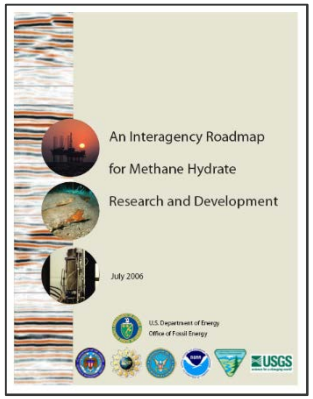
GH R&D in Alaska

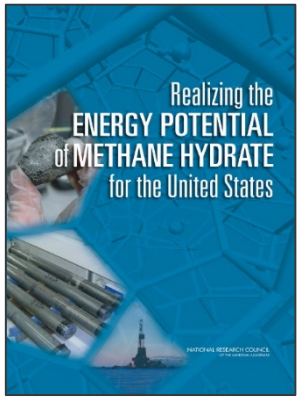
MHFAC Meeting, March 2, 2018

Doe-BPXA-USGS Mt Elbert Test Site, Milne Point Unit, 2007. Photo by R. Boswell

Alaska Testing: A Long-standing Priority

Internal, Interagency, External Oversight, Congressional, Programmatic





The Methane Hydrate Advisory Committee

Advisory Committee to The Secretary of Energy

May 21, 2014

The Honorable Ernest J. Moniz
Secretary of Energy
1000 Independence Avenue, SW
Washington, D.C. 20585

Dear Mr. Secretary:

The Methane Hydrate Advisory Committee (MHAC) is composed of international experts in methane hydrate research from academia and industry. Our charge is to provide you with guidance to sustain and improve the Methane Hydrates R&D Program in the U.S. Recent advancements have identified ways of exploring for and producing from high concentration methane hydrate deposits. Our primary priority must now be to demonstrate, through a long term production test, the technical feasibility of producing methane hydrates.

We recommend the following focused 10-year investment.

1) **Perform a production test on land in the Arctic within 4 years.** The State of Alaska has temporarily set aside unleased onshore state lands just north of the Prudhoe Bay Unit for a potential methane hydrate te… a long term methane hydrate…

Department of Energy
Washington, DC 20585
December 21, 2016

Ms. Janet Weiss
Regional President
BP Exploration (Alaska) Inc.
900 E. Benson Blvd.
Anchorage, Alaska 99508

RE: Gas Hydrate Research and Production Testing on the Alaska North Slope

Dear Ms. Weiss:

I would like to express my appreciation for the sharing of proprietary data that BP Exploration (Alaska) (BPXA) and the other Prudhoe Bay Unit (PBU) working interest owners agreed to this past June. This has allowed the Department of Energy (DOE), U.S. Geological Survey (USGS) and industry partner Japan Oil, Gas, and Metals National Corporation (JOGMEC) to prepare a conceptual draft work plan for gas hydrate production testing within the PBU.

The DOE, USGS, and BPXA have a long history of collaboration in the evaluation of gas hydrate resources in Alaska. An extended-duration scientific production test is warranted to better understand the nature of gas hydrate resources. Toward this end, DOE has entered into separate Memoranda of Understanding with the Alaska DNR and with JOGMEC to evaluate opportunities for conducting such a test. A conceptual draft work plan has been developed which indicates that the optimal place to conduct the desired gas hydrate field testing is most likely within the west end of the Prudhoe Bay Unit. Specifically, we have identified the gravel pad known as the Kuparuk State 7-11-12 pad. We believe this location offers the best potential balance of access to infrastructure and minimized impact on ongoing unit operations. Our plan includes an initial stratigraphic test well (with conventional logging program only), followed, if successful, by a production test well, scientific coring programs, and installation of one or more close-offset monitoring wells.

A long-term production test is necessary to advance the scientific understanding of gas hydrates as they …that their resource potential can be fully understood. DOE fully supports this plan …fully requests that BPXA (as Operator of the PBU) and the other PBU working …ve full consideration to the plan as briefly discussed herein. If you would like to …please feel free to contact me at 202-586-6660.

Sincerely,

Christopher A. Smith
Assistant Secretary
Office of Fossil Energy

STATE OF ALASKA

SARAH PALIN, GOVERNOR

550 WEST 7TH AVENUE, SUITE 1400
ANCHORAGE, ALASKA 99501-3650
PHONE: (907) 269-8431
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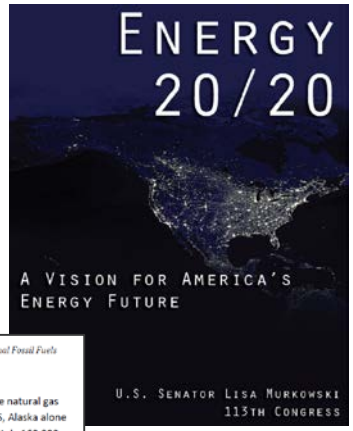
DEPARTMENT OF NATURAL RESOURCES
OFFICE OF THE COMMISSIONER

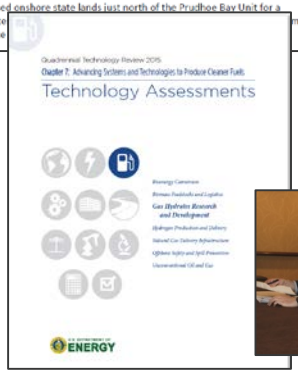
January 30, 2009

Dr. Ray Boswell
Manager, Gas Hydrates R&D Programs
U.S. Department of Energy, National Energy Technology Laboratory
3610 Collins Ferry Road
Morgantown, WV 26507

Dear Dr. Boswell:

The State of Alaska Department of Natural Resources would like to confirm our commitment and show our support for the important leadership role the federal government is providing concerning permafrost related gas hydrates research on the North Slope of Alaska. This work, led by the U.S. Department of Energy (DOE) and the U.S. Geological Survey (USGS) in collaboration with numerous universities and industry partners, is some of the most critical energy-related research being undertaken around the globe. If viable development and production scenarios for gas





Producing More — Unconventional Fossil Fuels

METHANE HYDRATES AND OTHER UNCONVENTIONAL GAS RESOURCES

The U.S. contains an estimated 200,000 trillion cubic feet (TCF) of methane hydrates – methane natural gas locked in solid, ice-like structures, underground or under the sea floor.[36] According to the USGS, Alaska alone contains between 560 and 600 trillion cubic feet of methane hydrate onshore[37] and approximately 160,000 TCF offshore.[38] Once safely unlocked, Alaska's methane hydrate resources could power America for nearly 1,000 years at current rates of gas consumption, according to the Alaska Division of Geological and Geophysical Surveys (ADGGS).[39] Important steps we need to take to access these resources include:

- Expedite research on methane hydrate well flows to prove that methane will continue to "flow" to the surface after drilling efforts. Increase funding for environmental reviews of the effects of liberating methane hydrates, the resulting land impacts, and for research already underway by the DOE National Energy Technology Laboratory (NETL).

