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Thank you, Mr. Chairman and Members of the Subcommittee. I appreciate this opportunity to provide testimony on the status of the United States Department of Energy's (DOE's) research efforts in naturally-occurring gas hydrates.

INTRODUCTION

Since 2000, DOE, through the Office of Fossil Energy's National Energy Technology Laboratory (NETL), has led the national research program in gas hydrates. The program is conducted through partnerships with private institutions and universities, and supported using the unique capabilities of DOE's National Laboratories.

Program planning and implementation is also greatly aided by the expertise of scientists from the Department of the Interior's U.S. Geological Survey (USGS), Minerals Management Service (MMS) and Bureau of Land Management (BLM), the U.S. Naval Research Laboratory (NRL), the National Science Foundation (NSF), and the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA).

Scientific program oversight is conducted through regular external merit reviews, which include a Federal Advisory Committee comprising leaders from industry and academia, and periodic reviews by the National Research Council. DOE also has active, ongoing collaborations with many of the world's leading gas hydrate programs in Japan, Korea, Canada, and India.

The program is driven by the recognition that gas hydrates represent a significant global storehouse of methane – a fact with far-reaching implications for the environment and for the Nation's (and the world's) future energy supplies. DOE is now conducting and supporting a comprehensive suite of field and modeling studies of gas hydrates' link to climate and carbon cycling, greatly elucidating the role gas hydrates may play during changing climates.

Regarding gas hydrates as an energy source, notable recent successes within the program's primary field efforts have confirmed significant accumulations of the most promising gas hydrate resource targets. We have and continue to prepare for the next stage of gas hydrate research and development (R&D) that will include extended testing of alternative production methods, as well as comprehensive resource confirmation and sample collection. While much work remains to be done, results, to date, are consistently encouraging, and the program remains on pace to accomplish its resource and environmental goals.

BACKGROUND

Through the past 50 years, the Nation's available supply of natural gas has steadily expanded to meet growing demands. Key to this expansion is periodic advances in knowledge and technology that enable new and increasingly remote and challenging resources to be commercially developed.

Over the past half-century, technology has provided the ability to safely and efficiently extract natural gas from previously unobtainable resources, including ultra-deep formations, and those "unconventional" formations that do not readily release natural gas, including tight gas formations, coal-bed methane, and shale gas reservoirs. Federally-funded R&D has been a critical part in enabling many of these successes to benefit the Nation. The next resource element poised to be added to this list is gas hydrates, which may be considered a frontier resource.

Gas hydrates form wherever appropriately-sized molecules of gas (most commonly, methane) and water occur together under specific conditions of low temperature and high pressure. These conditions exist on land in areas of permafrost, and within the shallow sediments of continental margins where water depth exceeds roughly 500 meters.

Until the early 1970s, gas hydrates were not confirmed to exist in the natural environment; however, by the late 1990s, a general consensus had emerged that gas hydrates occurred in vast quantities, perhaps housing more organic carbon than all of the world's coal, oil, and natural gas deposits combined. The total resource estimates are astronomical: the most commonly-cited estimate for the global abundance of methane stored in gas hydrate form is 700,000 trillion cubic feet. However, these volumes are poorly constrained by geologic formations.

Recent estimates continue to range over nearly two orders of magnitude, pointing out the immensity of the problem in assessing gas hydrate resources, and the limited data available on the occurrence and fundamental controls on gas hydrates in nature. The implications of the vast scale of gas hydrates in nature, for our understanding of carbon cycling and climate change, are critically important and are the subject of extensive ongoing studies. However, the primary driver for the rapidly accelerating international investment in gas hydrates research is the emerging potential of gas hydrates as an energy resource.

A RECENT PARADIGM SHIFT

A key development in gas hydrates research in recent years is the realization, based on the findings of a series of recent scientific drilling programs around the world, that all gas hydrates accumulations are not created equal. Gas hydrates accumulations range from large, diffuse accumulations in clay sediments, to smaller, discrete, high-concentration accumulations in sand reservoirs. Gas hydrates occur both on the sea-floor as solid massive mounds, as well as buried several thousands of feet below the sea-floor. When considering gas hydrate potential as an energy supply, we now recognize that those deeply-buried deposits housed within coarse-grained (sand) sediments are the most favorable. It is significant as well that these are the deposits that are most highly-buffered from environmental change.

