

**Near Term Energy Potential Realization of
Domestic Methane Hydrate Deposits: The
Need for Funding and Industry Participation**

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August 3, 2006

*Sponsored by
The American Institute of Chemical Engineers*

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Near Term Energy Potential Realization of Domestic Methane Hydrate Deposits: The Need for Increased Funding and Industry Participation

Executive Summary:

Energy security is a serious concern as US natural gas imports are estimated to increase 32% by the year 2030.¹ In the United States natural gas is an essential fuel for electricity generation, home heating, and as a feedstock for producing household and industrial products from fertilizers to paints. The US is sitting on a tremendous untapped resource that could go a long way to solving the problem of a limited natural gas supply: methane hydrate. Before methane hydrate can be commercially produced in the US, many questions must be answered. Specifically, the US must be able to answer the question, "**Can methane hydrates be technically and economically produced in the US?**"

The roadblocks that Congress must address, before the energy potential and production questions can be answered, are not scientific issues. The two managerial roadblocks are the broad research goals of the government program and the funding irregularity and deficiency that both decrease industry involvement. As time progresses, even more research goals are added to the scope of the Methane Hydrate Research Program. With the same amount of funds to cover more research ground, progress slows. These barriers hold back the potential US production date.

Though the 2006 Interagency Research Roadmap, created by the Methane Hydrate Technical Coordination Team, reflects the emphasis of the *2000 Methane Hydrate Research and Development Act* to determine the energy supply potential of methane hydrates, it is helpless, since such an action is illegal, to directly suggest to Congress the funding level required to complete such a program. The publication of the roadmap is a step to overcome the barriers, but Congress must support this newfound focus for the program to be successful. Because of the great benefits related to energy security, the environment, and the economy, that may be realized through the commercialization of methane hydrate production Congress should support the formation of industry-government partnerships, the development of methane hydrate related technologies, and the assessment of domestic methane hydrate deposits by the following actions:

¹ Energy Information Association, Annual Energy Outlook, 2005.

1. **Funding Magnitude:** Congress must appropriate funds to the Methane Hydrate Research Program that are at least equal to the value authorized by the Energy Policy Act of 2005.

2. **Funding Consistency:** Multiple year appropriations are politically unfeasible. Therefore should use an advanced appropriation process to fund the Methane Hydrate Research Program. This would allow research programs to more accurately plan future research and still allow Congress to maintain power through annual appropriations.

3. **Research Focus:** Congress must amend Section 928 of the 2005 Energy Policy Act to include an initiative to authorize funds to be directly allocated to a the USGS, the BLM, and the MMS for assessment of domestic methane hydrate reserves.

This targeted, long-term funding lends industry confidence in government support of methane hydrate research to build strong government-industry partnerships. It also supports organizations that have made considerable effort to integrate the values of both government and industry to efficiently and quickly address the question of domestic hydrate energy resource and production viability.

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The Goal

“The overriding focus of the DOE Methane Hydrate R&D Program in the future should be on the potential importance of hydrate as a future energy resource for the nation and the world...”

At this time, commercial interest in drilling and production of methane hydrate is low. Therefore, the DOE Methane Hydrate R&D Program’s continued support of research is a key component of evaluating the nation’s ability to produce energy from gas hydrate in the future.”

*- National Research Council
“Charting the Future of Methane Hydrate Research”*

1.0 Introduction

To realize the energy potential of domestic methane hydrate deposits, the government must encourage focused research goals pertaining to domestic methane hydrate technology development, assessment, and production.

Energy security is a serious concern as US natural gas imports are estimated to increase 32% by the year 2030.¹ In the United States natural gas is an essential fuel for electricity generation, home heating, and as a feedstock for producing household and industrial products from fertilizers to paints. The US, however, is sitting on a tremendous untapped resource that could go a long way to solving the problem of a limited natural gas supply: methane hydrate. Before methane hydrate can be commercially produced in the US, many questions must be answered. Specifically, the US must be able to answer the question, **“Can methane hydrate be technically and economically produced in the US?”**

A focus on energy potential evaluation and an increase in funding and industry participation are needed to answer the question of energy resource and production viability in a reasonable timeframe. To answer this question, government must support the completion of the following steps:

1. Overcome technical issues associated with methane hydrate detection, characterization, and production, and
2. Rigorously assess (map) domestic methane hydrate deposits in permafrost and marine environments.

The barriers to completion of these steps include:

1. Broad government program research goals, and

2. Lack of appropriate funding – the wrong amount at the wrong time.

Solutions to both problems may be the same. For example, increased appropriations to specific agencies can both increase support of research and focus goals. This paper formulates policy recommendations to help government agencies answer the question of sufficient energy supply potential and feasible production of domestic methane hydrate. The steps in formulating these recommendations are:

1. Provide a background understanding of why domestic methane hydrate research and assessment is important and needed for US energy security, the environment, and the economy (Sections 1-2)
2. Identify program needs to answer viability and production questions through a summary of current research and legislation. (Section 3)
3. Identify potential solutions based on the structure, funding, and organization of other oil and gas research programs. (Section 4)
4. Make policy recommendations based on industry and government agency input, and the success and failure of past policy to increase funding for focused research goals and so that industry partners may be enticed to form joint methane hydrate research projects with the U.S. government (Section 5)

Though international partnerships will be essential in the development of methane hydrate technology and fields, the development of these partnerships deemphasized as industry partnerships are the focus of this paper.

2.0 Methane Hydrate Background

Methane liberated from methane hydrate may be used for any application that normally uses natural gas obtained from a traditional reservoir.

Methane hydrate, a crystal of which is shown in Figure 1, are solid crystalline structures that resemble ice, but burn when exposed to atmospheric temperatures and pressures.