Memorandum of Understanding
Alaska Department of Natural Resources
and
U.S. Department of Energy, Office of Fossil Energy
Energy Research, Methane Hydrates, and Other Unconventional Resources in Alaska

A Memorandum of Understanding (MOU) between the Alaska Department of Natural Resources (Alaska DNR) and the United States Department of Energy, Office of Fossil Energy, (DOE/FE) regarding energy development and unconventional resource research and demonstration in Alaska's Arctic.

Whereas, Alaska DNR's mission is to responsibly develop Alaska's resources by making them available for maximum use and benefit consistent with the public interest.

Whereas, DOE/FE is responsible for managing the Department of Energy's fossil energy research and development programs and advising the Secretary of Energy on all matters related to our nation's fossil energy resources, including research and demonstration of methane hydrates, viscous oil, and other potential unconventional resources.

http://www.jogmec.go.jp/english/news/release/news_10_000039.html

Prior Alaska Field Programs

Conducted in Partnership with Industry and Academia

"Mt. Elbert" (2007) with BP Exploration Alaska, Inc

- Safe/efficient scientific field program within industry operations area

"Iġnik Sikumi" (2011-2012) with ConocoPhillips and JOGMEC

- Short term (days) field test of CO_2 injection
- Mechanical stability through standard engineering controls.
- Demonstration of the issues that attend any well shut-in.
- Flow assurance/wellbore maintenance through chemical intervention
- Confirmation of the superiority of depressurization

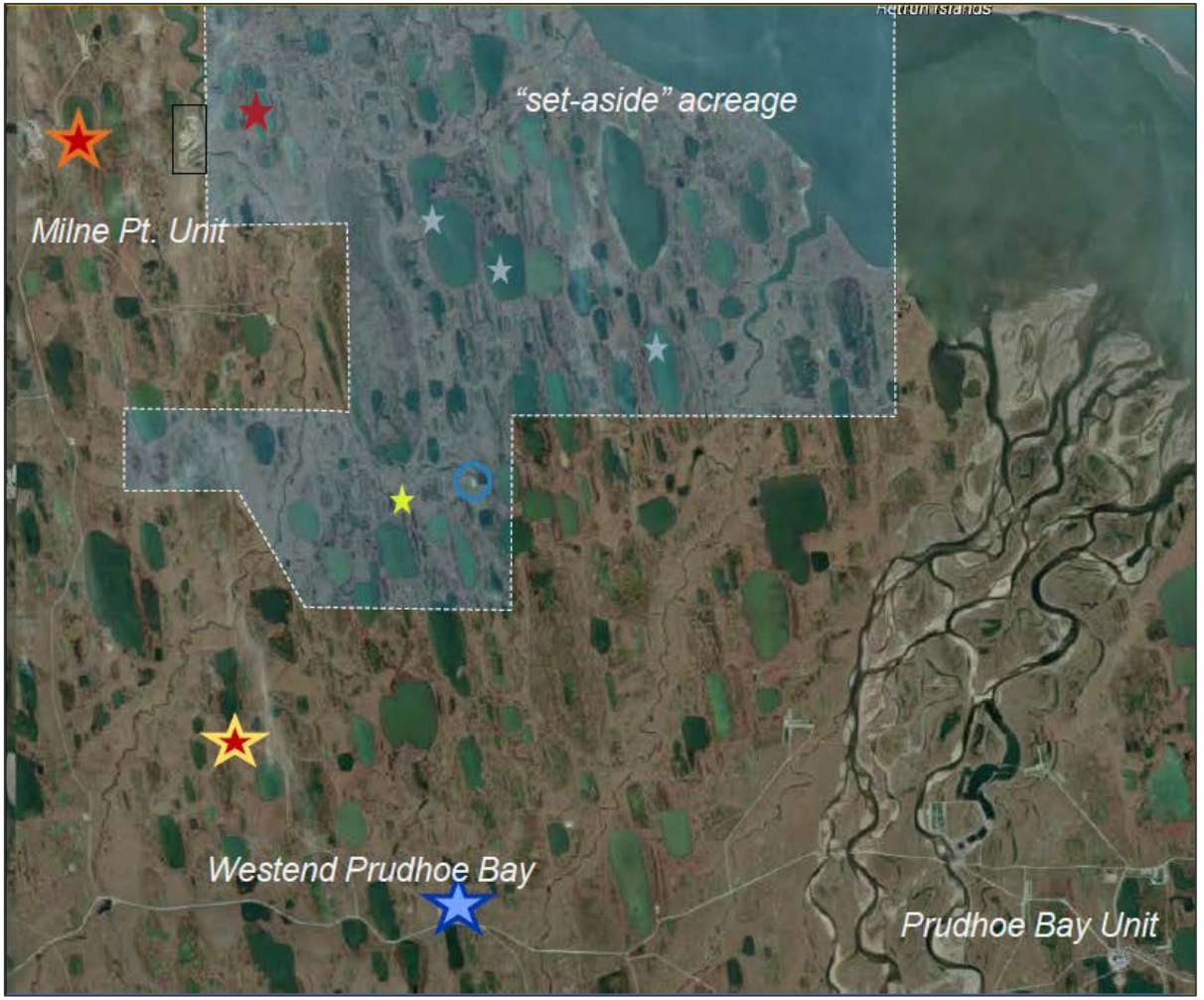
2013: DOE/AK MoU:

- AK sets aside unleased land to allow their evaluation as sites for GH R&D

Review of Sites on Unleased Land

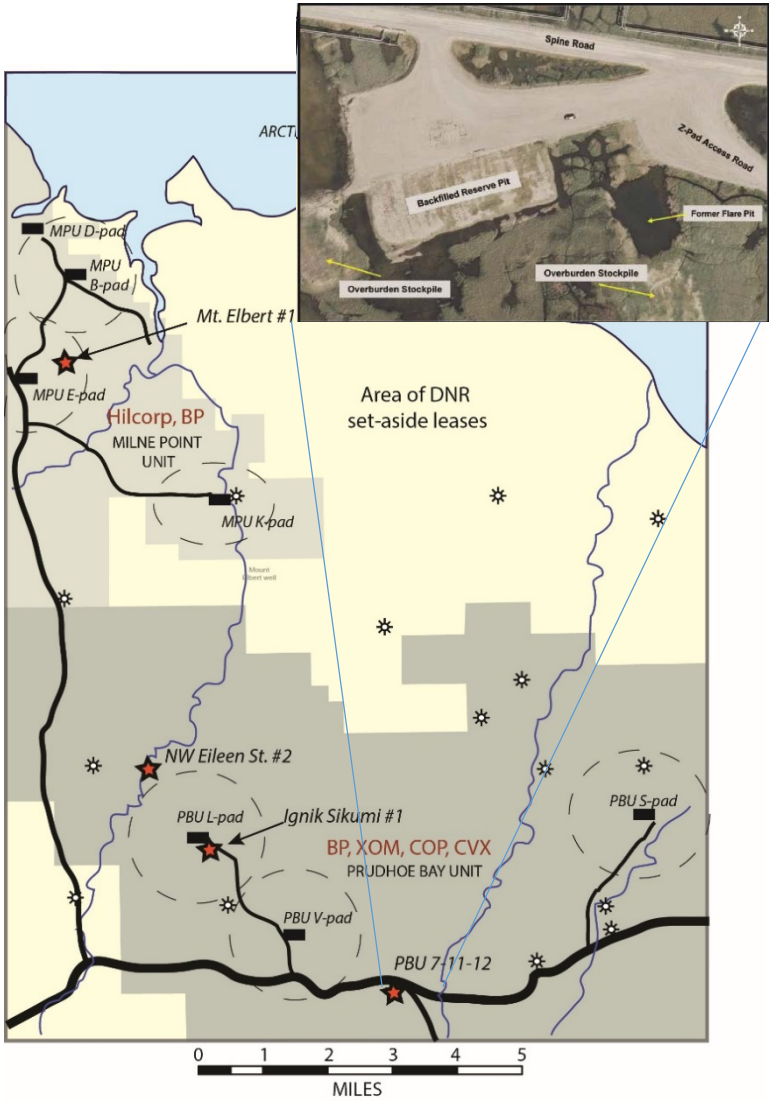
Potential Recognized, but....

- **Remote:** High logistics cost (roads, pads)
- **Remote:** High operational risk (lack of infrastructure)
- **Unleased:** Uncertain regulatory environment.
- **Undrilled**: High geologic risk; (limited indications of GH and free gas)
- Who would operate?



Where We Are

- Evaluation indicates high costs and elevated operational and geological risks for operations outside established infrastructure.
- DNR/DOE re-engage the PBU companies. WIOs approve our review of proprietary data for a site in the Westend PBU.
- 2015: AK DNR conducts scoping studies to refine list of greater PBU test site opportunities.
- 2015: A three-well science plan is drafted featuring a field program designed to maximize science and minimize impact on existing operations.



Consensus Production Test Concept

The Test:

- Focus on depressurization
- Focus on Science not Rate Demonstration (Scale to commercial applications)
- Flow assurance - ability to maintain wellbore during likely interruptions
- Sand control
- Robust downhole equipment; Minimize risks; Use proven oilfield tech where possible.
- P/T monitoring and DTS; offset monitoring wells
- Progressive well stimulation available – thermal, mechanical, chemical
- Operational plan flexibility – ability to "listen to" and respond appropriately to reservoir

The Site:

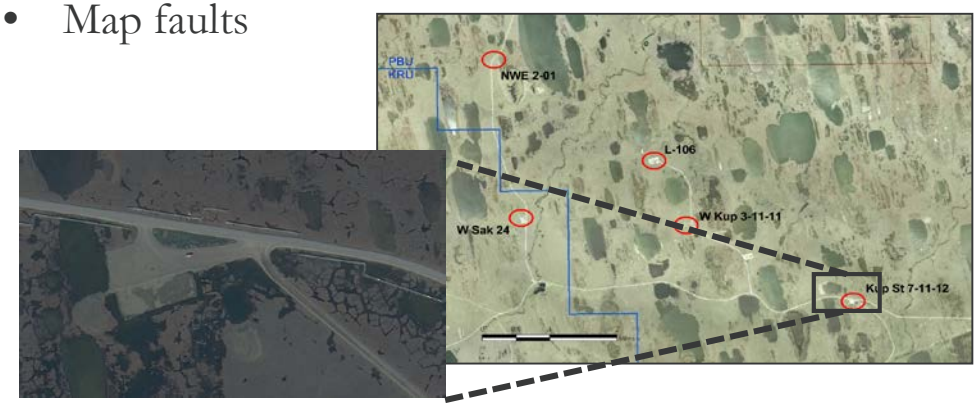
- Geologically well-characterized (complimented as needed by project strat/sci test wells)
- Hydraulic isolation (away from sources of free gas or water)
- Sufficient reservoir temperature (at least 5C) and intrinsic reservoir quality
- Multiple reservoir zones – operational risk mitigation and expanded science options
- Well location that allows continual operations of 6 mo (minimum); optimally18-24 mo.
- Location that minimizes interference with ongoing operations
- Non-disruptive gas/water handling
- Minimal complexity – avoid use of unproven technologies