What makes sand reservoirs attractive is their permeability – a measure of the ease with which fluids can move through the sediment. On the one hand, this permeability appears to be critical in enabling gas hydrates to accumulate to very high concentrations, typically 60 percent to 90 percent of the pore space. In addition, reservoir permeability may be the key to enabling methane production from gas hydrate reservoirs using, to a large extent, existing drilling and completion technologies. Numerical simulations conducted in both the United States and Japan have shown that conventional wellbores penetrating sand reservoirs can be used effectively to: 1) impart changes in reservoir conditions that dissociate the gas hydrates in place; and 2) then gather the released methane at rates that make commercial production a possibility. As a result, substantial resources may be available using largely existing drilling and production technologies. More exotic or potentially intrusive approaches, such as deep sea mining or dredging, are not under consideration.

This refined focus is now enabling more targeted technological development, and more sophisticated and relevant assessments of gas hydrate resources. Recently, the USGS, building on several decades of their own efforts, and integrated with DOE-sponsored field data collection and numerical simulation studies, reported a mean estimate of 85 trillion cubic feet (tcf) of technically-recoverable gas resources in hydrate-bearing sands underlying the Alaska North Slope (ANS). In the marine environment, MMS also reported last year that of more than 20,000 tcf of gas in-place in gas hydrate deposits in the Gulf of Mexico, more than 6,700 tcf is contained at high concentrations in sand reservoirs. These estimates, while less than the volumes that had previously framed gas hydrate potential, are far more meaningful, and indicate that significant potential resources of domestic natural gas from hydrates occurs within areas of existing oil and gas production infrastructure. Assessments of resources in other regions of the United States, including Atlantic and Pacific offshore areas, is also underway within the Department of the Interior, but supporting data are notably absent at this time.

STATUS OF THE EFFORT: RECENT ADVANCES AND REMAINING CHALLENGES

DOE’s stated goals in gas hydrates research are to provide the knowledge and technology to enable environmentally-sound and commercially-viable production of gas from gas hydrates by 2015 (for arctic resources) and 2020 (for resources in the Gulf of Mexico). We remain firmly on track to accomplish these goals. Prior research within the program has established a strong foundation of fundamental science and experimental modeling capabilities. Completing this will require a continuation of these efforts, as well as a strong commitment to conducting extensive field operations in both arctic and deep-water marine settings.

Key to fulfilling the promise of gas hydrates as a resource is the ability to confirm resource volumes, and effectively explore for the most favorable deposits. In Alaska, efforts by the

USGS, in collaboration with the cooperative research program between DOE and BP Exploration Alaska (BPXA), resulted in the recognition of more than a dozen discrete and potentially drillable accumulations within a small area of the greater Prudhoe Bay region, using existing geophysical and geologic data. A logging, coring, and testing program, conducted at the BPXA-DOE-USGS "Mount Elbert" test well in February of 2007, validated these predictions, provided insight into the planning for future production testing, confirmed the ability to safely conduct scientific data acquisition within an operating oil field with minimal impact to operations, and increased the confidence in the broader assessment of gas hydrate resources throughout the ANS.

More recently, a concerted effort within the interagency technical coordination team, enabled by the DOE-sponsored gas hydrates Joint Industry Project (JIP), resulted in the development of a series of gas hydrate-bearing sand prospects in the deepwater Gulf of Mexico. A three-week drilling program conducted by the JIP in the spring of 2009 similarly validated this prospect development, finding highly-concentrated gas hydrates in reservoir-quality sands, as predicted, in 4 of 7 wells drilled. Future work in the Gulf of Mexico includes dedicated coring programs, utilizing specialized devices in development by the JIP, to collect samples of these reservoirs for further detailed studies.