Methane hydrates are found buried in two types of regions: in permafrost and in the costal deep-water seabed. For example, methane hydrates have been found at Blake Ridge, in the Gulf of Mexico, in the North American Artic Regions, the Nankai Trough, and the Cascadia Margin.² These are ideal locations for methane hydrates to form because they are formed at conditions of low temperature and high pressures when methane, which is normally produced by the decomposition of organic matter, seeps through the ground and is trapped by water as it freezes into ice in the sediment. These conditions can be found in

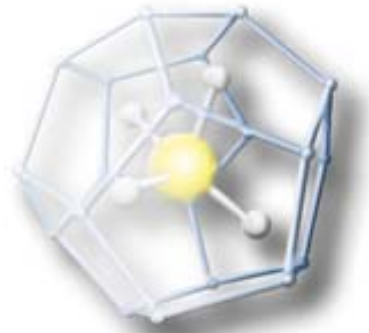


Figure 1: Methane hydrates are also known as clathrates. Clathrates are a family of substances whose molecular structure resembles cages. In the case of methane hydrate, frozen water molecules form cages around methane molecules

sediment, like sand stone, shale, and sand, on ocean floors, and in arctic permafrost.³ The type of sediment in which the hydrate is trapped and how the hydrate is dispersed throughout the sediment are two key factors that determine the ease and the economics of the hydrate production.

Hydrates, in general, were first discovered in the early 1800s when scientists were performing laboratory experiments with chlorine-water mixtures.



In the 1930s methane hydrates were observed in oil and gas transmission lines where they clogged the lines and were considered a nuisance. They were not considered to be an energy source until the 1960's when methane hydrates were observed in operating Siberian gas reserves.⁴ Methane has conventionally been delivered as a gas via long transmission pipelines. Basic equipment for drilling and producing methane

hydrates does exist.⁵ Currently, there are three methods to liberate methane gas from methane hydrate: depressurization, heating, or using a solvent like methanol. Depressurization seems to be the most viable because it does not involve chemicals that may be environmentally harmful. This liberated methane gas can then be either put into existing natural gas pipelines or converted to a liquid if infrastructure does not exist near the wellhead. The Syntroleum Corporation is one company that has already has a patent (US Patent 5,950,732) to recover methane hydrates from the ocean floor.⁶ Commercial production will most likely begin in the Alaska North Slope (ANS) and the Gulf of Mexico (GOM) since transmission and drilling infrastructure exists. Though the transportation system exists, that says nothing about the spare capacity in that infrastructure.

3.0 The Importance of Methane Hydrates

The US must have energy resources that have secure supply volumes and prices because energy is essential to daily lives and is a driving force behind the US economy. As both US natural gas supplies dwindle to record lows and prices soar at record highs, the U.S. government has to respond with legislation that alleviates the costs to both residential and industrial consumers. Energy security, therefore, has become a significant issue as US natural gas imports rise to attempt to keep pace with US demand. Policy to encourage energy security attempts to mitigate the risk of being dependent on fuel sources from remote and unstable regions of the world. Since significant deposits are located domestically, funding of research and development for methane hydrates has the potential give the US additional needed energy independence.

3.1 Energy Potential

If commercially produced, methane hydrates may increase energy security because of the volume and location of methane hydrate deposits. The volume of domestic methane hydrate is about 20,000 times larger than that of conventional gas reserves in the US. This statistic, however, is misleading because, unlike the estimation of the conventional natural gas reserve, it does not factor in how much of the methane hydrate deposit is technically recoverable. This is an example of why making an accurate assessment of the domestic methane hydrate deposits is important. Domestic methane hydrate reserves have a mean estimated value of 320,222 trillion cubic feet and be located under existing drilling and transportation infrastructure⁷ in on- and off- shore in Alaska, Washington, Oregon, California, New Jersey, North Carolina, South

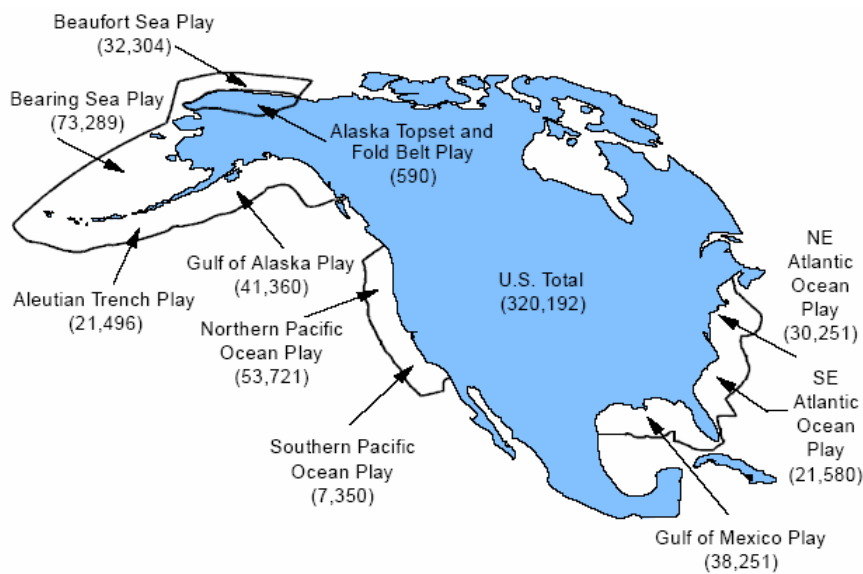


Figure 2: USGS Assessment of methane hydrate plays and provinces, 1995. Volumes: T.S. Collett, Gas Hydrate Resources of the United States, Table 2. Map: U.S. Geological Survey, Digital Map Data, Text.

Carolina (the Outer Continental Shelf (OCS)), and in the Gulf of Mexico (GOM), as shown in Figure 3.⁸ Before hydrate will be produced, however, an accurate economic and geologic assessment is necessary. This requires advanced technologies specialized for methane hydrate detection/production. The Energy Information Administration (EIA), in their Annual Energy Outlook Report, predict a positive correlation between increased investment in technology development and increased domestic production. Figure 3 shows this correlation. If technology was developed and appropriate deposits were located so that only 1% of the domestic gas hydrate reserves could be technically and economically produced, the US natural gas reserves would more than double. This large volume of natural gas would not only increase supply, it would increase a reliable

supply of a fuel, cleaner than the dominant domestic fuel source², and therefore increase our energy independence.