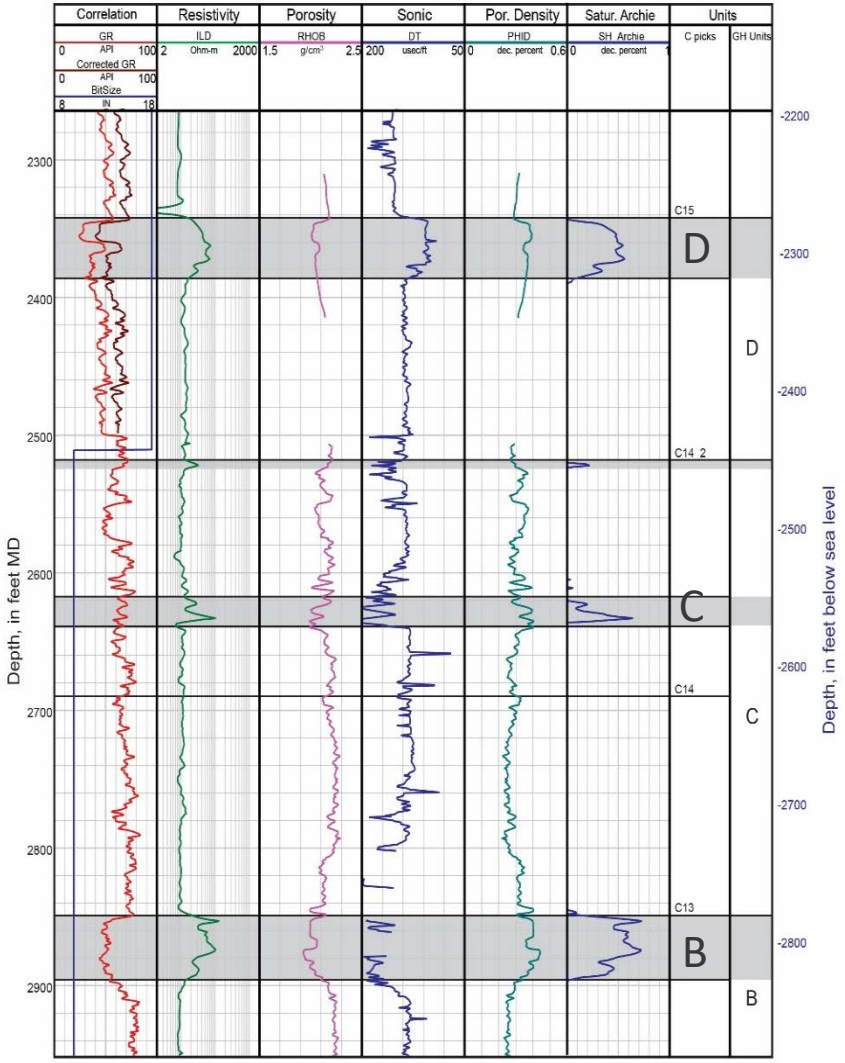
7-11-12 site meets these criteria: Ongoing G&G review to confirm

Kuparuk 7-11-12 Well Site (PBU)

Confirmed GH in D sand. Limited GH in C sand. Uncertain GH in B sand.

- Two exploration wells from pad: One log suite
- D-sand low geologic risk
- C-sand: limited charge.
- B-sand: HC-charge but poor log quality
- Drilling-disturbed at time of logging
- B-sand is predicted to occur 100'+ above BGHS
- Slight well deviation: BHL away from old boreholes
- Assess potential for nearby free-gas or water
- Map faults

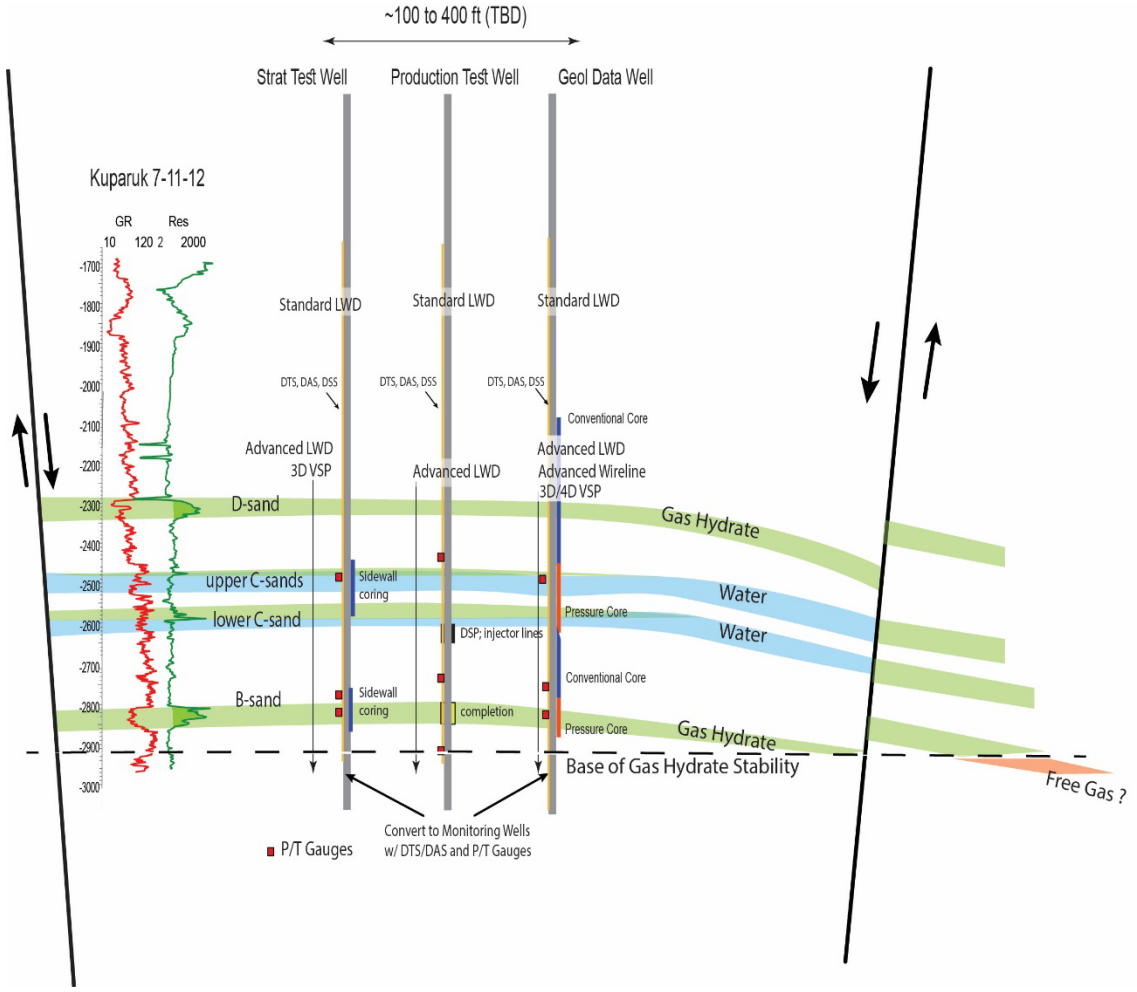




Seismic Data Review (2016)

Enabled by AK DNR and PBU WIOs

- Preferred BHL identified.
- Geologic risk in B-sand reduced but not eliminated.
- Prospectivity of D-unit confirmed.
- Three-Well/Two Phase Program developed
- Phase 1: Conduct stratigraphic test → complete as monitoring well
- Phase 2: Establish facilities; drill and instrument science well; drill, complete and conduct test in production test well.

