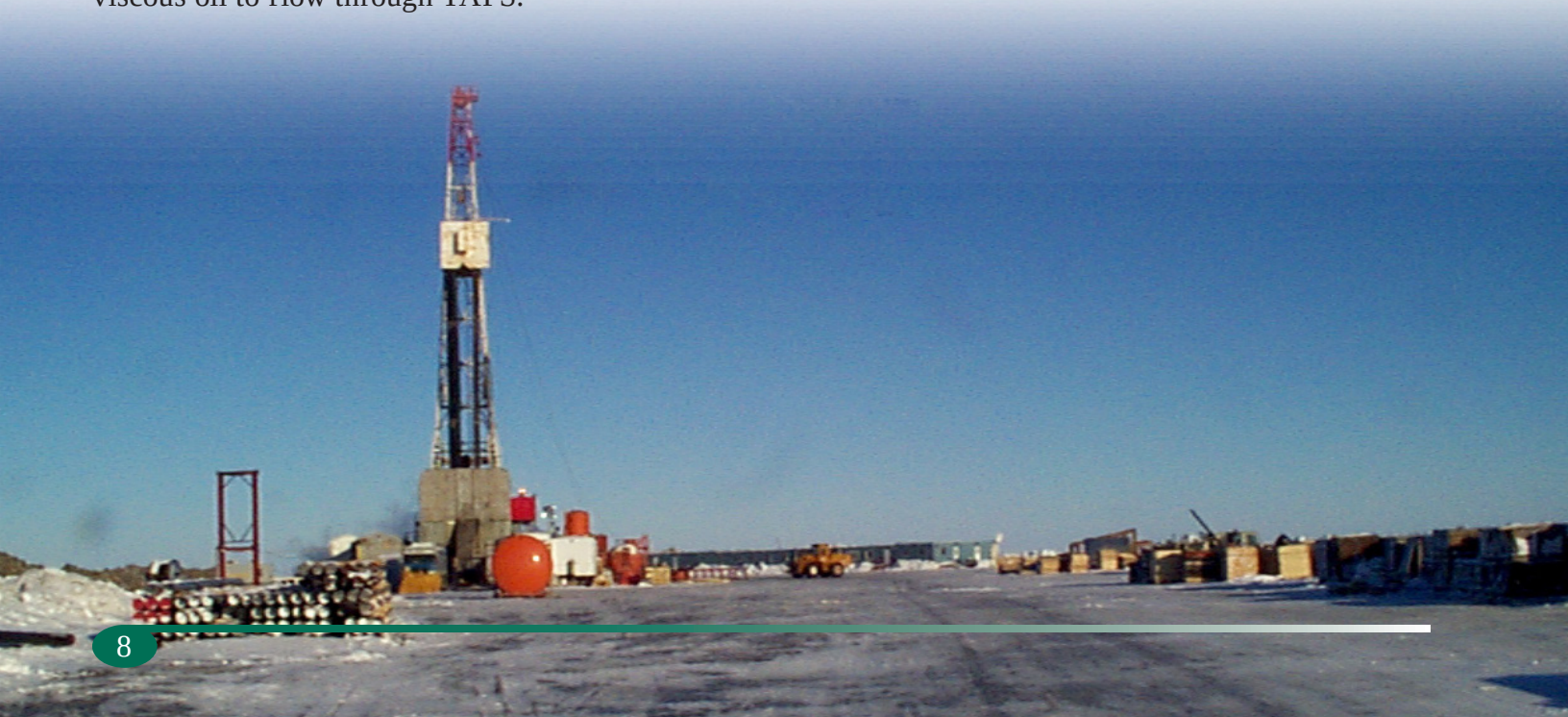
Enhanced Oil Recovery Assessment

In 2004, the DOE Office of Fossil Energy initiated a series of basin-oriented CO_2-Enhanced Oil Recovery (EOR) studies. Preliminary results show the North Slope and Cook Inlet regions could hold as much as 12 billion barrels of stranded oil that could be economically recovered using CO_2 injection. CO_2 injection will also play a key role in the development of the Alaska Gas Pipeline, as CO_2 recovered from the gas will need to be reinjected in the North Slope fields to maintain production pressure on the oil reserves.