Maintaining hope that methane hydrate may be a viable source of energy for the US is not pie in the sky optimism for two reasons. First, other non-conventional sources of natural gas have become economically viable. For example, coalbed

methane (CBM), a relatively unheard of source about 20 years ago, now makes up about 10% of domestic

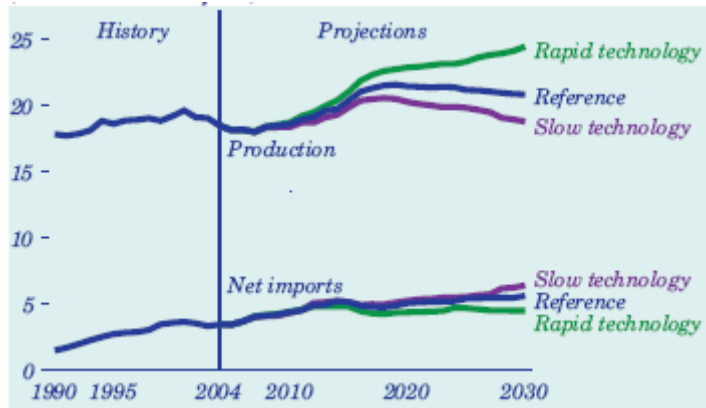


Figure 4: Higher technology investment and development rates have the potential to increase domestic production and decrease the amount of imports, thus, investing in new technologies for natural gas production will increase the Nation's energy security.

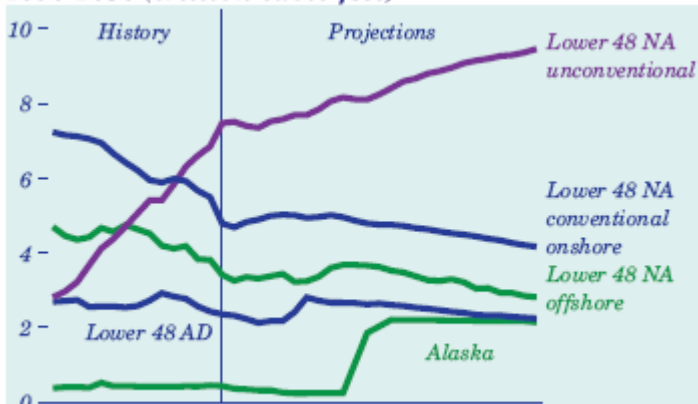


Figure 3: Domestic natural gas production by source in trillion cubic feet. As shown by the graph, unconventional sources are the largest source of US gas supply.

increase by about 4 trillion cubic feet by 2030. Past experience and future government projections indicate that there is a high potential for success, but the barriers to methane hydrate energy potential realization may remain too strong for goals to be realized if appropriate support and legislative action are not enacted by Congress and other advisory committees.

production. CBM research began in the DOE and was originally funded by the government. As the technology developed and demonstration projects were performed, industry became more involved and took over the project. Second, not only are non-conventional sources economical and significant, but the EIA predicts that natural gas from non-conventional sources will

² Natural gas emits half of the CO₂ and a third of the NO₂ when burned as coal does.

3.2 Environmental Impact

Energy independence is not the only potential benefit received through methane hydrate production. Natural gas is also an environmentally better alternative for industrial processes where the fuel is burned, like in electricity generation, than other fuel sources like coal and oil. Figure 6 shows the diversity of fuel sources used for electricity generation in the US. There are currently about 1,400 gas fired power plants in the US which account for about 19% of the electricity produced in the US.⁹ Natural gas also burns much cleaner than coal. Natural gas produces about half the amount of CO₂ as coal and about less than a third of nitrogen oxides.¹⁰

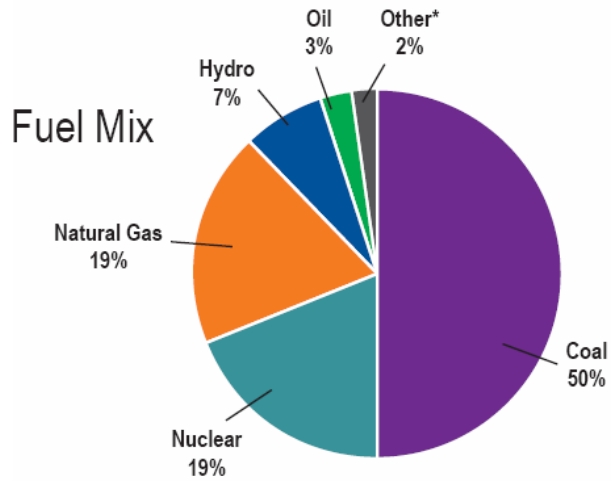


Figure 5: Fuel Sources for US electricity generation from the Edison Electric Institute. Primary data from the EIA.