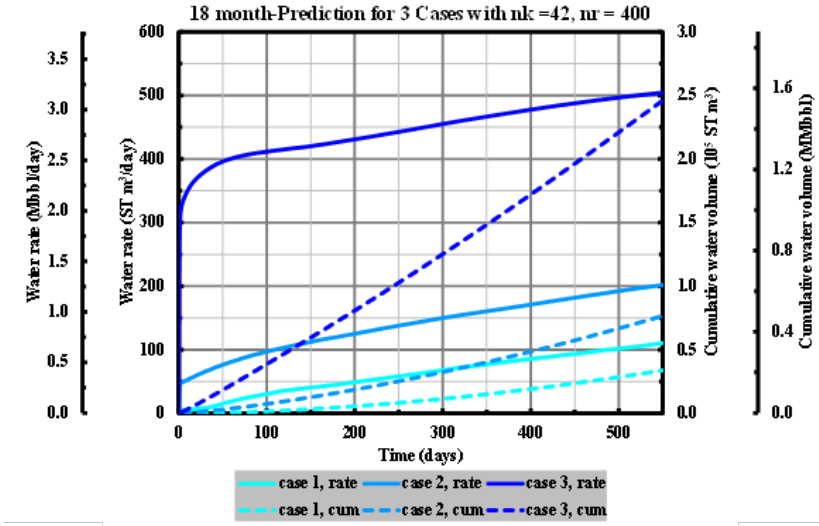


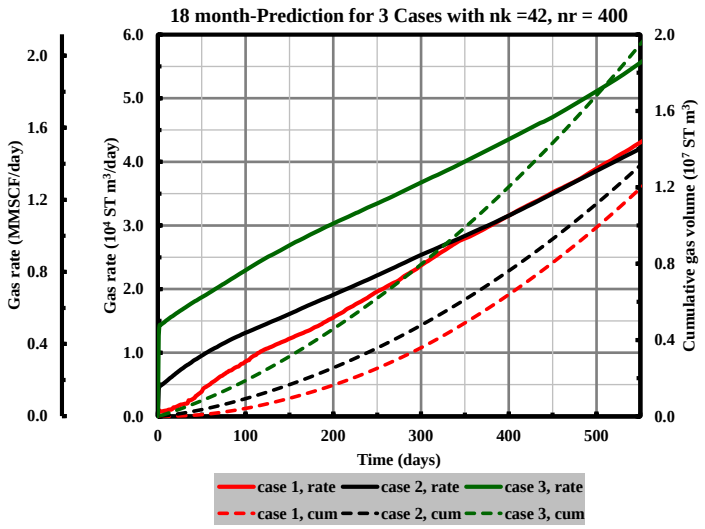
Reservoir Modeling

NETL, USGS, and JOGMEC collaborative effort

- Working to compare and reconcile model ing results
- Multiple scenarios to accommodate data uncertainties
- Range of rates for gas and water needed developed to guide facilities planning
- Modeling also supporting well test alignment and spacing

						3 cases				
Top (ft)	H (ft)	Por	Sgh	Swfree	Swirr	Kinit	Kinit	Kinit	Kintr	N
2782	2	0.37	0.75	0.10	0.15	0.10	1.00	10.00	400.00	
2784	2	0.40	0.80	0.08	0.12	0.10	1.00	10.00	500.00	
2786	2	0.40	0.80	0.08	0.12	0.10	1.00	10.00	500.00	
2788	2	0.40	0.65	0.12	0.23	0.10	1.00	10.00	300.00	
2790	2	0.40	0.65	0.15	0.20	0.10	1.00	10.00	300.00	
2792	2	0.40	0.80	0.12	0.08	0.10	1.00	10.00	500.00	
2794	2	0.40	0.75	0.10	0.15	0.10	1.00	10.00	400.00	
2796	2	0.40	0.80	0.09	0.11	0.10	1.00	10.00	500.00	
2798	2	0.39	0.75	0.10	0.15	0.10	1.00	10.00	400.00	
2800	2	0.38	0.80	0.09	0.11	0.10	1.00	10.00	500.00	
2802	2	0.38	0.85	0.08	0.07	0.10	1.00	10.00	700.00	
2804	2	0.39	0.85	0.08	0.07	0.10	1.00	10.00	700.00	
2806	2	0.42	0.85	0.08	0.07	0.10	1.00	10.00	700.00	
2808	2	0.42	0.80	0.09	0.11	0.10	1.00	10.00	500.00	
2810	2	0.41	0.75	0.12	0.13	0.10	1.00	10.00	400.00	
2812	2	0.41	0.60	0.12	0.28	0.10	1.00	10.00	200.00	
2814	2	0.40	0.55	0.14	0.31	0.10	1.00	10.00	100.00	
2816	2	0.39	0.55	0.14	0.31	0.10	1.00	10.00	100.00	
2818	2	0.30	0.70	0.12	0.18	0.10	1.00	10.00	400.00	
2820	2	0.39	0.80	0.11	0.09	0.10	1.00	10.00	500.00	
2822	2	0.38	0.70	0.12	0.18	0.10	1.00	10.00	400.00	
2824	2	0.38	0.55	0.11	0.34	0.10	1.00	10.00	100.00	





Technology Evaluation

Robust, Proven, State-of-art for Well Sampling, Completion, and Monitoring

- Mud-chiller
- MOBM
- Sidewall pressure coring
- Whole core pressure coring
- Pressure core analyses (onsite and lab-based)
- Full suite LWD and wireline logs
- Sand control completion
- Fiber-optic Strain Monitoring
- Fiber-optic Temperature Monitor
- Pressure monitoring (cables and/or gauges)
- Monitoring inside and outside casing
- Artificial Lift (ESP, Jet-pumps, TBD)
- VSP (potentially)