CO_2 injection can reduce the viscosity of heavier crude oils and may hold the key to viscous oil production on the North Slope. Alaska's North Slope contains over 20 billion barrels of heavy/viscous oil, perhaps the largest unexploited heavy oil resource in the United States. Using new advanced technologies, industry has just begun to tap a portion of this relatively shallow oil resource in the Schrader Bluff and West Sak formations on the North Slope. Conventional heavy oil recovery techniques are not practical due to the proximity of this shallow oil to the permafrost layer, and oil upgrading may be required in order for the heavy/viscous oil to flow through TAPS.

Alaska North Slope Resource Study

The purpose of this report, which could be released in early 2007, is to provide a detailed assessment and analysis of North Slope oil and gas resources and the interrelated technical, economic, and environmental factors controlling future development of those resources. The scope includes known onshore and offshore fields (development and undeveloped) as well as prospective development areas such as NPR-A and various off-shore areas. The interaction of access to infrastructure, environmental regulations, advanced technology development, and development of a gas pipeline on the future viability of North Slope oil and gas production is described. Work to date suggests additions of economically recoverable reserves of about 36 billion barrels of oil and 137 TCF of natural gas by 2050. This work is also being incorporated into the Arctic Monitoring and Assessment Program, an international effort of the Arctic Council, of which the United States is a member country.



South Central Alaska Natural Gas Supply Study

This 2004 NETL study on the future supply of Cook Inlet natural gas identified key shortages in natural gas that could begin to occur as early as 2009 unless further exploration and development is conducted. Fortunately some drilling has occurred since the release of the report, and the anticipated natural gas shortfall could be forestalled to as late as 2012 at current production and consumption rates.

Bristol Bay Basin Analysis and Assessment of Source Rock Potential and Fossil Fuel Resources

The current state of geological knowledge of Bristol Bay (in southwestern Alaska) is insufficient to attract private exploration investment or to allow assessment of potential hydrocarbon resources. Lacking any coherent integration of geologic analyses, the Bristol Bay basin remains enigmatic as a hydrocarbon basin. The first phase of this DOE project investigating the basin's resources was completed in 2004, and the second phase that began in 2005 will continue this work.

Development of a Novel Ceramic Borehole Sealant for Arctic Environments

One of the basic material requirements of drilling operations in permafrost regions is a suitable insulating cement that will keep the permafrost frozen and undisturbed during subsequent production of oil and gas. Unique chemically bonded phosphate ceramic borehole cement developed at Argonne National Lab (ANL) may fulfill this need. In this NETL project, ANL, in partnership with the University of Alaska, will tailor this cement for permafrost regions and demonstrate its applications in Alaska.