As natural gas prices rise,

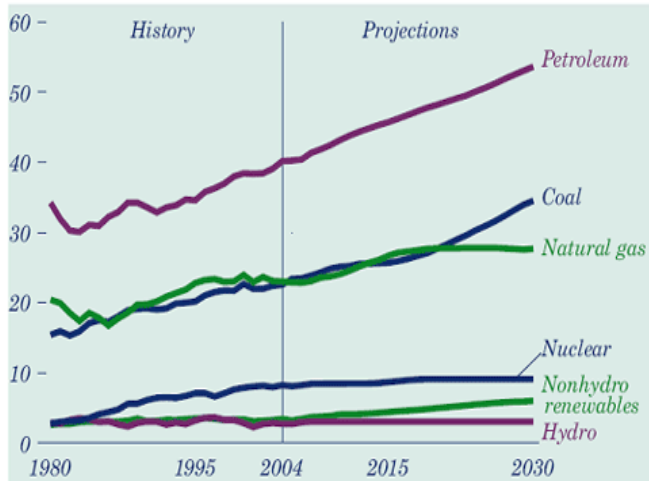


Figure 6: US energy consumption history and projections for various fuels in quadrillions of Btus. http://www.eia.doe.gov/oiaf/aeo/figure_3.html, Annual Energy Outlook 2006 with Projections to 2030 (Early Release) – Overview

natural gas demand will slow. To meet energy demands, natural gas must be imported or other fuel sources, less clean fuels sources must be utilized. If methane hydrates are developed, this energy demand could be met via a more environmentally friendly fuel. Figure 8 shows projected consumption through the year 2030. As mentioned before, natural gas demand will stall around 2017 and less clean fuels like oil and coal will increase dramatically. Unless new technology is used to

decrease emissions, more CO₂ and NO_x will be released into the atmosphere.

The Problem

4.0 U.S. Policy, Funding, Political Support, and Research

The progress of a research program is often a function of the amount of support, in dollars and advocacy, which it receives. Japan and India have very aggressive methane hydrate production schedules. One aspect of an accelerated schedule is the close coupling of government and industry to aggressively pursue fieldwork. Japan began research in 1995 and had a \$65M budget for 2004.¹¹ The US government faces limitations because of funding, the separation of industry and government, and thus finds ways different than other countries to encourage R&D cooperation and progress. The US government also provides funding but on a much smaller scale. All of these funding and organization decisions are made through legislation. Groups that may encourage legislation to support the program's goal realization are Congress, the Methane Hydrate Advisory and other oversight committees, government agencies, independent organizations such as review committees and professional societies, and the public. The historical and current influence of these bodies is presented in the following section. The amount of support each group offers is evaluated based on the funding they provide, the legislation they write, the official recommendations and the official organization position statements they issue, and/or the research they conduct.

4.1 Congressional Legislation

There are three major pieces of methane hydrate legislation: pre-2000 legislation, the *Methane Hydrate Research and Development (MHR&D) Act of 2000*, and the *2005 Energy Policy Act (EPACT)*. Methane hydrates were originally considered a bother in conventional oil and gas production because they would plug transmission lines and pose a threat to production safety. From 1982 to 1992 the DOE began its first national methane hydrate research program in conjunction with the USGS and other international bodies. Over this period, the DOE spent only \$8M on research to establish a base of methane hydrate knowledge and to validate the existence of methane hydrate deposits under the Alaska North Slope (ANS). The DOE program was then suspended, though USGS and international work continued. In contrast to domestic results, international exploration, specifically the Mallik well in the McKenzie River Delta in Canada and a well off the southeast coast of Japan in the Nankai Trough, found regions of highly concentrated methane hydrates (a desirable trait for production). These results showed the need for more US exploration and the significance of the limited US research done, and in response, a report by the President's Council of Advisors for Science and Technology (PCAST, 1997) strongly recommended renewed and significant funding for hydrate R&D.¹² After that, the DOE published, "A Strategy for Methane Hydrates Research and

Development” in 1998 and “The National Methane Hydrate Multi-Year R&D Program Plan”, in 1999. All of this preparation was done in order to prepare Congress and government agencies for the Methane Hydrate Research and Development (MHR&D) Act of 2000.

The MHR&D Act, which was introduced in 1999 and became Public Law No: 106-193 in 2000, authorized funds to be given to the Secretary of Energy, working through the Director of the Office of Fossil Energy, to award research

Text Box 1: MHR&D Act of 2000 Goals

(Bullets in italics are research goals the NRC reported the DOE invested well and made significant progress in.)

- A. *conduct basic and applied research to identify, explore, assess, and develop methane hydrate as a commercially viable source of energy;*
- B. *identify methane hydrate resources through remote sensing;*
- C. acquire and reprocess seismic data suitable for characterizing methane hydrate accumulations;
- D. assist in developing technologies required for efficient and environmentally sound development of methane hydrate resources;
- E. promote education and training in methane hydrate resource research and resource development through fellowships or other means for graduate education and training;
- F. *conduct basic and applied research to assess and mitigate the environmental impact of hydrate degassing (including both natural degassing and degassing associated with commercial development);*
- G. *develop technologies to reduce the risks of drilling through methane hydrates; and*
- H. conduct exploratory drilling, well testing, and production testing operations on permafrost and non-permafrost gas hydrates in support of the activities authorized by this paragraph, including drilling of one or more full-scale production test wells.

grants to higher education institutions and industry for methane hydrate related research via a merit-based application to achieve the goals stated in the act.¹³

Authorizations were set at \$5M for FY2001, \$7.5M for FY2002, \$11M for FY2003, \$12M for FY2004, and \$12M for FY 2005. The final appropriated value of these funds was available until expended.¹⁴ The goals of this program are written in Text Box 1.¹⁵ In addition to achieving the specific program goals, the Secretary of Energy is required to oversee the cooperation between the government agencies, industry, and academia, and to work in conjunction with individuals appointed by the Secretary of Commerce, the Secretary of Defense, the Secretary of the

Interior, and the Director of the National Science Foundation. To hold the partners responsible, the Secretary of Energy was also required to report to Congress on research priorities and progress, specifically citing the effect of methane hydrates role in climate change. The National Research Council was required to report to Congress on the progress of the research program and to make recommendations for the program.

Section 968 of the *2005 Energy Policy Act* renewed the *2000 MHR&D Act* to continue funding until 2010, since funds were not authorized past 2005. The act also provided royalty relief for industry to produce methane from methane hydrate and its associated conventional natural gas reserves. ‘Section 7 of this Act authorized the following funds for the programs: \$15M for FY2006, \$20M for FY2007, \$30M for FY2008, \$40M for FY2009, and \$50M for FY 2010. Again,

these funds, whatever the final appropriated value may be, will be available until expended.