Examples of tools under consideration

Planned Stratigraphic Test Well

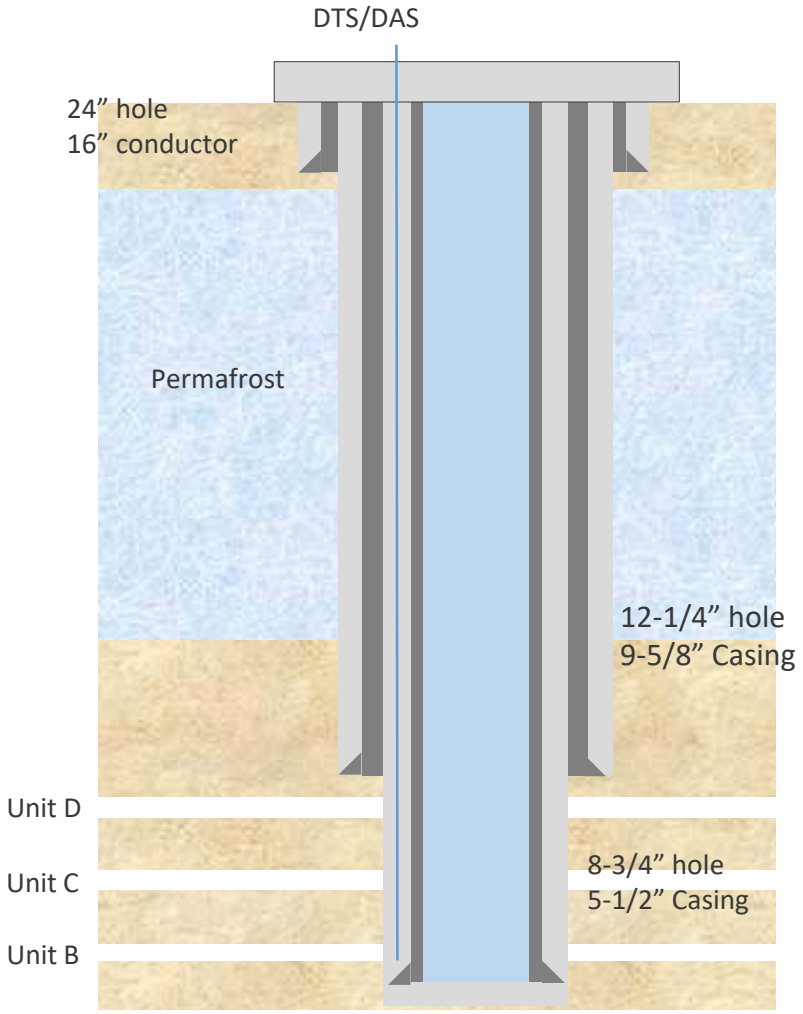
Simplest design desired. Expected Cost $10 to $15 million

Purpose

- Confirm state of GH at site
- Allow selection of test zone and finalization of science well and production well completion design
- Goal is fully saturated GH in B sand
- Fall-back is fully-saturated D sand: D sand test may require change in design.

Design

- Slightly deviated, potential S-shape
- Drill to above D-sand with LWD
- Set Surface casing
- Drill with Chilled Oil-based Mud with LWD to TD
- Wireline Log
- Sample: Likely 20-30 samples throughout interval
- 5 1/2" casing cemented to TD with DTS/DAS



Planned Geo-Data Well

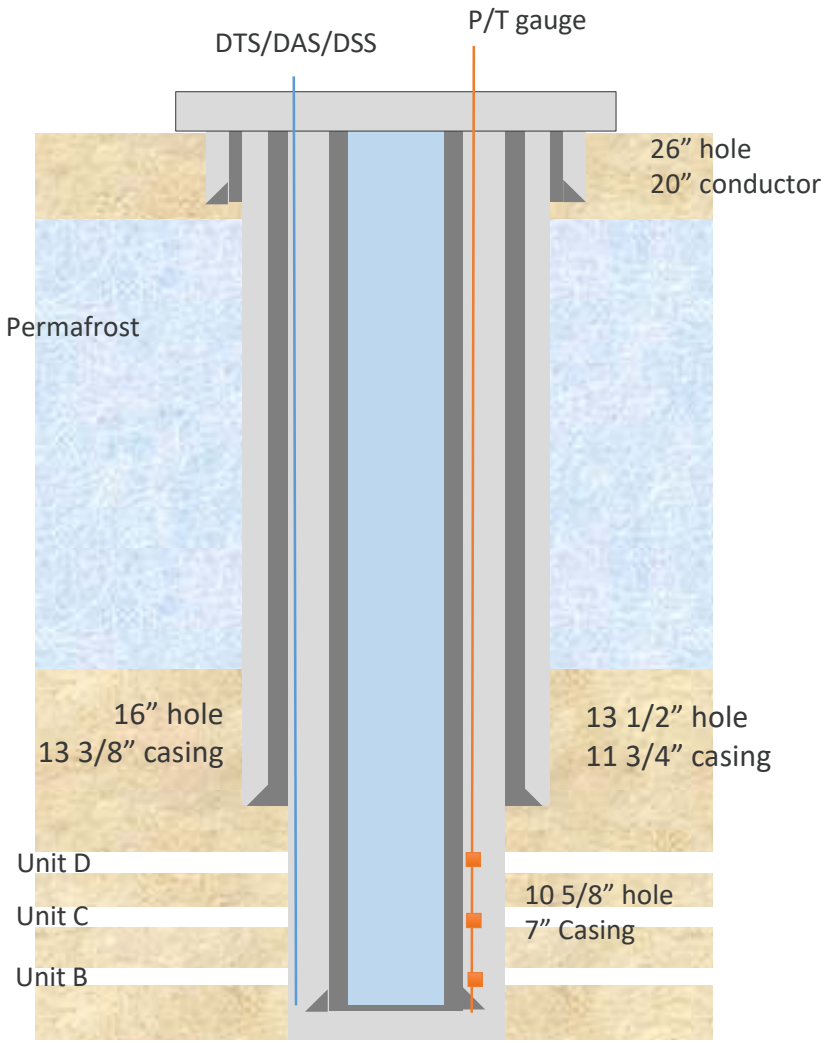
Offset from Stratigraphic well approximately 80 m

Purpose

- Acquire all geologic / engineering / petrophysical data needed to characterize the test reservoir and effectively interpret test results

Design

- Similar to Strat Test well but likely with bigger tubulars to enable deployment of pressure corer
- Acquire conventional core below surface casing with deployment of pressure core in reservoirs and seals
- DTS/DAS/DSS outside casing" 3 P/T gauges per zone
- Final hole/casing sizes depends on selection of coring device
- Most reliable PC device will be utilized