Agrium Coal Gasification Studies

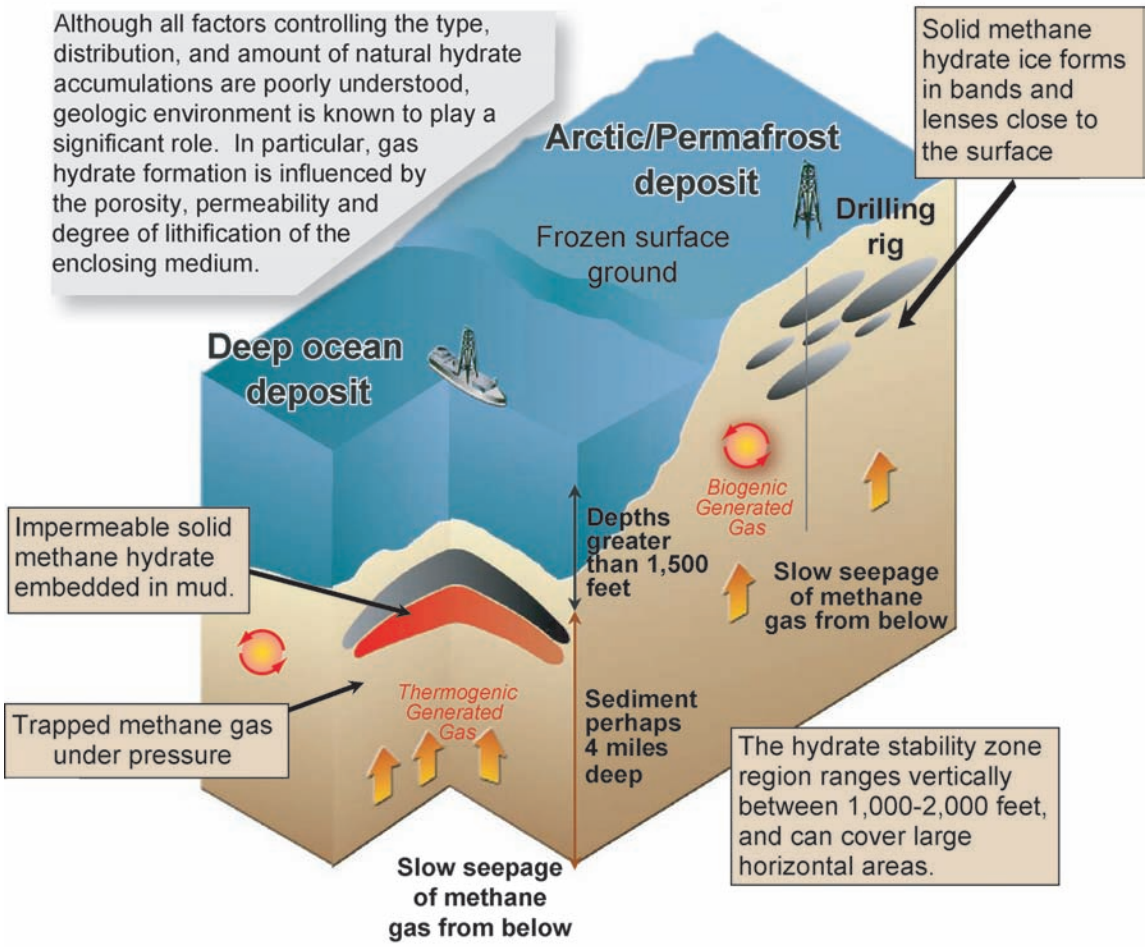
The coal gasification study aims to determine the economic feasibility of siting a coal-based gasification plant in the Cook Inlet region of Alaska for the co-production of electric power and marketable by-products. The plant products may include synthesis gas, Fischer-Tropsch (F-T) liquids, fertilizers such as ammonia and urea, alcohols, hydrogen, nitrogen and carbon dioxide that would be manufactured for local use or for sale in domestic and foreign markets. The project was divided into two phases. In Phase 1, the Agrium fertilizer plant in Nikiski serves as the case study site and customer for product gases (including hydrogen, nitrogen and carbon dioxide), steam and power from the coal gasification facility. In Phase 2, an assessment of alternative locations and plant designs based on local and export markets for the suite of potential products will take place.

Development of an Arctic Drilling Platform

In 2003, NETL announced the successful testing of a drilling rig that could reduce the surface footprint of arctic drilling operations. Anadarko Petroleum Corporation's "Arctic Platform," a lightweight, 100-by-100-foot aluminum drilling platform elevated a dozen feet above the frozen tundra on specially designed steel legs, is a prototype of a future environmentally-sensitive drill rig. Based on platforms similar to those used offshore, the Arctic Platform is compact and modular, allowing it to be safely transported by air or with ultra-low-impact vehicles. The concept could one day eliminate the need for gravel pads and the temporary ice roads and ice pads that oil companies now must use on the North Slope. It could also be used in the lower-48 states in ecologically fragile areas such as wetlands.

Characterization and Quantification of Natural Gas Hydrates

Under a cooperative agreement with DOE, BP Exploration, Inc., is working to determine the commercial viability of gas hydrates and associated free gas resources in three areas of the Alaska North Slope: Prudhoe Bay, Kuparuk River and Milne Point. This three phase project has recently completed Phase 1, the identification of gas hydrates resources. Phase 2 will be the drilling of a gas hydrates characterization well in BP's Milne Point field during the winter drilling season of 2006/2007. Phase 3 will the development of a production testing well.