Also in the 2005 EPACT, Section 353, the Gas Hydrate Production Incentive, was included to encourage industrial methane hydrate development in both Alaska and on the Outer Continental Shelf (OCS). It gave permission to the Secretary of Energy to provide royalty relief of up to 30 billion cubic feet of natural gas per eligible lease for natural gas that is producing natural gas from methane hydrates prior to January 1, 2018 in Alaska or the OCS. Senator Lamar Alexander (R-Tenn), who introduced this legislation in its original form, as part of the *Natural Gas Price Reduction Act of 2005*, which was later folded into *The 2005 EPACT* as stated previously, to the Senate stated, "This is not a question of tweaking our natural gas policy. It is time to aggressively revamp it. We need aggressive conservation, aggressive use of alternative fuels, aggressive research and development, aggressive production, and for the time being, aggressive imports of liquefied natural gas." Methane hydrate research had a significant role in this legislation since, as stated by Alexander, "[methane hydrates] hold tremendous potential to provide abundant supplies of natural gas." The co-sponsors of this legislation included Senator Tim Johnson of South Dakota and Rick Santorum of Pennsylvania. Some other supporters of this legislation included James Ray, VP and GM of Eastman Chemical Company's Texas Division, Robert Hardie, plant manager of DuPont's New Johnsonville Tennessee plant, and Henson Moore, president of the American Forest and Paper Association.¹⁶

The current DOE research program was zeroed by the President's budget for the FY2007 (as it was in FY 2006), but funding may be restored by Congress, as the House appropriated \$12M for the program.¹⁷ The \$12M in funding may be enough to cover the basic research already being conducted, but is not enough money to engage in multiple co-current field tests nor does it leave money to be specifically devoted to international and industry projects.

4.2 Advisory Committee Activities

There are three advisory committees that provide services to government methane hydrate research. These are, The Methane Hydrates Advisory Committee (MHAC), which was established by the MHR&D Act of 2000 to assist the development of recommendations and broad programmatic priorities for methane hydrate R&D, the Interagency Coordination Committee (ICC), and the Technical Coordination Team (TCT), which were both established by the MHAC. Panel members are chosen by the Secretary of Energy and represent methane hydrate expertise in industry, academia, oceanographic institutions, state agencies, and environmental organizations. The MHAC has provided the US Methane Hydrate Research Program with research direction and has addressed the concerns of many groups through their publications. Some of these publications include, the 2006 Interagency Research Roadmap that addresses the energy and production potential of domestic methane hydrates.¹⁸

4.3 Government Agency Research

There are three main areas of federal research in methane hydrate that are all long term and/or high risk projects. First, the government is interested in the role of hydrates in the environment, second, the economic significance of methane hydrates, and, third, international methane hydrate R&D.¹⁹ Government agencies involved and interested in methane hydrate research include the Department of Energy (DOE), which supports methane hydrate research through two organizations, The National Energy Technology Lab and The Office of Fossil Energy, the United States Geological Survey (USGS), the Bureau of Land Management (BLM), the Mineral Management Services (MMS), The National Science Foundation (NSF), the Naval Research Lab (NRL), and the National Oceanic and Atmospheric Administration (NOAA). Some agencies have programs solely dedicated to methane hydrate research while others include their research about methane hydrates under other research directives. Oversight and organization from the Methane Hydrate Research Advisory Committee (MHRAC) and the Interagency Coordination Committee (ICC) aim to minimize overlap between the research goals of different government agencies.

The DOE research goals are based on the 2002 MHAC Report to Congress and are summarized in Text Box 2. Significant

international and industrial projects, or “targeted research” projects, in which the DOE has been involved include The Mallik expedition, The HOT ICE Project with Anadarko, The BP-DOE ANS project, and The ChevronPhillips-DOE JIP. Government research agencies also support methane hydrate research, through means other than just research, like public education and dissemination of data and results via the internet. Government websites and publication/reporting of research are excellent ways to inform the public about methane hydrates and to highlight government research successes and successful industry-government projects. One publication that achieves this goal is the Office of Fossil Energy in the DOE Fire in the Ice (FITI) Newsletter.

Text Box 2: DOE Methane Hydrate Research Goals

- A better characterization of the chemical and physical properties of hydrates,
- The development of technology needed to achieve a more complete survey of hydrate distribution,
- An improved understanding of how to mitigate the hazards that hydrates pose to ongoing deep-water oil and gas drilling and production,
- An improved understanding of how hydrates interact with the natural environment, including any links to issues of seafloor stability and global climate,
- An improved understanding of biological communities dependent upon hydrate occurrences and how to protect them,
- The development of improved tools for studying hydrates in both the lab and the field, and
- An appraisal of technologies for the safe and commercial production of methane from hydrates and industry resources to enable cost-efficient R&D in the field.

4.4 Independent Organizations: Committee Reviews and Professional Societies

The National Research Council (NRC) published a report in 2004, "Charting the Future of Methane Hydrate Research in the United States", that evaluated the effectiveness of the DOE Methane Hydrate Research Program. This report was intended to be used for the 2004 consideration for reauthorization of the 2000 Methane Hydrate Research Act. In this report the following conclusions were made.

When progress towards the goals set by the Methane Hydrate Research and Development Act of 2000 were evaluated, it was found that the DOE has funded and made progress in the fields of research goals A, B, F, and G. (See Text Box 1.) The NRC report found shortcomings in three areas that the DOE Methane Hydrate Research Program did not address: storage and transportation of methane from methane hydrates, education and training in the field of methane hydrates, and the environmental impacts of degassing and its impact on climate change. Also, though other government agencies have invested in drilling and sample collection, the DOE has fallen behind in this area.