Planned Production Test Well

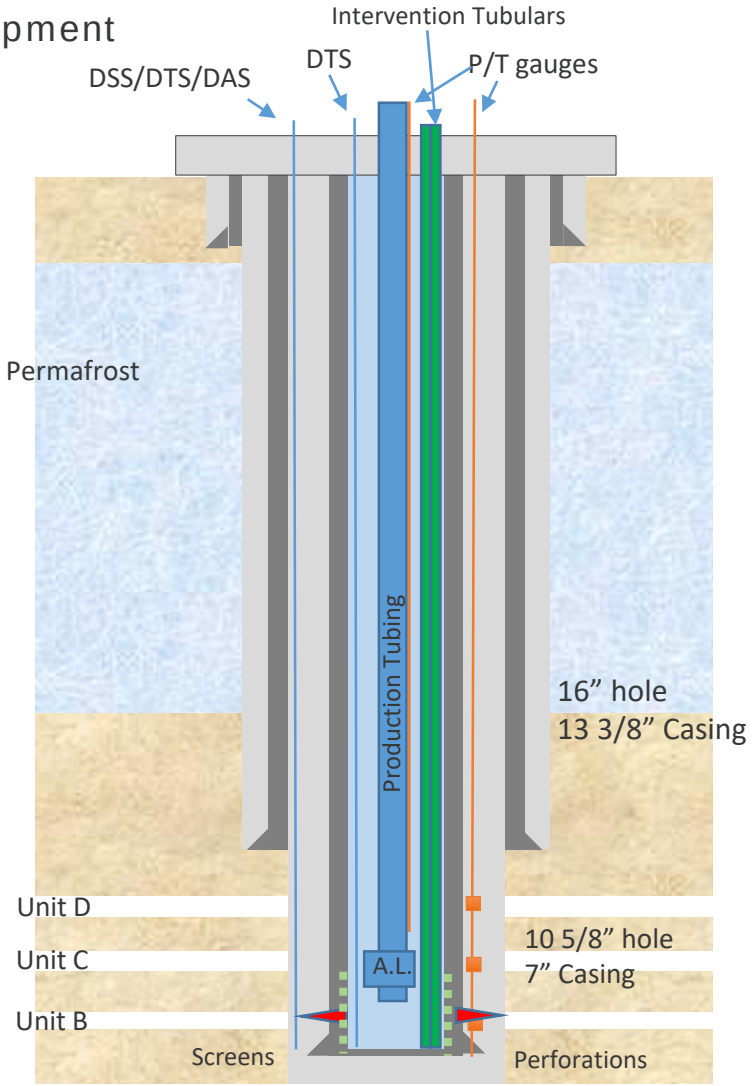
Located between two monitoring wells: design in development

Purpose

- Completed for Production and Monitoring over extended period: artificial lift
- Surface Facilities for Measurement of Gas, Water Sediment Volumes and Analysis of Samples
- Well intervention pre-positioned
- Sand Control completion

Design

- Similar drilling design
- Tubulars set for most effective artificial lift and to accommodate ESP etc.
- Cased and Perforated; but other completions designs may be selected
- Perforation delayed 2 mo. to allow reservoir and monitoring well T equilibration



Project Structure

3rd Party and Standalone

"3rd Party"

- Operator may not be a PBU partner
- Operations would benefit from PBU operator experience and insight
- Operations would not be strictly tied to PBU approval processes.

"Standalone"

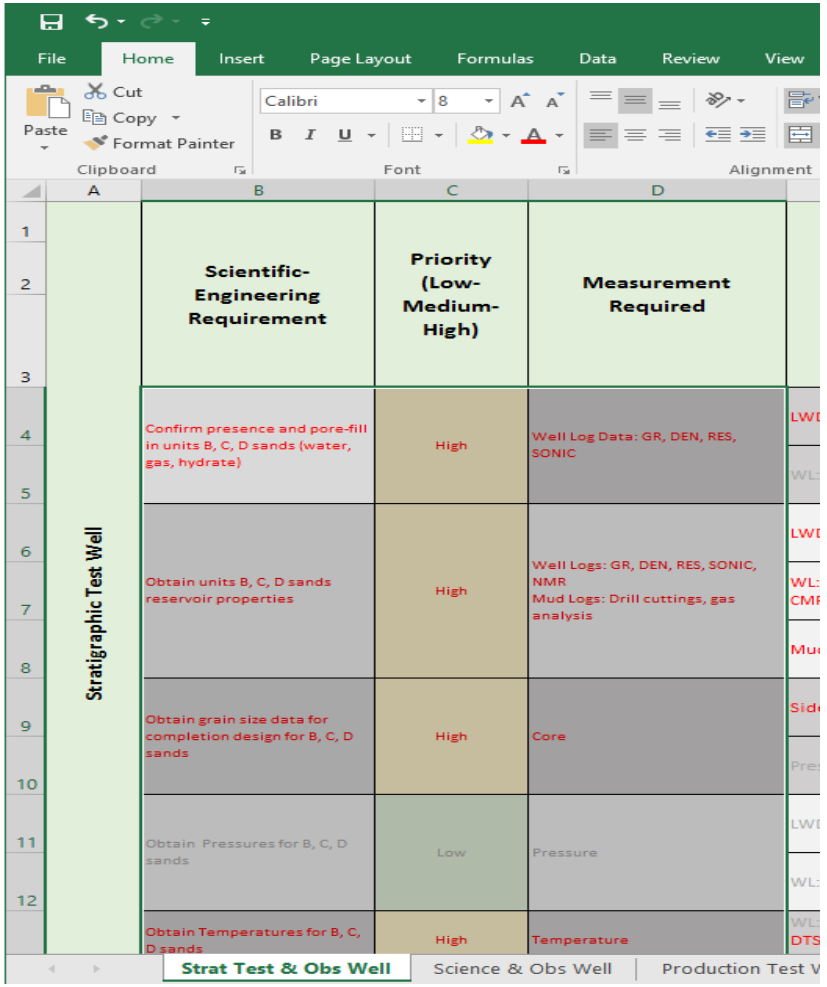
- Operations may not impact PBU operations
- Operations will benefit from existing gravel pad, roads, emergency facilities, solids and liquids disposal facilities, etc…
- Operations should not back oil out of PBU gathering lines – therefore a self-contained gas handling and disposal system
  - Options including flaring (air impact issues); local consumption
  - Would isolate the project from upsets within the PBU gathering system

Working Group Meeting: Denver

Last Week: 25 Attendees: 16 from Japan: 9 from the US

Topics

- Share information on relevant recent field program insights
- Approve the Data Acquisition (Log/Core/Monitoring) Plan
- Discuss the Strat Test Well "Success" Criteria
- Discuss potential well Testing plans, Potential Failure Modes and Mitigations



