# Scenarios for Energy and Resource Development on the North Slope and Adjacent Seas

Research and Monitoring Prioritization for the NSSI

## New Technology

### Summary

Advancements in drilling and exploration technology have been critical to improving identification and recovery of hydrocarbons from existing conventional and unconventional sources. As known light oil reservoirs on the North Slope become depleted, Enhanced Oil Recovery techniques have made it possible to continue extraction in these fields, as well as increasing access to less conventional heavy and viscous oil deposits. Outer Continental Shelf (OCS) exploration has also relied on improvements in semi-submersible drilling rigs, well containment systems, and seismic surveys to characterize these offshore hydrocarbon resources.

Other unconventional hydrocarbon sources are being explored using new methods, including hydraulic fracturing ("fracking") to extract tight oil from shale formations, as well as a pilot project that used $CO_2$ to displace methane from gas hydrate formations. Underground coal gasification is also being researched. Each of these resources exists in abundant quantities in northern Alaska, and may be more economically-feasible to pursue in the future.

***The potential for prolonging hydrocarbon extraction from existing reservoirs, allowing access to unconventional oil and gas, and enabling exploration and development of new conventional hydrocarbon deposits suggests that new technology may be an important driving force for the future of resource development on the North Slope and adjacent seas.***

### Overview

As technologies for hydrocarbon exploration, extraction, and processing improve, they are providing methods to increase and extend the productivity of existing oil fields, as well as making it more economically feasible to pursue unconventional hydrocarbon sources, such as heavy and viscous oil, shale oil and gas, and methane hydrates. Many of these new technologies are still in the testing phase, and have not yet been applied commercially; however, the existence of large deposits of unconventional hydrocarbons on the North Slope may result in wider use of these novel approaches in the future.