The NRC also cited significant accomplishments made in international collaborative projects like the Mallik 2002 Production Research Well Program and ODP Leg 204. These projects are considered to be significant successes because the program made significant achievements with relatively small funds. "These projects [international projects] represent significant achievements with relatively small investment... the DOE Methane Hydrate R&D Program is currently not funded at a level sufficient to allow a major role in large-scale international research efforts, such as proposed for continuing studies at Mallik." The NRC also suggested that in the future, "Where appropriate, the DOE Methane Hydrate R&D Program should be encouraged to lead such endeavors." It was noted, however, that funds to do this were not available.

Over 60 percent of planned DOE Methane Hydrate R&D Program funding through 2005 was associated with targeted (industry) research projects. These partnerships provided opportunities for great achievements, but the NRC cited difficulties meeting project deadlines and objectives due to project assessment and evaluation processes that were unsuited to recognize and evaluate progress of the program. Science-based evaluation criteria were considered the most rigorous evaluation method. Also, results of these projects have not been made publicly available. The NRC recommendations included implementing science-based proposal review, science-based assessments of project progress and milestones, expert consultation with a diverse project team, data made publicly available, and peer-reviewed publication of results.

The NRC was very positive when evaluating the USGS field and laboratory efforts in methane hydrate research. The contributions to the geological occurrence of hydrate deposits that have been essential for many DOE primary and targeted research projects contributed to this positive review.

Smaller-scale projects, which include seafloor observation in the GOM, university-based studies, and laboratory issues, like international collaborative projects, had much success considering the amount of funding available. They, however, also encountered problems associated with transparency issues. The NRC thus suggested the construction of an internet site, updated annually, to display research projects and develop clear and strict guidelines for publication requirements and deadlines.

Overall, the NPC suggested that, “The overriding focus of the DOE Methane Hydrate R&D Program in the future should be on the potential importance of hydrate as a future energy resource for the nation and the world.” Industry can provide significant help in meeting many of the overall program recommendations that the NRC set. (Text Box 3)

Other industrial and professional societies that take an interest in methane hydrates include the American Petroleum Institute (API), the American Chemical Society (ACS), and the American Institute of Chemical Engineers (AIChE). The API “...recognizes the potential for hydrates to provide answers to both transport and storage of natural gas.”²⁰ AIChE and ACS support the National Research Council’s specific suggestions to direct government research as stated in their report, “Energy and Transportation: Challenges for the Chemical Science in the 21st Century”. In addition to policy recommendations for university, private sector, and Federal laboratory research, energy efficiency and conservation, industrial innovation, tax incentives, and regulatory change, AIChE and ACS support, “technologies for improved use of conventional fossil fuels and unconventional sources such as oil shale, tar sands, and deep-sea methane hydrates.”²¹ Groups like these find themselves in a special position where they have both technical expertise to make policy recommendations and the freedom to lobby government officials. Government research groups, like those in the NOAA or the DOE, do not have this privilege and can only hope to influence policy through recommendations made to the Secretary of Energy or through invited testimonials to Congress.

4.5 Summary

The current research environment for government methane hydrate research is a supportive one. Congress has passed legislation that has created infrastructure, provided basic support for the research programs in that infrastructure, and encouraged industry to invest in production of natural gas in areas that contain methane hydrate. Use of earmarks has been avoided to grant researchers freedom to determine necessary research, but it may also be detrimental to the program for specific research goals and deliverables to Congress are not identified. Independent reviews of the research done by government agencies has also had a major part in influencing the research objectives set by the Methane Hydrate Advisory Committee and the Technical Coordination Team for the government methane hydrate research agencies. Though research goals have been able to evolve and address a well-rounded group of subjects relating to methane hydrates, from technical to environmental

questions, funding has not increased to support a research program with such a broad spectrum of goals. Thus, as it has been one of the most influential groups in affecting methane hydrate research, Congress has a unique opportunity to address this funding gap by approaching the problem from two sides. It can first increase funding to bring the funding to levels appropriate for the research goals and timelines the government wishes to undertake, and, second, it may optimize the benefit received from the funding invested in the program by making the funding regular and reliable so that industry will partner with government. When industry and other groups partner with government, as the NRC stated, great benefit is achieved, especially when compared to the initial investment made.

Methane hydrate research has no voice that may be an advocate for it. The review committees are meant to be impartial and the advisory committees may not directly address or lobby Congress. Since methane hydrates are not proven to be able to be commercially produced, not even industry has an interest in lobbying Congress for additional funding. All that is left is the lone voice of the professional societies and interest groups. Because of this, Congress must take their role in the success of the US Methane Hydrate Research Program very seriously and support, with legislation that grants appropriate funding, the research done by government agencies.

The Solution

“Government should make targeted investments in demonstration projects bridging development and commercialization – particularly those involving high-potential, yet high-risk, technologies. The market place could not support these projects without such a demonstration. Government should explore and support new R&D consortia and public/private partnership models (with appropriate cost sharing, tax benefits, and intellectual property protections) to foster R&D on targeted and market-relevant energy technologies.”

*- AIChE Policy Recommendations
“Science and Technology to Meet Our Energy Needs”*

5.0 Policy Options

Though infrastructure, guidance, and funding have been given to the Methane Hydrate Research and Development program, more is needed and Congress must be the one to provide the support. This section reviews the funding methods and legislation of past oil and gas research programs that have seen success and that are policy options to address the barriers to methane hydrate goal realization. Based on the findings from the research conducted for this policy paper, recommendations are based on the past success of research program organization and the political feasibility of implementing the needed legislation. As stated previously, the focus of Congressional legislation should be to increase appropriate funding, encourage industry-government collaboration, and to promote the goal of assessing the energy potential and production viability of methane hydrate deposits.

5.1 Increased Funding: Increased Appropriations, and Tax Incentives

Funding must be increased so that the US may adopt a more aggressive R&D schedule and to entice industry to participate in R&D. Funding, to accelerate the R&D schedule, may simply be done by increasing the amount of funds that are appropriated annually to the Methane Hydrate Research and Development Program. No new legislation would be required as the amount being appropriated is less than the value that was authorized through the Methane Hydrate Research and Development Act.