The potential to safely and efficiently produce gas from hydrate reservoirs is also clarifying. For example, results from an independent 2002 test, led by Japan and Canada, determined that the depressurization method (withdrawal of fluids from the well-bore and the formation, reducing pressures below the stability point of gas hydrates) was likely the most effective means to produce gas from gas-hydrate bearing sands. This finding is in agreement with analyses conducted using data obtained at the "Mount Elbert" test well in 2007. Further depressurization tests at Mallik in 2008 and 2009 confirmed relatively high volume, sustainable flow rates over a six-day testing period.

These tests, combined with findings from laboratory studies, have enabled increasingly sophisticated numerical simulations to be conducted, which indicate that commercially viable production rates are possible in certain settings. However, it remains a challenge to predict the long-term behavior of any reservoir, particularly a non-conventional one, based on short-duration tests. Longer-term (up to a year or more) production tests are needed to understand the true deliverability of gas hydrate reservoirs. At present, the only locations where such tests can be feasibly conducted are the known gas hydrate accumulations within the Prudhoe Bay region on the ANS. DOE is currently coordinating with ANS operators on the complex problem of developing such a test within an area of established production.

An additional promising opportunity that has recently emerged is the potential to inject CO_2 into gas hydrate reservoirs, leading to the release of the methane and the sequestration of the CO_2 within hydrate form. DOE has recently established a research agreement with ConocoPhillips to conduct a field trial of this concept on the ANS, building on prior and encouraging laboratory and modeling findings by a ConocoPhillips-University of Bergen (Norway) research team. If successful, this project could provide a sound option for the disposition of CO_2 that comprises a portion of existing conventional gas resources on the ANS.

Ultimate acceptance of gas hydrates as a new energy supply option will also require demonstration of a full understanding of the role gas hydrates play in the natural environment. To that end, DOE is supporting a range of studies to document the processes that impact the stability of gas hydrates, their response to environmental changes, the flow of methane in sediments, and the ability of released methane to traverse the sea-floor and the water column. In addition, we recognize the need to monitor methane movement and geomechanical changes in reservoirs during field tests.

SUMMARY

Research results over the past decade, including drilling and coring programs, experimental studies, and numerical simulations are clarifying the resource potential of gas hydrates. In particular, application of the concepts that guide the assessment and exploration of traditional hydrocarbon resources are now enabling researchers to focus on the most promising gas hydrate occurrences – those reservoired in sandstone formations – yielding a series of encouraging research findings in both arctic and marine settings.

The DOE-led program in gas hydrates R&D is working to integrate and leverage efforts throughout the United States and internationally to enable gas hydrates to become a viable option for meeting future energy demands. The approach is to integrate three distinct lines of research.

- First, utilize the known gas hydrate accumulations on the ANS as a natural laboratory to study issues related to gas hydrate production. Based on the success of the 2007 "Mount Elbert" field program, DOE and its industry partners in Alaska are now poised to conduct a range of scientific production tests using different approaches.

- Second, conduct additional drilling and data collection expeditions in the Gulf of Mexico to confirm resource occurrence, refine exploration technologies, and identify sites for future production testing. That testing will build on the most promising approaches identified in the arctic testing program. With the successful completion of the spring 2009 JIP drilling and logging expedition, this effort is fully on track.

- Third, demonstrate an understanding of gas hydrate's role in nature and the potential environmental implications of gas hydrate production. To that end, DOE is supporting a broad range of studies to determine the links between gas hydrates, the oceans and the atmosphere, and is committed to ensuring full monitoring of all field testing programs

Despite all the progress of the past several years, there is still much to learn about the details of gas hydrate occurrence and behavior in nature. The research being conducted is wide-ranging, complex, and multi-disciplinary. The current effort is designed to simultaneously advance fundamental scientific understanding of gas hydrates, characterize marine resources, and explore gas hydrate production potential through Arctic field tests.

The Department looks forward to the challenge of completing these strategic activities that, in concert, support a potential global paradigm shift in energy supply.

Mr. Chairman, Members of the Subcommittee, I would be happy to take any questions you may have.