Review of Alaskan Coalbed Natural Gas Produced Water Treatment and Disposal Options

An important issue to resolve for coalbed natural gas production is water treatment and/or disposal methods. This NETL project will collect and analyze known information about coalbed natural gas formations, available water-quality data, community systems which could be used for water treatment systems and other community water use information needed for evaluating coalbed natural gas water management issues.

Light Weight Drill Rig at Fort Yukon

Coalbed Natural Gas as Local Energy Supply in Rural Alaska

The first phase of this project, the successful drilling of a slimhole well, has been completed at Fort Yukon, AK. This work was done in partnership with Alaska DGGS, BLM, and the USGS. This is the first time a light weight drill rig has been used for the purpose of drilling through the coals, gravels and permafrost necessary to produce natural gas from coal seams in a remote area. The information gained from this project will be used to develop an economic model to assess if coalbed natural gas can be used as replacement for diesel fuel in the generation of electricity, lowering the costs of producing electricity and securing a local source of power for Alaskan villages. A key component of this study will also be to understand the potential beneficial uses for produced water.

Solid Oxide Fuel Cell (SOFC) System or 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 DOE project, the first 5 kW SOFC to operate in the United States, completed a test run with over a year of trouble free operation. This test demonstrated that this type of technology can be competitive with diesel generators in Alaska.

However, natural gas is not a readily available fuel in remote locations, so the option of operating these fuel cells on diesel fuel is critical to its application in remote locations. A second project is designed to test a SOFC using hydrogen produced from reformed diesel fuel.