Table 2 shows the discrepancy that exists between the authorized funding levels for the program and the appropriated values. Even if higher amounts of funding are appropriated and the agencies don't spend it all, provisions in the MHR&D Act provide to funds to carry over to the next fiscal year. This would

also increase the flexibility the program would have to engage in data and wells of opportunity programs that are of high research value.

Table 1: DOE methane hydrate research program funding. Dollar amounts are in millions of dollars. ²²²³

Year	2001	2001	2002	2003	2004	2005	2006	2007	2008	2009
Authorization	7.5	11	12	12	12	12	15	20	30	40
Appropriation	n/a	9.9	9.9	9.6	9.4	9.4	11.9	-	-	-

Tax incentives are another way to increase dedicated funds. They do not directly give money to a project, but they decrease the project costs. As investment sizes decrease, the risk to the company investing in the project decreases, and the more they may be willing to invest. This was the case for coalbed methane, which was an unheard of resource 20 years ago, but now makes up about 20% of our domestic natural gas production. Methane hydrate and coalbed methane have many commonalities. The role the DOE played in the development of coalbed methane technology was indispensable as they provided a foundation that included assessing the resource, identifying geologic areas of favorable productions known as “sweet spots”, establishing efficient recovery schemes, demonstrating advanced drilling and completions technologies, and supporting capture and use of diluted natural gas streams. A great deal of the work done by the USGS included the development of assessment tools and continuously improving play assessments. The Internal Revenue Code Section 29 provided the initial production incentive by offering tax credit for the sale of CBM from wells drilled between 1980 and 1992. Currently, the NETL is performing research on water management issues associated with CBM recovery, CO₂ sequestration, and enhanced gas recovery, but no longer does fundamental research with CBM because it is considered a economically viable source of energy and therefore is of interest to industry.²⁴

The US Government commonly funds and subsidizes programs that have the potential for great public benefit though sustainable development, environmental protection, climate change mitigation, poverty reduction, etc. The 1993 President’s Climate Change Action Plan encouraged coal mines to recover and use methane from the coalbeds and provides financial incentives for doing so because of the environmental benefits, since, as with methane hydrate research, securing funding is a critical barrier to the development of coal mine methane (CMM) projects.

Though methane hydrate research does have a potential to improve climate conditions through research projects like the CO₂ sequestration program, it does not have the same environmental benefit as a program like CMM recovery projects that directly decrease greenhouse gas emissions. Though part of the carbon cycle, methane hydrates do not contribute significantly to normal emissions (though there is potential for a significant release of methane from a marine landslide or human activity). Thus, someone investing in methane hydrates would be unlikely to receive environmental incentives. A methane hydrate demonstration project or commercial production address none of these concerns, and thus, would not receive such funding. This make funds secured

through appropriations critical as the funding base for methane hydrate is not very diverse.

5.2 Regular Funding: Multi-Year Appropriations and Planning Ahead

A multi-year appropriation (MYA) is a fixed value appropriation for a specific purpose that can be used beyond one fiscal year (normally 3-5 years). Benefits associated with MYAs include decreased administrative costs, greater flexibility in conducting research, ability to budget for the long term, ability to commit to long-term projects, and increased partner confidence. MYAs are not commonly used because Congress asserts its power through the annual appropriations process. Also, the uncertainty of annual budget estimates can be large, so the potential for uncertainty in multi-year budget estimates may be even greater.

Industry requires solid commitment from all partners to decrease uncertainty in the project especially when they participate in projects with government agencies conducting high-risk, long-term projects. Multi-year appropriations address the concerns associated with project funding uncertainty, but there is much political debate associated with the subject and can sometimes be a political non-starter.

The most recent example of a program that uses this type of funding is the Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum R&D Program (H.R.6 2005 EPACT, Subtitle J, Section 999A). This program has two avenues through which it receives funds: through mandated funds that are independent of the appropriation process (\$50M per year that is collected from oil and gas royalty funds for 10 years) and through authorized funds (up to \$100M per year for 10 years). In time, the program is expected to pay for itself in the increased number of oil and gas royalties.²⁵

Funds are deposited in a separate account by the Secretary of Energy, and are managed by The Research Partnership to Secure Energy for America (RPSEA) consortium, a 501(c)(3) not-for-profit organization. Excess funds that are not expended in a fiscal year are allowed to remain in the account until they are spent. The consortium was founded in January of 2002 by five universities and now includes 20 universities, including MIT, Stanford, and The University of Kansas, industry, national labs, and not-for-profit organizations like the Gas Technology Institute and the Houston Advanced Research Center. The consortium manages and awards funds to research programs in academia and academia-industry joint projects across the nation. Applications are submitted to an external bi-partisan science-based peer-review process. Thus, a constant level of reliable funding that is removed from political influence has been created. Criticisms of this project have included those that state that the program hands out subsidies to Big Oil and fund research that is not high risk enough. In fact, programs such as this level the oil and gas R&D field so that many providers, small and large alike, have an equal opportunity to perform research. Industry is expected to provide up to 40 percent of the project costs in all projects. Political opposition to this type of project remains and therefore it take a considerable

effort to pass through Congress. The legislation for the Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum R&D Program was sponsored by Senate Majority Leader, Trent Lott. In the remarks of the honorable Gale Norton, Secretary of the Interior, at the July 2003 Natural Gas Roundtable stated, "We prefer the spirit of partnership over the power of pressure. Working together we can provide the natural gas America needs."²⁶ Though it is not specifically referring to the new consortium, it does display the need and desire of government to entice industry for a common benefit.

6.0 Recommendations

Based upon the assumption that government-industry partnerships are very beneficial for scientific research and the advancement of science and technology development, the following recommendations encourage formation of such partnerships. These recommendations are based on interviews with people in the methane hydrate field in both government and industry, on academic reviews, and other successful programs like the CBM research projects. Though the US government has performed excellent methane hydrate R&D over the past 10 years, the US government must do at least three things before the viability of domestic methane hydrate as an energy resource for the future is known.