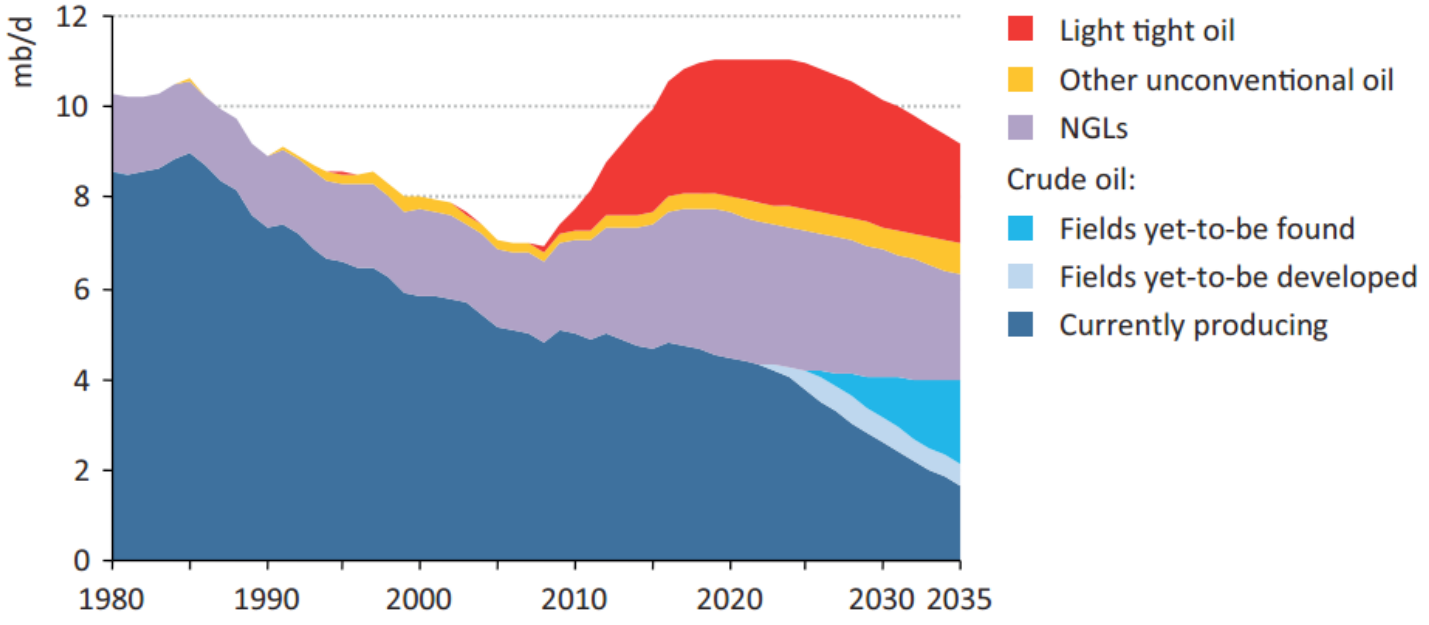


Figure 1. Projection of US oil production by type (3)

**Enhanced Oil Recovery**

Several methods for improving the rate and overall recovery of oil from both conventional and unconventional sources are currently being explored. These Enhanced Oil Recovery (EOR) techniques can employ heat, water/chemicals, or gases (including natural gas) to increase production from existing wells. Thermal EOR requires production of steam, which is more challenging (both physically and economically) on the North Slope due to the extreme cold, and loss of heat as it is pumped through permafrost (9).

Water flooding is a process which involves pumping seawater or low salinity water into injection wells, which subsequently forces oil towards one or more production wells. Trials using low salinity water were conducted at the Endicott field during the 2008-2009 season. This process can be enhanced through the use of polymers, which increase the viscosity of the water being pumped into the reservoir. This method is particularly useful for viscous oil extraction.

Another technique for enhancing recovery is injecting carbon dioxide or natural gas to increase pressure in the reservoir, thereby forcing more oil towards production wells. This method is sometimes referred to as water alternating gas (WAG) injection (see Figure 2). Natural gas is more commonly used on the North Slope because there is an abundant supply, and commercial production is not currently an option, without construction of a new pipeline. This technique is currently being applied in the Greater Prudhoe area.

Other modern drilling and extraction methods have been successfully applied on the North Slope. Multilateral and directional drilling, in particular horizontal and extended reach drilling, have enhanced productivity from existing wells, and made it easier to access offshore fields from land-based drilling platforms (1). Another approach that has been tested in a pilot project in the Ugnu Formation is called Cold Heavy Oil Production with Sand (CHOPS), which pumps sand and oil simultaneously and later separates the solids from the mixture (7).