Solid Oxide Fuel Cell in Fairbanks

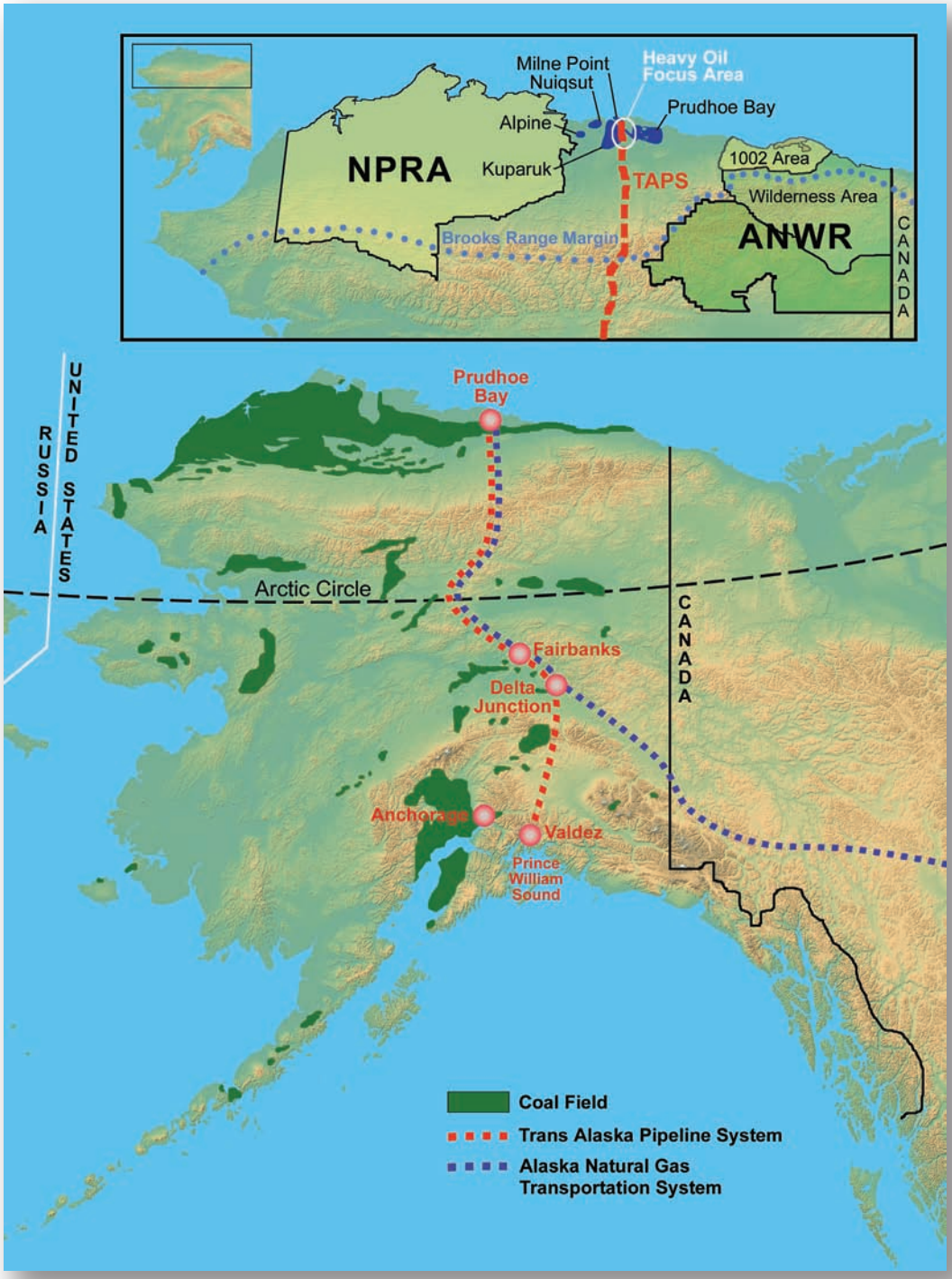
Village of Galena on the Yukon River

Galena Electric Power A Situational Analysis

The purpose of this NETL study was to evaluate electrical costs and possible options for electric power for the town of Galena, Alaska. 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 (the Toshiba 4S – 10 MW). Of these three options, the installation of a 10 MW nuclear reactor appeared to be the most economical option.

The Alaska Natural Gas Pipeline

The proposed Alaska Natural Gas Pipeline will be the largest commercially funded construction project in North America, meeting nearly 10 percent of the nations daily natural gas needs. Two configurations for delivering North Slope natural gas to the lower 48 are actively being debated within Alaska. The first configuration is the "Highway" route, generally paralleling the TAPS route to Delta Junction, Alaska, and then following the AlCan Highway into Alberta where it would join up with existing transmission systems. The second configuration will parallel the TAPS route to its terminus at Valdez, Alaska, where the gas would be liquefied for export.



South Central / Cook Inlet Gas Spur Pipeline Analysis

As a part of the pipeline approval process, the Federal Energy Regulatory Commission (FERC) requires applicants desiring to build the Alaska Natural Gas Pipeline to estimate in-state natural gas requirements, potential take-off points, and possible transportation rates. Building on past NETL work, Congress provided funds for NETL's Arctic Energy Office to develop such estimates to assist the state with developing a basis for evaluating estimates that may arise from the FERC application process. A related objective of this NETL project is to compare routes for the possible installation of a natural gas spur pipeline between Interior Alaska and South Central Alaska. The study has three goals: identify all possible uses of gas, both traditional and non-traditional, as key inputs to the to sizing of a line; optimize the line routing by developing a thorough understanding of permitting, right-of-way and community/commercial uses; and identify the potential social and economic impacts of the line, both positive and negative, on the affected communities.

Gas Spur Pipeline Routing Study

The construction of any buried pipeline in Alaska is a challenging undertaking. With 400 miles of pipeline required to bring gas to Southcentral, this will be a major project. To truly understand the costs and tariffs for this project an engineering study was commissioned by NETL to develop costs, identify key construction risks and to examine the socio-economic impacts on rural communities from a construction of such a pipeline. The two routes that are being examined are the Fairbanks-Wassilla route along the Parks Highway and the Delta Junction-Palmer route along the Richardson and Glenn Highways. Both routes will tie into an existing transmission infrastructure.

As a result of these natural gas supply and demand studies, interested parties will have access to peer-accepted estimates of in-state natural gas requirements (current and forecast) and possible transportation rates allowing for a reasonable nomination to FERC thus streamlining the design and permitting of the Alaska Gas Pipeline.

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