1. **Funding Magnitude:** Congress must appropriate funds to the Methane Hydrate Research Program that are at least equal to the value authorized by the Energy Policy Act of 2005.
2. **Funding Consistency:** Multiple year appropriations are politically unfeasible. Therefore should use an advanced appropriation process to fund the Methane Hydrate Research Program. This would allow research programs to more accurately plan future research and still allow Congress to maintain power through annual appropriations.
3. **Research Focus:** Congress must amend Section 928 of the 2005 Energy Policy Act to include an initiative to authorize funds to be directly allocated to a the USGS, the BLM, and the MMS for assessment of domestic methane hydrate reserves.

6.1 Increased Congressional Appropriations for the DOE Methane Hydrate Research Program

None of these policy recommendations can be achieved without more funding. These programs should at least be receiving the amount of that was authorized, but in order to be competitive with India and Japan the government must increase the funding to the program. Current government incentives include royalty relief to produce from methane from methane hydrates and from its associated conventional reserves. Since industry does not view methane

hydrates as commercially viable, the true effectiveness of such an incentive is hard to predict. It is difficult to apply royalty forgiveness when the resource market price is unknown, but it has been successful with programs like the CMB research project. This cut off price, however, has not been established. "It will be difficult to get industry involvement, until there is a production test. Acceleration of production tests could lead to a paradigm shift in gas hydrates development."²⁷

6.2 Advanced Annual Congressional Appropriations

Funding uncertainty is unappealing to industry. Funding will be more consistent if supplied/allocated by organizations independent of political influence. In addition to the fact that the government agencies cannot afford some projects with decreased funding, there is also a "confidence" problem that arises from late and decreased funding. "...uncertainty of funding for the program leads to delays in program action or short time requirements for solicitations, proposals, etc."²⁸

Many industry-government research projects last years. Partners, especially the government, involved in the research projects must be dedicated for the long term and provide consistent amounts of significant funding. The government has difficulties achieving this goal because of the vulnerability of research programs to annual appropriations. "[appropriations are] a complex process that can not be thought of as in corporate terms, where issues can be prioritized."²⁹

6.3 The Domestic Energy Assessment Initiative: An Amendment

In the 2006 MHAC Meeting, it was recommended that funding for international research should be broken out from the rest of the budget. This may also be done for funds meant for conference scheduling or industry partnership, but it was the opinion of the committee that government earmarking of appropriations is bad and counter to a good research plan. The government methane hydrate research community must be "coordinated and clear" when communicating specific research challenges and goals with the American public and the Federal government. It was suggested in the 2006 MHAC, that, "...one way to accelerate development is to create a challenge and make it available to all." This solidarity and organization may be provided through a legislative initiative to promote the realization of the energy supply and production potential of methane hydrates that is accompanied with additional funding. With this improved communication, it may be easier to take advantage of opportunities like "wells-of-opportunity", which were identified by the MHAC as "potential low-cost, short timeframe opportunities to collect data and information." "Wells-of-opportunity" are events where an agency has the opportunity to do unplanned field research. For example, a company may be drilling a new well and an agreement may be made where they allow government researchers to come on the platform and gather information and perform experiments, or the NOAA might

extend a planned ocean cruise to allow another government agency to use their equipment and perform additional experiments.³⁰

7.0 Conclusions

Industry will be a key component in the realization of energy resource and production potential, and it is the role of the government to support and nurture its relationships with industry. Though there is not a consensus on the viability of methane hydrates as an energy resource, its potential is very high. The potential benefits, energy security, advancements in CO₂ sequestration, increased use of a clean burning fuel, among many others, will only be realized if there is a significant paradigm shift. There is risk, but through collaborative research these risks can be mitigated to benefit US citizens, their pocketbooks, and the environment. Current support does exist, but not at the levels required to make the US a leader in global methane hydrate research. As support and funding slowly fades, the date for benefit realization also fades into the distance.

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⁴ U.S. Department of Energy. National Energy Technology Laboratory. 2006. *The National Methane Hydrates R&D Program: All About Hydrates*. Washington, D.C.: National Energy Technology Laboratory.

⁵ US Department of Energy. *Notes of the 2006 Methane Hydrate Advisory Committee Meeting*. http://www.fe.doe.gov/programs/oilgas/hydrates/Methane_Hydrates_Advisory_Committee.html. Visted 06/11/06.

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⁹ Edison Electric Institute. *Fuel Diversity*. http://www.eei.org/industry_issues/energy_infrastructure/fuel_diversity/index.htm. Visited 07/10/06

¹⁰ US Environmental Protection Agency. *Electricity from Natural Gas*. 19 July 2006. <http://www.epa.gov/cleanrgy/natgas.htm> Visited 07/20/06.

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¹² National Energy Technology Laboratory (DOE). *The National Methane Hydrates R&D Program: All About Hydrates*. <http://www.netl.doe.gov/technologies/oil-gas/FutureSupply/MethaneHydrates/about-hydrates/hydrateResearch.htm> Visted: 06/15/06

¹³ H.R.1753, "An act to provide the research, identification, assessment, exploration and development of methane hydrate resources, and for other purposes". <http://thomas.loc.gov/cgi-bin/bdquery/z?d106:HR01753:@@L&summ2=m&>. Visited 06/20/06.

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- ¹⁴ H.R.1753, United States Congress. “Methane Hydrate Research and Development Act of 2000”. Jan 24, 2000.
- ¹⁵ H.R.1753, United States Congress. “Methane Hydrate Research and Development Act of 2000”. Jan 24, 2000.
- ¹⁶ Alexander Introduces Natural Gas Legislation “Bold and Aggressive steps” to lower record high gas prices. Senator Lamar Alexander Homepage.
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