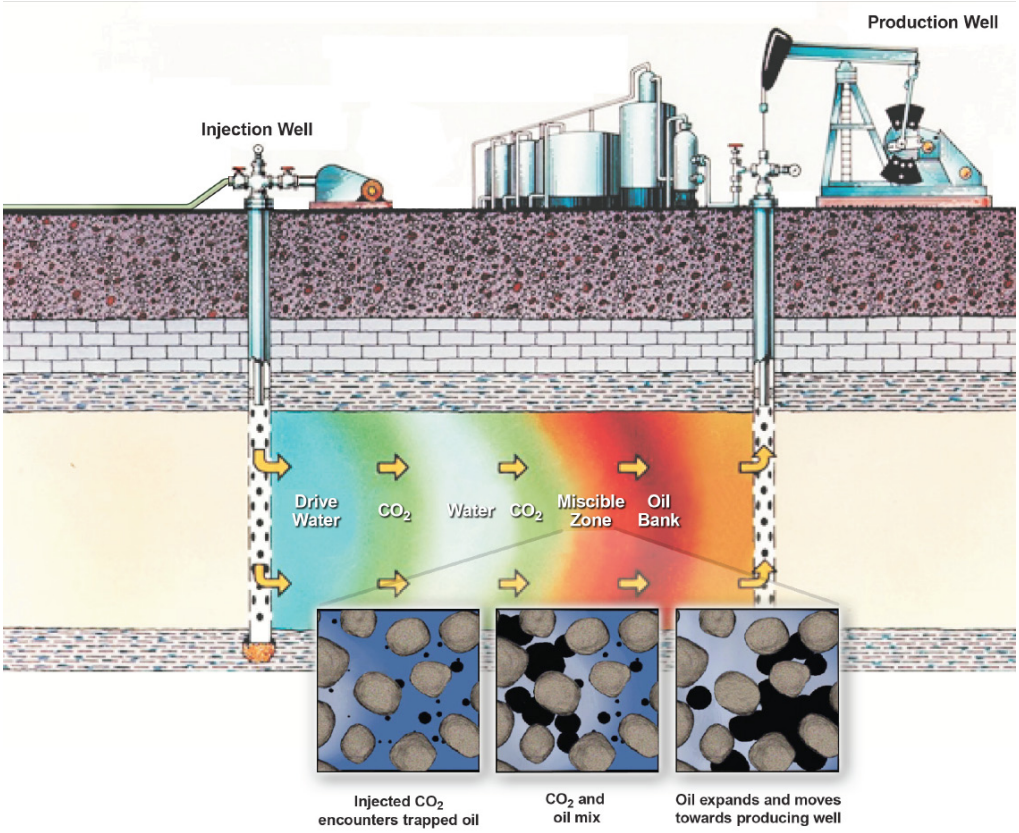


Figure 2. Enhanced Oil Recovery using $CO_2$ (water alternating gas) (5).

**Accessing OCS Resources**

Significant interest has been shown in exploring and developing Outer Continental Shelf (OCS) hydrocarbon resources. In the past several decades, multiple 2D and 3D seismic surveys have been completed in the Chukchi and Beaufort Seas. Some of the primary challenges with exploration and well development on the OCS are the short open water season, protecting infrastructure from ice during the harsh arctic winter, and, mitigating impacts to marine mammals (6).

Some existing technology has already served to make offshore drilling possible, including semi-submersible, floating production platforms, quick disconnect systems, and well containment systems. Additional issues include the construction of buried offshore pipelines that can withstand sea ice, developing platforms that can operate through the winter months, and limiting impacts to marine wildlife and shallow permafrost (6).

**Other Unconventional Sources**

In addition to heavy and viscous oil deposits, a range of other unconventional hydrocarbon resources exist on the North Slope, and may play a greater role as energy sources with the advent of new technologies. Shale oil and gas deposits have been identified in the Central North Slope, in the Shublik and Kingak formations. Leases are currently being explored through 3D seismic surveys, and planned extraction would rely on hydraulic fracturing techniques which are currently being used in other shale formations in the lower 48 states. Pilot projects and sufficient available water will be required to ensure this resource is worth pursuing on a larger scale (2). The introduction of 4D seismic technology has also made it possible to monitor these subsurface deposits over time, and track changes once extraction has begun, which can aid in the identification of unproduced pockets that may be economic to pursue at a later date.

Methane hydrates represent another significant untapped resource on the North Slope. Based on an assessment by the USGS, between 25 and 158 trillion cubic feet of methane may be contained in the region's hydrate formations. The distribution of this resource spans the NPR-A, Greater Prudhoe Bay, and the 1002 Area of ANWR, as shown in Figure 3 (10). Existing methods have been shown to allow extraction of gas from these accumulations, such as depressurization and $CO_2/CH_4$ exchange, which was verified at the Iġnik Sikumi test well from 2008-2012 (8).