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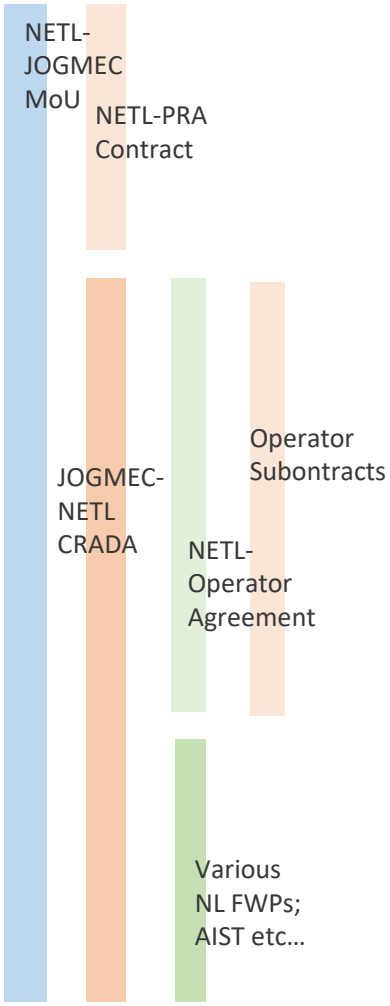
	A	B	C	D
1				
2		Scientific-Engineering Requirement	Priority (Low-Medium-High)	Measurement Required
3				
4	Stratigraphic Test Well	Confirm presence and pore-fill in units B, C, D sands (water, gas, hydrate)	High	Well Log Data: GR, DEN, RES, SONIC
5				
6		Obtain units B, C, D sands reservoir properties	High	Well Logs: GR, DEN, RES, SONIC, NMR Mud Logs: Drill cuttings, gas analysis
7				
8				
9		Obtain grain size data for completion design for B, C, D sands	High	Core
10				
11		Obtain Pressures for B, C, D sands	Low	Pressure
12				
		Obtain Temperatures for B, C, D sands	High	Temperature

Strat Test & Obs Well | Science & Obs Well | Production Test W

Nominal "Project" Structure

To achieve long-term gas hydrate test in partnership with PBU partners



Phase A: Plan Definitization

- Resolve Operator/Liabilities
- Detail the costs and logistics for the plan.
- Submit plan through PBU operator to PBU working interest owners.

Phase B: Stratigraphic Test well

- Confirm occurrence of viable test reservoirs and collect any data essential for planning further wells.

Phase C: Reservoir Testing

- Establish monitoring systems (surface, instrumented monitoring wells)
- Drill Geodata well, Test well, Conduct test.
- Site Abandonment (full compliance with all regulations)

Phase D: Data Evaluation

- Studies of log, core, monitoring, and production test data to be conducted by JOGMEC, NETL, and other collaborating organizations as selected and funded by NETL and JOGMEC.

Technical Coordination Team

Participants: DOE, NETL, USGS, NOAA, NSF, NRL

DOE could review policies that…

- limit select activities under funded work (ex. marine seismic).
- require cost share for clearly pre-commercial R&D.
- restrict select groups from leading projects proposed under FOAs.
- often require quarterly progress reporting.

Issues external to DOE…

- Regulatory agencies should develop protocols to ensure that inquiries submitted prior to and during permit application are addressed in a timely manner.
- Regulatory agencies should clarify or develop tailored permitting protocols for research activities

Technical Coordination Team

R&D Priorities

- Do we recommend extending the DOE effort to assess/constrain US resource potential beyond the ANS and the GOM? If so, what is the next priority basin?

YES. The Atlantic Margin – given its large resource potential, existing data gaps, opportunities for integrated basic science across the full range of gas hydrate geologic systems, and emerging potential for industry leasing and data acquisition

- Do we see continued value in international collaboration and what sort of collaborations should we seek?

YES. All opportunities to leverage collaboration to advance science opportunities and tool testing-development provide great value to the US program.

- Do we see continued value in the pursuit of projects related to gas hydrate feedbacks to near term environmental change or GH's role in long-term carbon cycling?

YES. With specific focus on assessment of the nature and evolution of geologic systems in regions of gas hydrate resource potential. ***Establishment of environmental baseline conditions in such areas may also be valuable in assessing and mitigating impacts of future development.***

DOE can report that specific focus on near-term feedbacks to changing environmental conditions has approached a consensus determination and that program element can be "off-ramped.

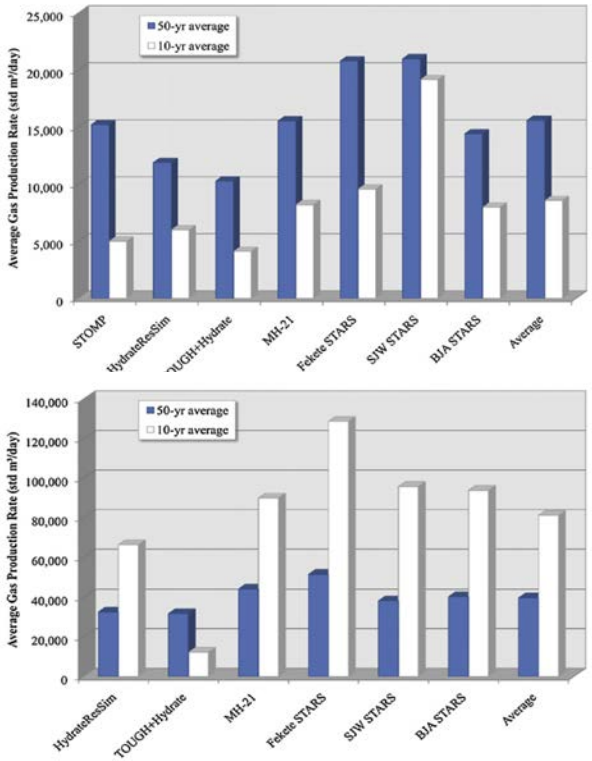
Int'l Gas Hydrate Code Comparison

2005-2011: Thermodynamics and hydraulics (US, Japan, Canada)

- Wilder et al., 2008 (ICGH-6): Anderson et al., 2011 (J. Mar Pet Geol 28)

2017- : Integration of geomechanics (US, Japan, Korea, China, Germany, UK)

2017- : Collaborative Modeling with Japan and for key sites in India



Thank You