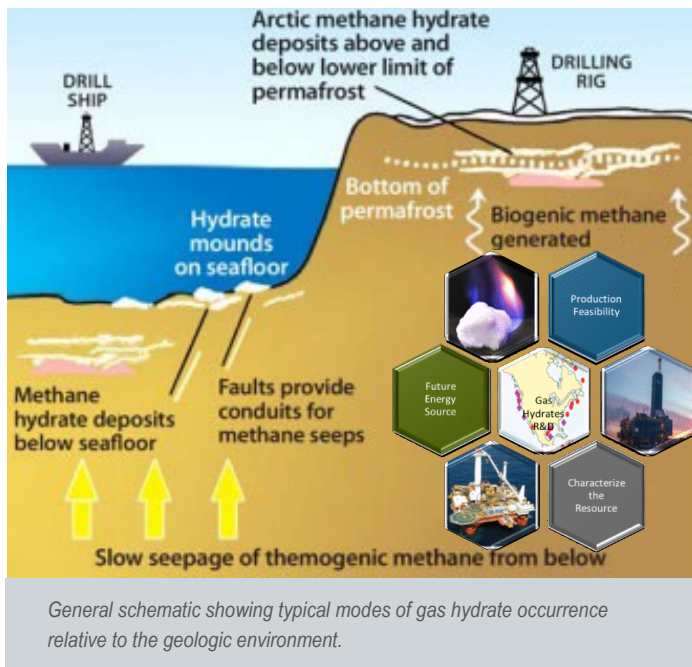




The U.S. Department of Energy Fossil Energy's Gas Hydrates R&D program's mission is to develop commercially viable processes for safely producing gas hydrates, and to advance the potential for gas hydrates as a future energy resource. Continued R&D investments have the potential to mature gas hydrates development in a similar manner to shale and unconventional resources, which benefited from long-lead technological advances over the past 30 years by the U.S. Department of Energy (DOE).

DOE was designated as the lead R&D agency for gas hydrate research by the Methane Hydrate Research and Development Act of 2000 and reauthorized by the Energy Policy Act of 2005.

The goal of the program is to advance scientific understanding of gas hydrates through research and develop the production technology needed to assess the commercial viability of the potentially enormous naturally-occurring gas hydrates resources within the U.S. and internationally.



## Program Components & Successes

In developing gas hydrate resources, DOE's key challenges include: assessing the location and amount of the hydrates resource; the commercial viability; and advancing the potential for gas hydrates as a future energy resource. The program also works to confirm the scale and nature of the potentially recoverable resource through complex drilling and coring programs and to develop the technologies needed to safely and efficiently find, characterize, and recover methane from hydrates through field testing, numerical simulation, and laboratory experimentation.

Early challenges associated with evaluating the production of methane from hydrate included confirming the existence and occurrence of quality reservoirs, demonstrating the ability to reliably locate such occurrences, and developing the techniques/technologies required to enable gas production. These challenges are being addressed through DOE and internationally supported research efforts. Ongoing research is needed to fully understand the potential for, and implications of, gas production from hydrate.

Commercial or sustained gas production from gas hydrates has yet to be achieved, albeit a limited number of production tests have been conducted to date. A series of controlled scientific field experiments, followed by extended duration production tests are needed to quantify the rates and volumes at which methane can be extracted and to further assess any potential environmental impacts.

The Gas Hydrates R&D program activities focus on early-stage research, which include the following:

## Gas Hydrates Quick Facts

Gas hydrates consist of molecules of natural gas (most commonly methane) enclosed within a solid lattice of water molecules (ice). When brought to the earth's surface, one cubic foot of gas hydrate can release 164 cubic feet of natural gas. Gas hydrate deposits are found wherever methane occurs in the presence of water under elevated pressures and at relatively low temperatures, such as beneath permafrost or in shallow sediments along deep-water continental margins.

Once thought to be rare, gas hydrates are now thought to occur in vast volumes and with global resource estimates from 250,000 to 700,000 trillion cubic feet (Tcf) of natural gas compared to 2,829 Tcf of technically recoverable resources of dry natural gas in the U.S. (EIA AEO 2020).

- **Tool Development and Experimental Work:** DOE oversees development of new tools to aid in sampling and analyzing methane hydrate properties including: instruments for measuring physical properties of gas hydrate-bearing sediment samples in the field; pressure coring devices for sample collection, retrieval, and transport at controlled pressures; and pressure core characterization tools for analyzing acoustic, geo-mechanical, and hydrological properties of samples in a laboratory setting.
- **Modeling and Analysis:** Work includes an expansion of numerical modeling capabilities to enable the first simulations of field-scale production of gas from hydrates and simulations for predicting geo-mechanical stability of hydrate-bearing sediment and hydrate-bearing reservoirs.
- **Fundamental Property Characterization of Hydrate-Bearing Sediments:** Work consists of experimental characterization focused on estimating geo-mechanical and relative permeability of hydrate reservoirs, which are critical numerical simulation inputs for accurately simulating real-world conditions. In 2019, the program team developed a technique to form hydrates in laboratory-fabricated sediments to obtain analogue sediments similar to hydrate pores found in nature.
- **Alaska Field Testing:** DOE will conduct a long-term reservoir response experiment of gas hydrate recovery on the North Slope of Alaska. In December 2018, in partnership with Japan, U.S. Geological Survey (USGS), Petrotechnical Resources of Alaska (PRA) and BP Alaska, and DOE successfully drilled the first project well in the Prudhoe Bay Oil field, the Stratigraphic Well Test (STW). The STW confirmed the occurrence of gas hydrates in two zones that are suitable for future testing. The success of this test well moves the program closer to characterizing, evaluating and confirming the potential for gas hydrates production in the U.S. The next phase is a long-term reservoir response experiment utilizing a depressurization production technology. This effort is a critical next step in advancing production knowledge to where industry can further develop this resource and assess the potential to produce the gas hydrates resource in similar settings throughout the U.S.
- **Gulf of Mexico (GOM) Resource Characterization:** In partnership with UT-Austin, DOE will conduct field research in the GOM to determine the nature of marine hydrate reservoirs through pressure-core sampling and new site exploration. In May 2017, UT-Austin completed a first expedition and successfully acquired core samples under in-situ pressure. Lab studies of those samples are informing further evaluation of the geologic systems that generate high-concentration gas hydrate deposits and their response to gas production. UT-Austin is planning a second expedition to evaluate a range of reservoir settings by pressure-coring and geophysical logging of additional hydrate reservoirs.

## Program Strategy

The Gas Hydrates program, through early stage R&D efforts will continue to evaluate the occurrence, nature, and behavior of naturally occurring gas hydrates. The program's major efforts will continue to focus on:

- Actively pursuing a long-term reservoir response experiment on the Alaska North Slope to evaluate the potential for economic recovery in partnership with Japan, private industry, USGS, and the Alaska Department of Natural Resources.
- Accurately characterize marine hydrate sediments in the Gulf of Mexico.
- An initial evaluation of potential gas hydrate occurrences along the Atlantic margin.
- Continuing ongoing collaborations through the Memorandum of Understanding with Alaska's Department of Natural Resources, Japan, South Korea, and India, which are a vital part of DOE's Gas Hydrate R&D program.
- Seek out opportunities to collaborate with international programs and partners.

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