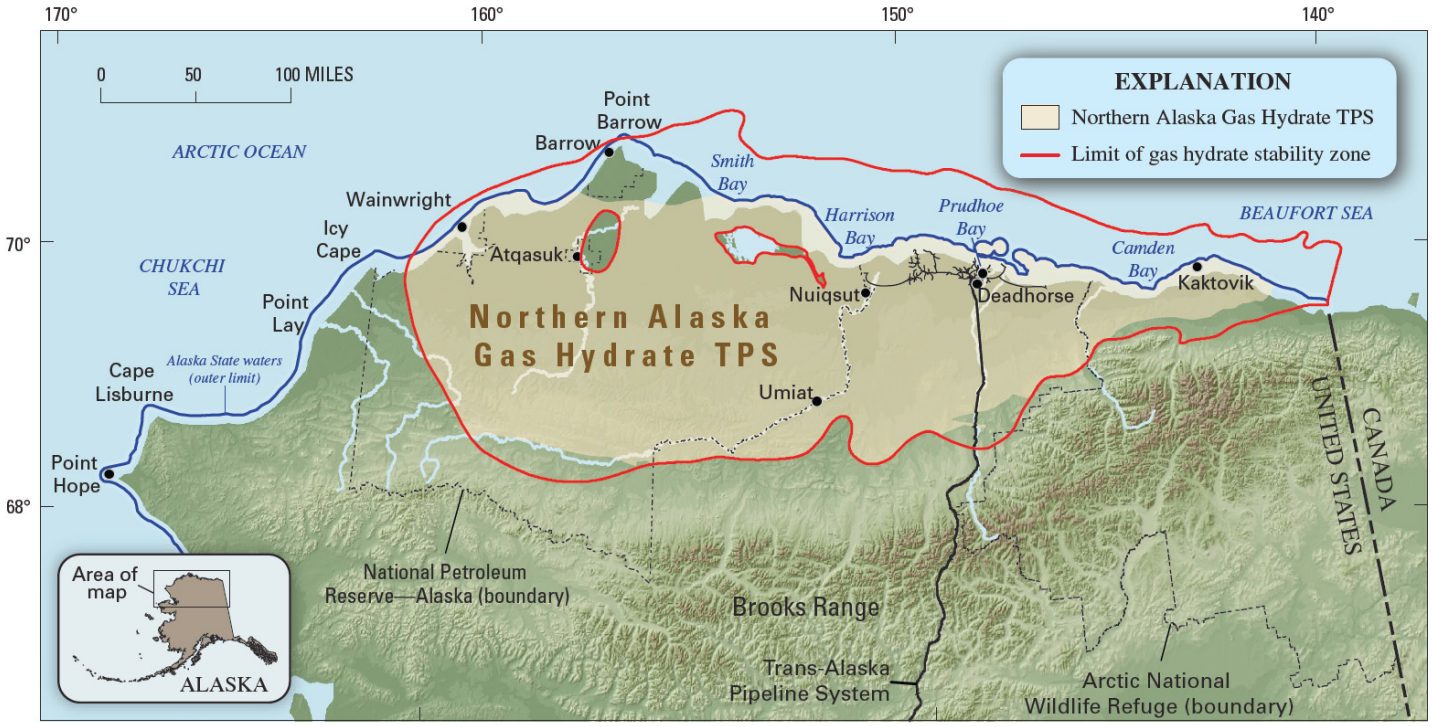


Figure 3. Northern Alaska Gas Hydrate Total Petroleum System (TPS). (10).

Due to the remote location of coal deposits, and lack of road or rail infrastructure to access them, mining of coal has not been an economically-feasible option on the North Slope. Underground coal gasification (UCG) is one alternative method for developing this energy resource without extensive mining operations. The process converts coal to synthetic gas (syngas), which contains methane, hydrogen, and other gases (4). Unless a gas pipeline is constructed to transport the methane collected using these methods, additional processing (such as Gas to Liquids (GTL) generation of synthetic crude) would be necessary in order to transfer the product through the TAPS pipeline.

## Projected Changes & Trends

Recent pilot projects on the North Slope have focused on extending the life of oil fields in the Greater Prudhoe complex, as well as exploring options for methane hydrate extraction. The direction of research and development of technology related to these resources will be driven in part by the expansion of oil exploration in the OCS, as well as the decision about whether to construct a gas pipeline. As production rates continue to decline from mature fields, there will be more pressure to implement new methods of developing heavy and viscous reservoirs, in order to ensure the TAPS system maintains enough volume to remain functional.

## Uncertainties

Many variables factor into the potential applicability of new technologies on the North Slope. While Enhanced Oil Recovery techniques and hydrologic fracturing to recover shale oil and gas are proven in other parts of the world, the extreme conditions on the North Slope may limit their utility. In addition, the prices of oil and gas will affect whether the cost of implementing these technologies on a larger scale will be profitable. Discoveries of new conventional sources in the region may also shift the focus away from alternate techniques of accessing less conventional hydrocarbon deposits.

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## Note about this Fact Sheet

This fact sheet has been produced with the goal of providing a general description of new technology associated with hydrocarbon extraction on Alaska's North Slope, as part of the project: Scenarios for Energy and Resource Development on the North Slope and Adjacent Seas.

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